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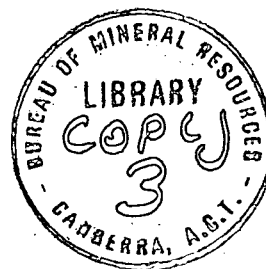
Record 1974/141

PERMIAN AND LATE CARBONIFEROUS PALYNOSTRATIGRAPHY
OF THE GALILEE BASIN, QUEENSLAND

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by

M. Norvick



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SUMMARY

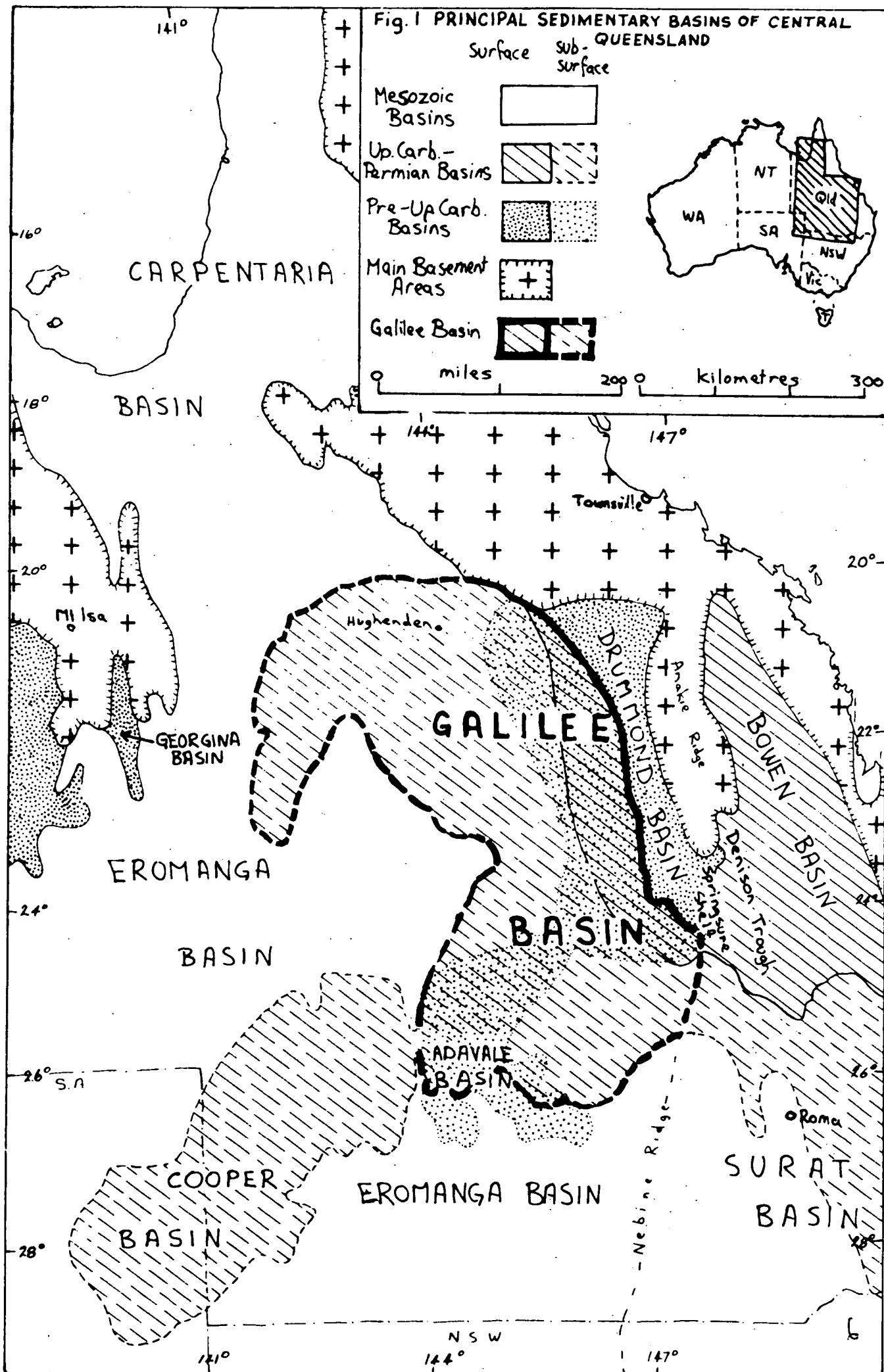
Palynological information from the Upper Carboniferous and Permian of 42 petroleum exploration well sections and two outcrop sections in the Galilee Basin, central Queensland, is compiled and re-evaluated. These data are used firstly to test and refine the eastern Australian Late Palaeozoic spore-pollen stage zonation of Evans (1967a, 1969), and secondly to show the broad geological evolution of the basin.

The stratigraphic ranges of selected spore-pollen species and species groups are used to define a sequence of nine Late Carboniferous and Permian palynologic intervals, with wide application in eastern Australia. The relationship between these stages and existing zonations is discussed.

In the Galilee Basin, Late Carboniferous stage 1 is represented by a thick, glaciogenic, coarse clastic sequence. Early Permian stage 2 comprises coarse clastics, passing up into a possibly glaciogenic fine clastic unit. Coal measure sedimentation began in Early Permian stage 3, possibly indicating warmer climatic conditions. A basinwide hiatus removed all of stage 4 and the lower part of stage 5. Upper stage 5, of late Early to Late Permian age, saw the widespread development of coal measures. Uppermost Permian rocks have not yet been recorded. The Galilee Basin was outside the influence of the sea, except during upper stage 5, when short-lived marine incursions extended into its southeastern margin.

ACKNOWLEDGEMENTS

The writer would like to thank D. Burger, firstly for originally suggesting this topic, and secondly for his help and encouragement during the preparation of the manuscript. The basin stratigraphy set out in this paper was largely by the work of R.R. Vine, and the author is grateful for a number of very useful discussions and for permission to use his charts. Further guidance was freely provided by R.J. Paten and P.L. Price of Mines Administration Pty Ltd, Brisbane, and by R.J. Helby of New South Wales Geological Survey. Their advice and help are acknowledged. E.M. Kemp and G.E. Wilford kindly checked and critized the manuscript.



3. INTRODUCTION

Since the 1950s many wells have been drilled in Queensland by oil companies in the search for petroleum. One of their major targets was Permian strata, which were eventually shown to extend over large areas beneath the outcropping Mesozoic formations of the Eromanga and Surat Basins. Palynology has become a very valuable tool in helping to elucidate the stratigraphy of the Australian Permian, much of which is non-marine. Permian strata have proved to be oil and gas-bearing in several parts of Australia and fossil pollen and spores have been used extensively to provide stratigraphic control for oil company drilling operations. However, while much information has been gathered in recent years, very little has been published. Much information is contained in reports by oil companies and by government agencies, most of which are relatively inaccessible to the general public. The rapid development and refinement of a palynological zonation, applicable to all of the Australian Permian, has emphasized the need for compiling this unpublished information. For these reasons a start is made here with a regional palynological synthesis of the Permian and Upper Carboniferous of the Galilee Basin in central Queensland.

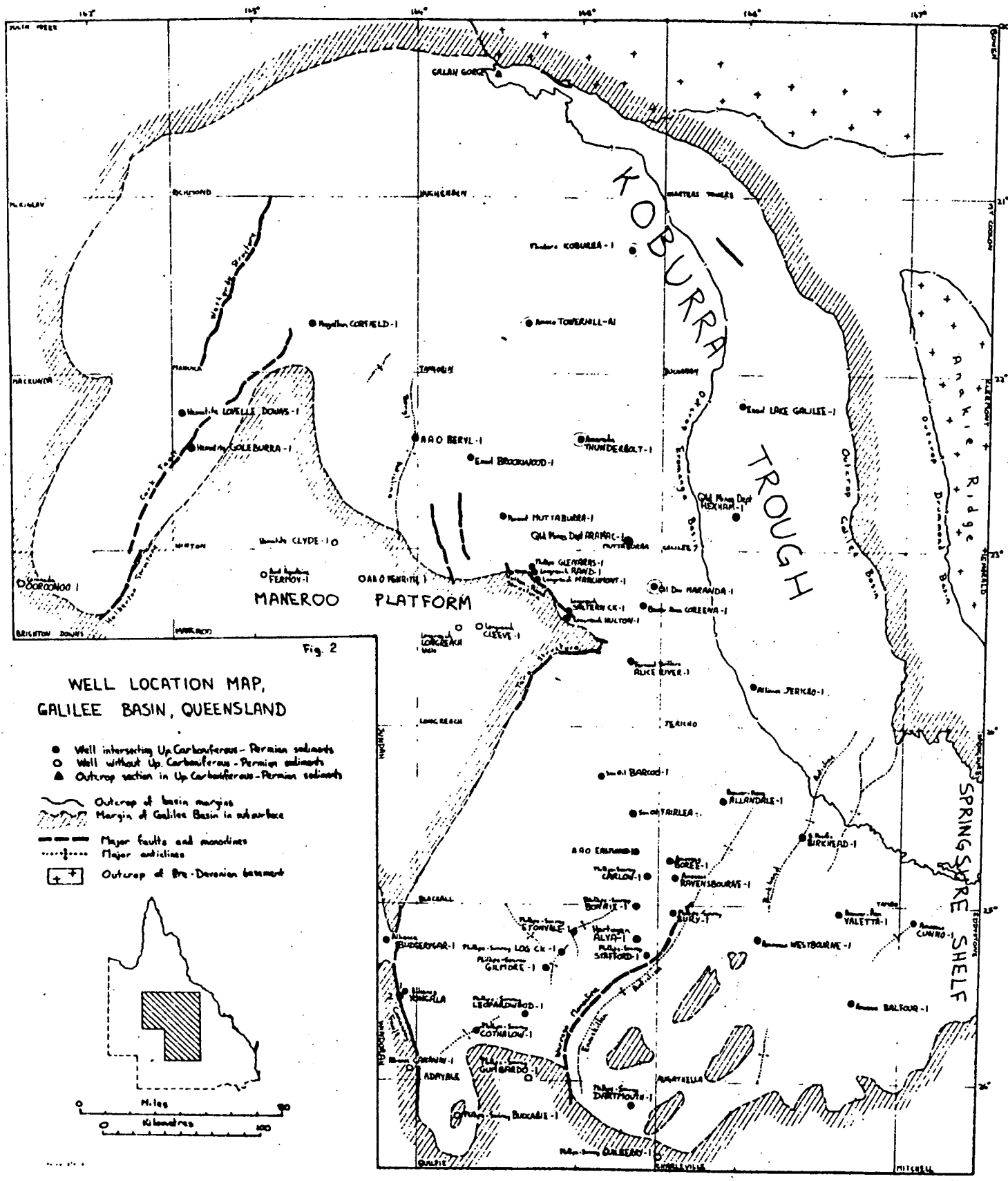
Two main topics are covered by this paper. Firstly, the various palynological zonal schemes of the Australian Upper Carboniferous and Permian are reviewed. The most widely applicable zonation is described and its constituent units are defined using the ranges of selected palynomorph species. Secondly, this zonation is applied to the stratigraphy of the Galilee Basin. All the available palynological data are compiled and are incorporated with the lithostratigraphy of the area. From this, the geological history of the basin is broadly outlined.

The Galilee Basin underlies 230 000 km² and contains an Upper Carboniferous to Upper Triassic sedimentary sequence (Allen, 1973, 1974). It is concealed, except along its eastern and northern margins, by the Jurassic to Cretaceous strata of the Eromanga Basin (Fig. 1). The Galilee Basin partly overlies two older, Devonian to Carboniferous, infrabasins: the Drummond in the northeast, and the Adavale in the south. Only the Upper Carboniferous and Permian parts of the Galilee Basin are dealt with in this report. The Triassic strata contain quite different spore-pollen assemblages and are not considered here.

Most of the stratigraphic and palynological information on the Galilee Basin comes from petroleum exploration wells. Forty-two subsidized wells,

TABLE 1 : SUMMARY OF WELL DATA

Well Name	Company	Reference	Latitude	Longitude	Sheet	Total Depth Metres	Feet	Kelly Bushing Metres	Feet	Ground Level Metres	Feet	Palynology Reference	Page
Alice River No.1.	Farmout Drillers	Hare & Associates, 1963	23°37'08"	145°19'15"	Longreach	1631	5352	269	882	265	868	Hodgson (in w.c.r.), Evans, 1964c, 1966a.	
Allandale No.1.	Beaver - Pexa	Leslie, 1971	24°25'00"	145°54'15"	Tambo	3004	9856	379	1244	375	1229	Price (in w.c.r.)	
Balfour No.1.	Amoseas	Gerrard, 1966a, 1968b	25°32'13"	146°42'40"	Augathella	1695	5560	454	1491	451	1479	Drugg, De Jersey, Playford, Evans (all in w.c.r.)	
Barcoo No.1.	Sun Oil	Garrett & Petersen, 1962b	24°17'09"	145°08'18"	Blackall	1716	5631	253	829	248	815	Kemp, Paten, (both in w.c.r.)	
Beryl No.1	Assoc. Aust. Oilfields	Wines Admin., 1964	22°22'08"	143°58'26"	Winton	1266	4154	269	882	265	871	Evans (in w.c.r.)	
Birkhead No.1.	South Pacific	Grissett, 1957	24°36'34"	146°23'27"	Tambo	1580	5185	479	1570	474	1556	Evans, 1961b, 1962a, 1966a.	
Bonnie No.1.	Phillips-Sunray	Kyranis, 1966b	25°00'43"	145°22'01"	Adavale	2745	9005	320	1050	316	1036	De Jersey (in w.c.r.)	
Boree No.1.	Amoseas	Gerrard, 1964b	24°45'32"	145°34'36"	Tambo	2676	8781	338	1110	333	1094	Evans (in w.c.r.)	
Brookwood No.1.	Exoil	Pemberton, 1963	22°28'55"	144°19'58"	Muttaborra	1465	4806	227	746	224	735	Evans, De Jersey (both in w.c.r.), Evans, 1964c.	
Budgerygar No.1.	Alliance	Cadart, 1969	25°14'19"	143°48'28"	Windorah	1631	5350	189	621	184	605	Paten (in w.c.r.)	
Bury No.1.	Phillips-Sunray	Patterson, 1966	25°02'40"	145°36'20"	Augathella	2744	9004	333	1091	328	1077	Evans (in w.c.r.)	
Carlow No.1.	Phillips-Sunray	Kyranis, 1966a	24°50'27"	145°25'48"	Blackall	3666	12028	285	934	280	920	De Jersey, Evans (both in w.c.r.)	
Coreena No.1.	Beaver-Pexa	Leslie, 1970b	23°18'53"	145°23'19"	Longreach	1587	5208	254	833	250	820	Paten (in w.c.r.)	
Corfield No.1.	Magellan	Harris, 1960	21°42'46"	143°22'30"	Manuka	1374	4507	258	847	257	842	Evans, 1961a, 1962b.	
Cothalow No.1.	Phillips-Sunray	Lewis, 1961; Phillips Pet. Co. 1965	25°43'34"	144°23'22"	Adavale	2613	8573	245	805	241	791	None	
Cunno No.1.	Amoseas	Gerrard, 1966b	25°06'55"	147°04'34"	Eddystone	862	2828	558	1830	554	1818	Drugg (in w.c.r.)	
Dartmouth No.1.	Phillips-Sunray	Knuth, 1967	26°08'39"	145°20'34"	Quilpie	3051	10010	341	1118	336	1104	Evans, De Jersey (both in w.c.r.)	
Eastwood No.1.	Assoc. Aust. Oilfields	Wines Admin, 1970	26°46'23"	145°20'56"	Blackall	3385	11106	282	925	277	910	Paten (in w.c.r.)	
Etonvale No. 1.	Phillips-Sunray	Lewis & Kyranis, 1962	25°09'40"	144°59'40"	Adavale	3465	11368	334	1097	330	1083	Evans, De Jersey (both in w.c.r.)	
Fairlea No.1.	Sun Oil	Garrett & Petersen, 1968a.	24°29'50"	145°19'52"	Blackall	3120	10235	297	973	292	959	Paten (in w.c.r.)	
Galah Gorge, Section X16	outcrop	Vine et al., 1964	20°18'	144°30'	Hughenden							Evans, 1964a	
Galah Gorge, Section X23	outcrop	Vine et al., 1964	20°19'	144°28'	Hughenden							Evans, 1964a	
Gilmore No.1.	Phillips-Sunray	Lewis & Kyranis, 1965	25°21'33"	144°48'38"	Adavale	4346	14260	327	1072	322	1058	De Jersey (in w.c.r.)	
Glenaras No.1.	Phillips-Sunray	McDonagh, 1967	23°05'52"	144°43'23"	Longreach	1637	5371	239	784	235	772	Evans (in w.c.r.)	
Hulton No.1.	Longreach Oil	Mott & Associates, 1964a	23°23'25"	144°50'20"	Longreach	661	2169	235	772	231	759	Playford (in w.c.r.), Evans, 1964c	
Jericho No.1.	Alliance	Benedek, 1965	23°46'19"	146°05'01"	Jericho	2786	9142	396	1299	391	1282	Evans (in w.c.r.), Evans, 1966a.	
Koburra No.1.	Flinders	Pemberton & Brereton, 1970	21°17'48"	145°18'06"	Tangorin	3259	10693	375	1229	370	1215	Price (in w.c.r.)	
Lake Galilee No.1.	Exoil-Transoil	Pemberton, 1965	22°11'33"	145°58'32"	Galilee	3406	11175	294	964	289	947	Evans, Playford (in w.c.r.), Evans, 1966a.	
Leopardwood No. 1.	Phillips-Sunray	McDonagh, Knuth & Patterson, 1966	25°37'10"	144°40'13"	Adavale	4184	13727	291	954	287	940	De Jersey (in w.c.r.)	
Log Creek No.1.	Phillips-Sunray	Kyranis & McDonagh, 1966	25°15'56"	144°54'37"	Adavale	4440	14566	295	968	291	954	De Jersey (in w.c.r.)	
Lovelle Downs No.1.	Hematite	Watson, 1973	22°12'37.8"	142°33'05.8"	Winton	2028	6652	184	604	179	588	Price, Burger (in w.c.r.)	
Maranda No.1.	Oil Development	Le Blanc, 1963	23°12'14"	145°26'40"	Longreach	1978	6491	263	862	259	850	Evans, De Jersey (in w.c.r.) De Jersey et al., 1963, Evans, 1964c	
Marchmont No. 1.	Longreach Oil	Mott & Associates, 1964c	23°10'15"	144°44'21"	Longreach	1990	6530	230	755	226	740	Playford (in w.c.r.), Evans, 1964c.	
Muttaborra No.1.	Pursuit Oil	Meyers & Spencer, 1970	22°48'33"	144°31'35"	Muttaborra	1449	4753	215	705	211	693	None	
Rand No.1.	Longreach Oil	Harris, 1969	23°07'23"	144°43'06"	Longreach	1986	6516	236	774	232	760	None	
Ravensbourne No.1.	Amoseas	Sirovs, 1968	24°50'06"	145°37'08"	Tambo	2358	7736	343	1126	339	1113	Paten, De Jersey, (both in w.c.r.)	
Saltern Creek No.1.	Longreach Oil	Mott & Associates, 1964b	23°20'54"	144°56'24"	Longreach	1514	4966	234	768	230	753	Hodgson, Evans, Playford, (in w.c.r.), Evans, 1964c.	
Stafford No.1.	Phillips-Sunray	Hetzl, 1967	25°17'33"	145°26'03"	Adavale	3141	10306	357	1172	353	1158	De Jersey, Evans (in w.c.r.)	
Thunderbolt No.1.	Amerada	Amerada, 1967	22°22'02"	145°00'10"	Muttaborra	1611	5286	232	761	226	743	Evans (in w.c.r.), Norvick, 1971	
Towerhill No. A1	Amoco	Haworth, 1968	21°43'06"	144°40'50"	Tangorin	1489	4886	299	982	295	768	Burger, 1970	
Valetta No.1.	Beaver-Pexa	Leslie, 1970a	25°02'50"	146°36'00"	Augathella	1340	4396	548	1798	544	1785	Paten (in w.c.r.)	
Westbourne No. 1.	Amoseas	Gerrard, 1964a	25°11'27"	146°08'02"	Augathella	1483	4867	380	1247	375	1231	Evans (in w.c.r.), Evans, 1965a.	
Yongala No.1.	Alliance	Laing, 1966	25°30'19"	143°55'48"	Windorah	3105	10187	208	683	204	668	Evans (in w.c.r.), Evans, 1966d	
Yongala No.2.	Alliance	Laing, 1967	25°31'40"	143°53'33.5"	Windorah	2027	6650	237	779	233	764	None	



A preliminary broad stratigraphic reappraisal has recently been completed by Vine (in press) and more extensive studies are in progress at the Geological Survey of Queensland. The work of Vine forms the basis of the stratigraphic summary presented here. He was able to divide the Galilee Basin sequence into seven broad intervals, and to demonstrate the development of the basin using isopach maps of each unit. Of these, his four Upper Carboniferous and Permian intervals are recognized here with slight modification and are described below.

4. STRATIGRAPHY

Regional Geology

The Upper Carboniferous to Triassic Galilee is one of several Palaeozoic and Lower Mesozoic intracratonic basins, which mostly lie beneath the more widespread Eromanga Basin (Fig. 1). Two sets of Palaeozoic sedimentary basins are preserved in central Queensland; the Adavale and Drummond Basins are Devonian to Lower Carboniferous; the Bowen, Cooper, and Galilee Basins are Upper Carboniferous to Triassic. The Drummond Basin, which is separated from the Bowen Basin by a crystalline basement high (the Anakie Ridge) outcrops in the northeast and is probably connected in the subsurface with the coeval Adavale Basin. The Drummond Basin contains thick, mainly non-marine clastic sequences, with some volcanics and some evidence of marine incursion (Lindner, 1966; Durkee, 1965; Mollan et al., 1969; Vine et al., 1965; Olgers, 1972). In the Adavale Basin, Lower Devonian Gumbardo Volcanics, Lower to Upper Devonian carbonates, evaporites, and clastics (Etonvale Formation), and ? Lower Carboniferous red-beds (Buckabie Formation) are preserved in a series of deep, partly fault-bounded troughs (Heikkila, 1965; Durkee, 1965; Tanner, 1966; Slanis & Netzel, 1967). Natural gas has been discovered in potentially economic quantities in the Adavale Basin (Gilmore gas field).

Widespread orogenic movements followed by a period of erosion, occurred between the deposition of the Middle and the Upper Palaeozoic sedimentary successions. Sedimentation began in the Galilee and Cooper Basins in the Late Carboniferous, when non-marine coarse clastic sequences, at least partly of glacial origin, were laid down. By Early Permian time, deposition spread to the Bowen Basin. Up to the middle of the Permian, sedimentation was strongly influenced by cold climatic conditions, resulting in a mainly non-marine glacial or fluvioglacial sequence of sandstones, conglomerates and shales. During the Late Permian, the climate became warmer and clastics with prominent coal measures accumulated. The sea

extended periodically from the Bowen Basin onto the Springsure Shelf but rarely as far as the Cooper and Galilee Basins, where the Permian sequence is almost entirely non-marine. The climate changed from humid to arid at the beginning of the Triassic, and mainly non-marine clastic sediments, at least partly of the red-bed type, accumulated in all three basins. At the end of the Triassic, a second series of orogenic movements ended Galilee, Bowen and Cooper Basin sedimentation. At the beginning of the Jurassic, subsidence over a very large area marked the initiation of the Eromanga Basin in the west and the Surat Basin in the southeast.

Main Features of the Galilee Basin

The main structural features of the Galilee Basin, together with the locations of well sections, are shown on Figure 2. In general, Upper Carboniferous to Triassic strata are thick in the north and thin over a broad area in the south, where they partly overlie the Adavale Basin. Allen (1974) introduced the term Koburra Trough for the northeastern part of the Galilee Basin, which contains the thickest sedimentary sequences.

The northern and eastern margins of the basin are limited by outcrop. The Permian and Triassic is well exposed in the Hughenden Sheet area (Vine et al., 1964) but Cainozoic sand obscures much of the outcrop in the south, on the Buchanan, Galilee and the northern part of Jericho Sheet areas (Vine et al., 1965). The Permian and Triassic are exposed in the southern half of the Jericho Sheet area (Vine et al., 1965), and in Tambo (Exon & Kirkegaard, 1965; Exon et al., 1966, 1972) and Springsure Sheet areas (Mollan, 1967; Mollan, Exon & Kirkegaard, 1964; Mollan et al., 1969).

The western subsurface extent of the northern Galilee Basin is partly fault-bounded. Permian and Triassic strata are absent over the Maneroo Platform, where the Jurassic rests directly on possibly Lower Palaeozoic metamorphic or granitic basement (Evans, 1966c). Both the northern and the southern sides of the Maneroo Platform are partly fault-bounded; by the Hulton-Rand structure and the Tara structure respectively. Mott & Associates (1964 a, b, c) showed that the Hulton-Rand structure (they called it the Hulton-Rand monocline) effectively acted as the margin of the basin throughout much of the Permian. However, for a short time during the Late Permian a very thin section accumulated to the southwest, around Hulton no. 1 well. Both structures were intermittently active through the Mesozoic and are now discernible as a series of surface photogeologic trends (Vine et al., 1965). West of the Maneroo Platform, thick Permian sequences occur again in the subsurface lobe of the basin around Lovelle Downs no. 1 well. Faults limit at least part of the basin subcrop; the Holberton structure in the southwest and the Cork Fault and Wetherby structure farther north. The western side

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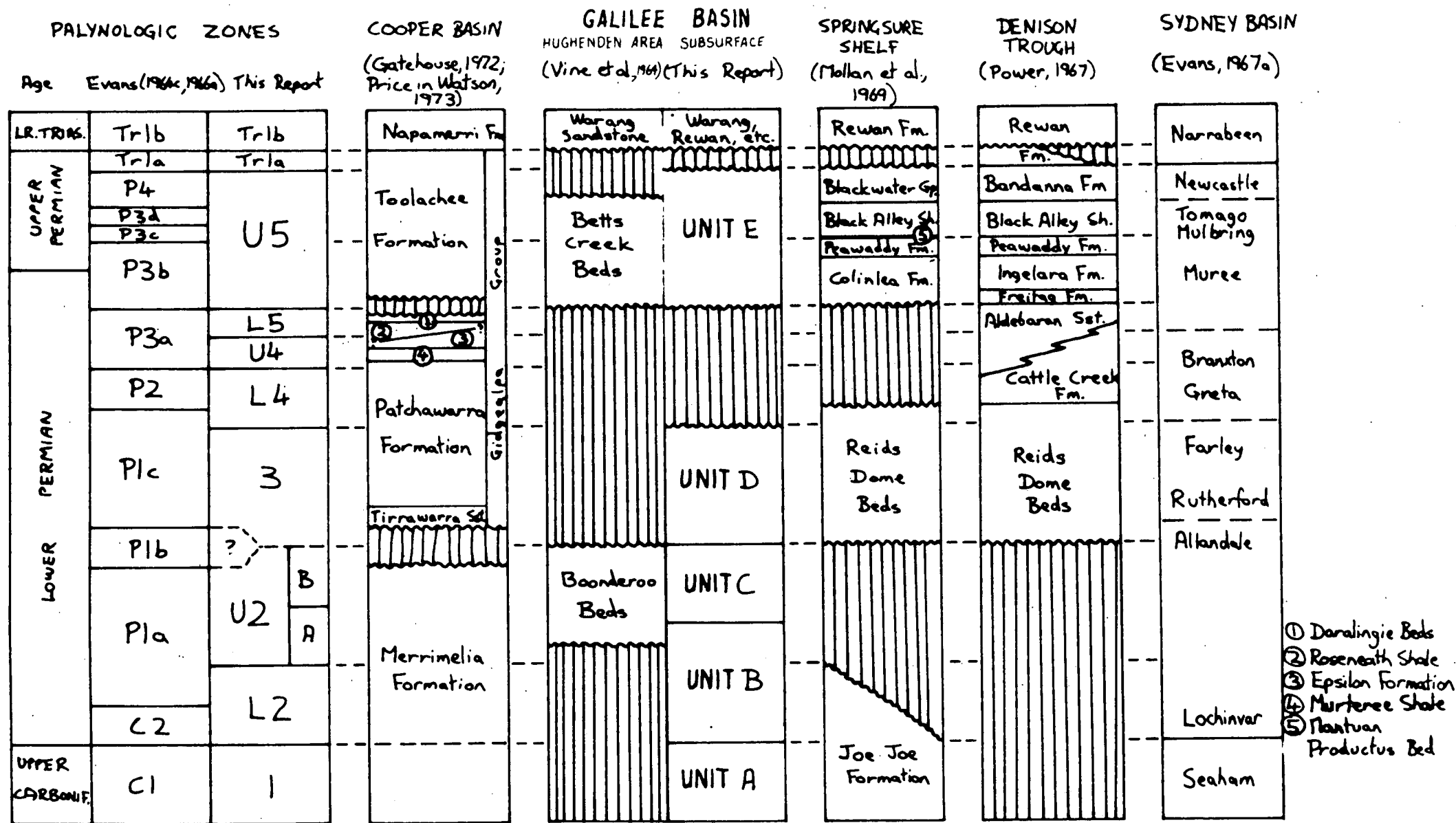


Fig. 3: Correlations between the Permian Basins of eastern Australia.
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of the Lovelle Downs Trough is unusual in that the Triassic probably partly overlaps Permian strata (Vine, pers. comm.).

Along the southern edge of the Galilee Basin, Permian sediments thin to a feather edge. The supra-Permian unconformity oversteps earlier unconformities in this area, but a depositional basin edge is also suspected. To the southwest, the Galilee Basin is separated from the contemporaneous Cooper Basin by a subsurface horst, the Canaway Ridge. For a short period during the Late Permian, sedimentation was continuous across this barrier.

Rock Units

Using wireline logs, lithologic information and palynologic age control, it is possible to correlate well sections and to identify a succession of five wide-ranging rock units in the Galilee Basin. These have been modified from the four intervals established by Vine (in press) (see below). Parts of three rock units can be identified in outcrop sections along the northern basin rim and the more complete subsurface succession can be tentatively correlated with the Upper Carboniferous to Permian succession in the Cooper Basin, the Springsure Shelf and the Denison Trough (Fig. 3). A representative correlation between four wells in the central part of the Galilee Basin is shown in Figure 4, and this can be used to illustrate the main features of the sequence.

Unit A is a succession of thick conglomerates and sandstones, with minor shales. At least some of this unit is glaciogenic in origin. It correlates with the lower part of the Joe Joe Formation on the Springsure Shelf, and with Vine's (in press) "Upper Carboniferous sequence". On palynologic evidence lithologic unit A can be dated as Stage 1 (see section 6).

Unit B comprises a series of interbedded sandstones and shales, and equates with Vine's (in press) "early Permian sandstone-shale sequence". He states that "lithologically the sequence is similar to the Upper Carboniferous one, except that conglomerate is rare, shale is a little more common, and interbedding tends to be thinner. There is no evidence of glaciation". The microfloras indicate that this unit can be dated Lower Stage 2 and part of Upper Stage 2, i.e. Early Permian. On lithologic evidence, the basal sandstone of the Boonderoo Beds in the Hughenden area may be the uppermost part of unit B.

Conformably overlying the sandstone-shale unit over a large area of the northern Galilee Basin is a thick shale sequence, Unit C, which is readily identified in many wells from wireline logs. It equates with Allen's (1973) "Marchmont Formation", and with the lower part of Vine's (in press) "Mid-Lower Permian coal measures and varved shale sequence". It has been dated

palynologically as Upper Stage 2. Most of the Boonderoo Beds in their type area belong in unit C, and these contain glaciogenic varves and thin tillites (Vine et al., 1964).

Unit D is a series of sandstones and shales with thin coal seams, which represent the first major climatic amelioration in the area. The unit contains Stage 3 microfloras and can thus be dated as Early Permian. It includes the upper part of Vine's (in press) "Mid-Lower Permian coal measures and varved shale sequence" and correlates with part of the Reids Dome Beds on the Springsure Shelf (Mollan et al., 1969) and Denison Trough (Power, 1967).

The top of the unit D coal measures is truncated everywhere in the Galilee Basin by a major unconformity. No Stage 4 or Lower Stage 5 microfloras have yet been identified and this interval is represented by a regional hiatus. Above this is a series of coal measures, here termed Unit E. This contains Upper Stage 5 microfloral assemblages and can thus be dated youngest Early to Late Permian. Unit E outcrops as the Betts Creek Beds along the northern margin of the Galilee Basin. In the southern part of the basin, a basal sandstone unit correlates with the Colinlea Formation of the Springsure Shelf (Vine, in press). On palynologic evidence, unit E correlates with most of the Toolachee Formation in the Cooper Basin, with the Colinlea Formation to Blackwater Group on the Springsure Shelf, and with the Freitag to Bandanna Formations in the Denison Trough. A second hiatus tops the Permian in the Galilee Basin and no youngest Permian (palynologic unit Tr1a) microfloras have been identified. Unit E is everywhere unconformably overlain by Triassic or younger clastic formations.

5. PREVIOUS WORK ON PALYNOLOGICAL ZONATION

Balme (1964) made one of the first attempts to sub-divide the Australian Upper Palaeozoic on its spore and pollen assemblages. He differentiated a Carboniferous "Lycosporoid" Microflora, a Permian Striatites Microflora and a Lower Triassic Taeniaesporites Microflora. Working chiefly with West Australian formations, containing marine invertebrates (including ammonoids), he subdivided the Striatites Microflora into three parts and correlated them with the standard Russian Permian stage nomenclature (Fig. 5). Thus he identified a Nuskoisporites Assemblage, which he dated as Sakmarian to early Artinskian; a Vittatina Assemblage, to include most of the Artinskian and "Kungurian"; and a Dulhuntyispora Assemblage, which he correlated with the whole of the Upper Permian (uppermost "Kungurian" to Tartarian). These units are sufficiently broad to allow their

WESTERN AUSTRALIA

Balme, 1964

CANNING BASIN
Balme (in
Johnson, 1968)

PERTH BASIN
Segroves (1970)

Balme, 1969

Taeniasporites Microflora		LR. TRIASSIC	
Striatites Microflora	Dulhuntyispora Assemblage	TARTARIAN	UPPER PERMIAN
		KAZANIAN	
	Vittatina Assemblage	"KUNGURIAN"	PERMIAN
		ARTINSKIAN	
Nuskoisporites Assemblage	SAKMARIAN	LOWER	
"Lycosporoid" Microflora		UPPER CARBONIFEROUS	

Taeniasporites
Dulhuntyispora
Vitt. III
Vitt. II
Vitt. I
Nusk. III
Nusk. II
Nusk. I

LR. TRIASSIC
Dulhuntyispora Assemblage
Haplacystia Assemblage
Acanthotriletes Assemblage
Quadrifidites Assemblage
Microbaculites Assemblage

LR. TRIASSIC	SCYTHIAN	Tr1b
UPPER PERMIAN		Tr1a
		5

EASTERN AUSTRALIA

PLANT
MACROFOSSILS
Walkem, 1945

PALYNOLOGY

This Report Evans, 1964, 1966 Age

Discooidium
Glossopteris
Rhaconites

Tr1b	Tr1b	LR. TRIAS	
Tr1a	Tr1a	UPPER PERMIAN	
U5	P4		
	P3d		
	P3c		
	P3b		
L5	P3a	LOWER PERMIAN	
U4			
L4	P2		
3	P1c		
	P1b		
B	U2		P1a
A			
L2	C2		
1	C1		UPPER CARBONIF.

Fig. 5. Relationship between Permian palynologic zonation in eastern and western Australia

recognition in eastern Australia (Evans, 1967a, 1969), although some of his overseas stage correlations have been questioned. In particular, there is controversy about the position of the Carboniferous/Permian boundary and this is explained in section 6. Later Balme (in Johnson, 1968) refined this zonation by dividing the Nuskoisporites and Vittatina Assemblages each into three parts (units N I to III and V I to III). He based this on a well section in the Canning Basin (WAPET Blackstone no. 1). Some of the species on which these units were defined have not yet been identified in eastern Australia and consequently this subdivision has not been applied to the Permian succession in Queensland.

Upper Carboniferous and Permian strata in Queensland were subdivided by Evans (1964c), using a series of lettered palynologic units (figs. 5, 6), and these were first applied to outcrop sections in the Denison Trough and the Springsure Shelf. They were defined on well sections in the southern subsurface part of the Bowen Basin (Evans in Mines Administration, 1962). The palynologic units were based on several different criteria, including stratigraphic limits of major spore groups (e.g. base of *Striatiti* at C1/C2 boundary), ranges of individual spore taxa, and the occurrence of particular acritarch species (e.g. in P2, P3c, P3d). Unfortunately the geographical distribution of these acritarch "swarms" was controlled by the rather limited incidence of marine or brackish water conditions. As a result, the confident application of units defined by acritarchs is limited to the Denison Trough and to the easternmost margin of the Galilee Basin, as far west as Jericho no. 1. Attempts to correlate Permian strata in areas beyond the reach of microplankton, i.e. where deposition was wholly non-marine, resulted in the use of clumsy combinations of spore units. Thus in the central Galilee Basin (Evans, 1966a) up to six units could be recognized (C1, C2, P1a, P1b, P1c-P2, P3-4), and in the Cooper Basin (Evans, 1966d) three were differentiated (P1b, P1c-P2, P3b-P4). Later work by Price (in Gatehouse, 1972; in Watson, 1973) also showed the presence of spore unit P3a in the Cooper Basin. When the Sydney Basin was examined (Evans, 1967b), the marine incursions and the acritarch "swarms" which they contained could not be correlated with those of the Denison Trough. Again recourse was made to groups of units defined entirely on spores. Evans (1966a, e) was able to extend the use of spore units to Triassic, Jurassic and Cretaceous strata in a much more widely applicable manner. His subdivision of the Triassic is in need of revision but recent work by Burger (1968a,b, 1973a, b) has shown that the ranges of spores pollen and microplankton in the Jurassic and Cretaceous can be integrated into a very useful biostratigraphic scheme.

The confusion surrounding the use of the lettered spore units was partly resolved when Evans (1967a, 1969) erected a new palynostratigraphic classification for the Permian based on the distribution of spores and pollen alone. This division consisted of five numbered stages; from Stage 1, in the Upper Carboniferous to Stage 5, in the Upper Permian. He was able to correlate these throughout most of eastern Australia and produced maps showing their distribution. Paten (1969) refined this zonation in his study of the Cooper Basin, dividing Stages 4 and 5 on the distribution of certain common and specifically well-defined forms. The restricted ranges of other species allowed Price (in Gatehouse, 1972; in Watson, 1973) to further differentiate an uppermost division in both Upper Stage 4 and Lower Stage 5. I was also able to identify a lower and an upper interval in Stage 2 microfloras from a well in the Galilee Basin (Norvick, 1971). Upper Stage 2 was further subdivided into two assemblages (A and B) but these are now thought to be of only limited use. A number of inconsistencies in the interpretation of Stages 4 and 5 in Norvick (1971) have been brought to the author's attention and have now been corrected.

A different zonal scheme was erected by Segroves (1972) for Permian strata in the Perth Basin. He identified five units, including Microbaculispora (the oldest), Quadrisporites, Acanthotriletes, Haplocystia and Dulhuntyispora assemblage zones (Fig. 5). These were based upon both stratigraphic limits of individual species and upon the percentage distribution of certain taxonomic groups. Both microplankton (acritarchs and probable green algae) and spore-pollen taxa were incorporated into the one system. Although at least two of Segroves assemblage boundaries can be identified with those of the eastern Australian palynological stages, his zonal scheme cannot be satisfactorily applied to the Queensland Permian.

The work of Evans (1967a, 1969) and Paten (1969) forms the basis of zonation used in the present report. The relationship between the differing zonal classifications, put forward separately for eastern and for western Australia, is shown in Figure 5. The development of the present system, via the successive interpretations of the authors mentioned above, is illustrated by Figure 6 and the ranges of stratigraphically important palynologic taxa are summarized in Figure 7.

One major problem which remains is that taxonomic work on Australian Permian microfloras is chronically incomplete. Many widely distributed, common and stratigraphically useful species have not yet been validly described or even illustrated, and others are in urgent need of revision. This has led many Australian palynologists to devise informal numbering systems to accommodate unnamed taxa. Each institution has its own system and the proper description of these species, particularly those

from Lower Permian, is an urgent priority. In this paper, BMR Palynological Species Catalogue numbers are used. All species, both described and undescribed, are given numbers and are assigned "morphotypes", which are lodged in the Bureau collections. Elsewhere in this report, whenever a species has been positively identified with a BMR "morphotype", the species number is given (parenthesised for named forms).

6. DISCUSSION OF ZONATION

The Permian - Carboniferous Boundary

There is disagreement among palynological workers as to the placing of the Permian/Carboniferous boundary in Australia (see Fig. 6). This is taken by some macropalaeontologists at the incoming of the Eurydesma fauna. Walkom (1945) and David (1950) chose to further define the boundary in Australia at the replacement of the Upper Carboniferous Rhacopteris macroflora by the Permian Glossopteris macroflora. Balme (1962) suggested that the palynologic expression of the Glossopteris macroflora lay in the presence of Striatiti. He thought that striate bisaccate pollen was produced by at least some of the plants with Glossopteris-type leaf venation.

The stratigraphically oldest known Glossopteris flora in Australia occurs in the Boonderoo Beds of Galah Gorge (White, 1964). These are glaciogene strata which have yielded microfloras, dated as P1a by Evans (1964a). A closely sampled section in the Galah Gorge has since been collected by the present author, and the horizon from which White described her macroflora can now be placed in Upper Stage 2. The Carboniferous-Permian boundary must thus be below this level. In continuing his argument from the relationship between the Glossopteris flora and the striate pollen, Balme (1964) put the base of the Permian at the base of the lowest division (Nuskiosporites Assemblage) of his Striatites Microflora. Evans (1967a, 1969) showed that striate pollen did not appear until above the base of the Nuskiosporites Assemblage; at the NI/NI^{II} boundary of Balme (in Johnson, 1968) or the C1/C2 boundary of Evans (1964c, 1966a) and the Stage 1/Stage 2 boundary of Evans (1967a, 1969). He placed the base of the Permian at this level. These arguments were restated with respect to the Sydney Basin by Evans (1967b), when he placed the Seaham Formation in the Upper Carboniferous. He showed that this formation, which contains a Rhacopteris macroflora, is characterized palynologically by abundant Parasaccites and Potonieisporites. It lacks Striatiti, which make their first appearance higher in the succession.

21

Helby (1969a,b) placed the top of the Carboniferous at a somewhat lower horizon. He examined evidence from overseas and noted that in the northern hemisphere, coincident palynologic, (Lycospora to Illinites/Potonieisporites microfloras) and foraminiferal (Fusulina to Triticites fusulinid faunas) changes occurred at a level near the base of the Kiaman magnetic reversal. His correlations to Australia suggested that this horizon and the Permo-Carboniferous boundary lay at the base of his Potonieisporites microflora and the top of his Grandispora microflora. Striatiti do not appear until at least the upper part of the Potonieisporites microflora and so that interval, as described by Helby (1969b), is assignable to Stage 1 of Evans (1967a, 1969).

For the purpose of this report, Walkom's (1945) interpretation of the incoming of the Glossopteris flora, and Balme's (1962) and Evans' (1967a, 1969) correlation of this event with incoming striate bisaccate pollen are taken to mark the Permian/Carboniferous boundary.

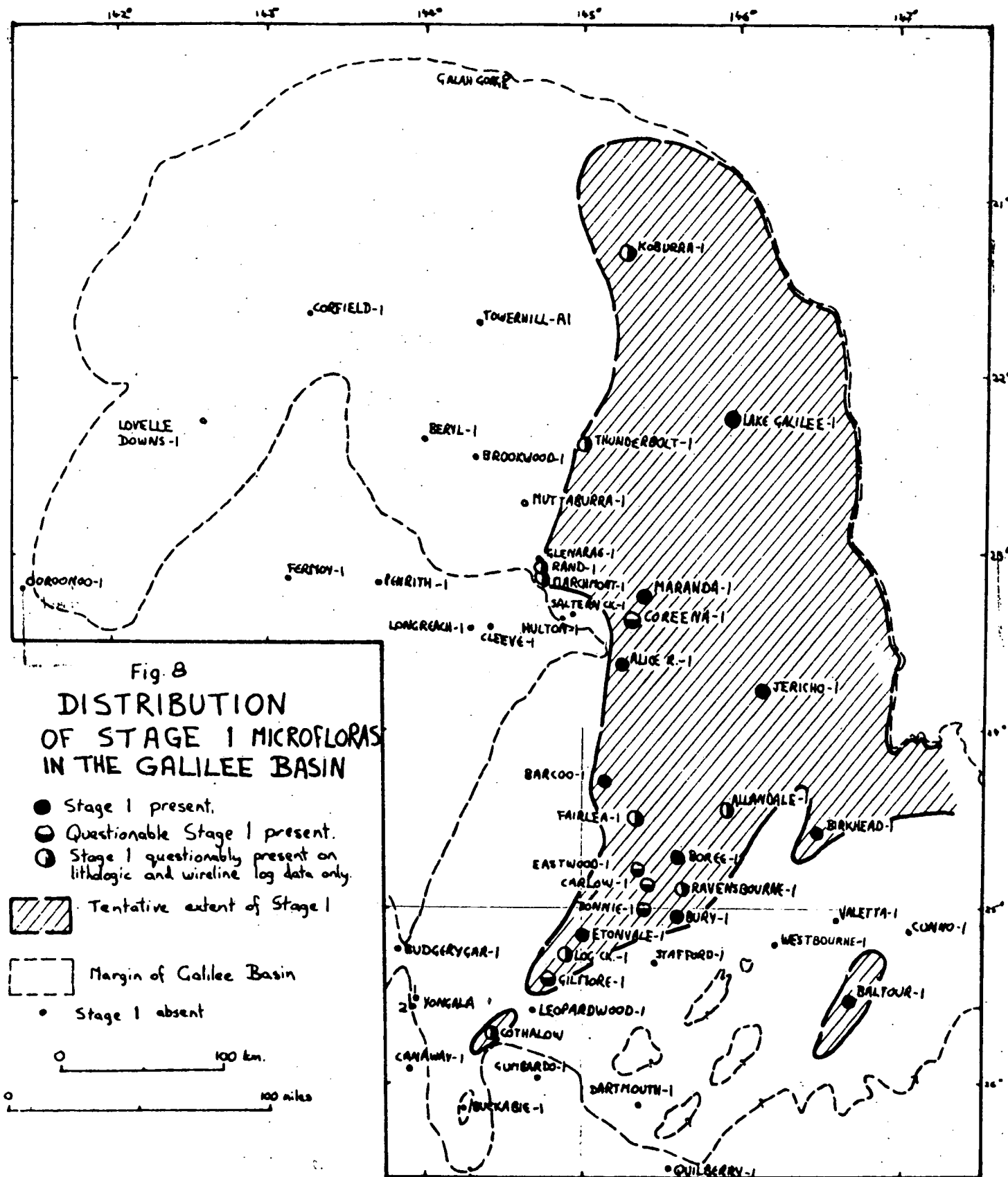
Stage 1

Stage 1 microfloras are characterized by an abundance of monosaccate pollen, particularly species of Parasaccites, and Potonieisporites, including P. neglectus (sp.192). Several large bisaccate pollen grains are typically present, such as Vestigisporites spp. 44 and 45. Trilete spore assemblages are dominated by simple smooth types like Phyllothecotriletes spp. 7 and 10, Punctatisporites gretensis (sp.5) and Calamospora sp.4. These are associated with a distinctive suite of verrucate spores (Rugulatisporites sp.22, Verrucosisporites sp.910) and zonate spores (Kraeuselisporites sp.35, Vallatisporites spp.37 and 36).

The base of Stage 1 is marked by the incoming of saccate and monocolpate pollen (Evans, 1967a, 1969). In the Sydney Basin, Evans (1967b) noted that certain species characteristic of spore unit C1 (he mentioned Vallatisporites sp.37) are known from horizons below the first appearance of saccate pollen. Stage 1 can be equated with spore unit C1 (Evans 1967a, 1969). It also represents the same interval as Nuskoisporites I assemblage of Balme (in Johnson, 1968) (fig. 2). Helby (1969a,b) noted that monosaccate pollen, including Potonieisporites neglectus, first appeared at the boundary between his Grandispora and Potonieisporites microfloras. Striatiti make their debut high in his Potonieisporites microflora and so the interval between these two levels can be correlated with Stage 1 (fig. 3).

Stage 1 shows a widespread development in Australia and is typically represented by clastic rocks of glacial origin. In the northern Galilee Basin,

m



rocks of Stage 1 age have been identified in the Koburra Trough and with the outcropping Joe Joe Formation. Stage 1 microfloras are also known in the southern part of the basin, around Gilmore no. 1 well. In the Sydney Basin, palynologic associations typical of Stage 1 are well documented in the Seaham Formation (Evans, 1967b; Helby, 1969a,b). The lower part of the Grant Formation of the Canning Basin, can be probably also dated as Stage 1. Evans (1967a, 1969) also referred to Stage 1 certain subsurface strata beneath the Simpson Desert in the Pedirka Basin, and from the Lake Phillipson bore in South Australia (from the description by Balme, 1957).

Preservation of Stage 1 assemblages in the Galilee Basin is generally very poor. Spores are commonly heavily carbonized, some to the point of being completely unidentifiable. In the northeastern part of the Galilee Basin, partly carbonized Stage 1 assemblages occur at depths up to nearly 3000 m. Here the phenomenon may have been caused by the same type of diagenesis or eometamorphism as was suggested by Evans (1963, 1966b) in the Bowen Basin and by Paten (1969) in the Cooper Basin.

In the Galilee Basin, Stage 1 can be correlated with the partly glaciogenic, coarse clastic rocks of unit A, which is equated with Vines (in press) "Upper Carboniferous sequence". The main features of their distribution (Fig. 8) includes a thick development close to the northeastern margin of the basin in the Koburra Trough, a gradual westward thinning, and a smaller downwarp in the south, parallel to the Warrego monocline. Stage 1 microfloras have not been recorded from the western or southernmost parts of the Galilee Basin, and were probably outside the limit of sedimentation at that time. Vine (in press) thought that a late Carboniferous glaciation in the "Drummond Mountains" provided the source for the sediments in the Koburra Trough.

Stage 2

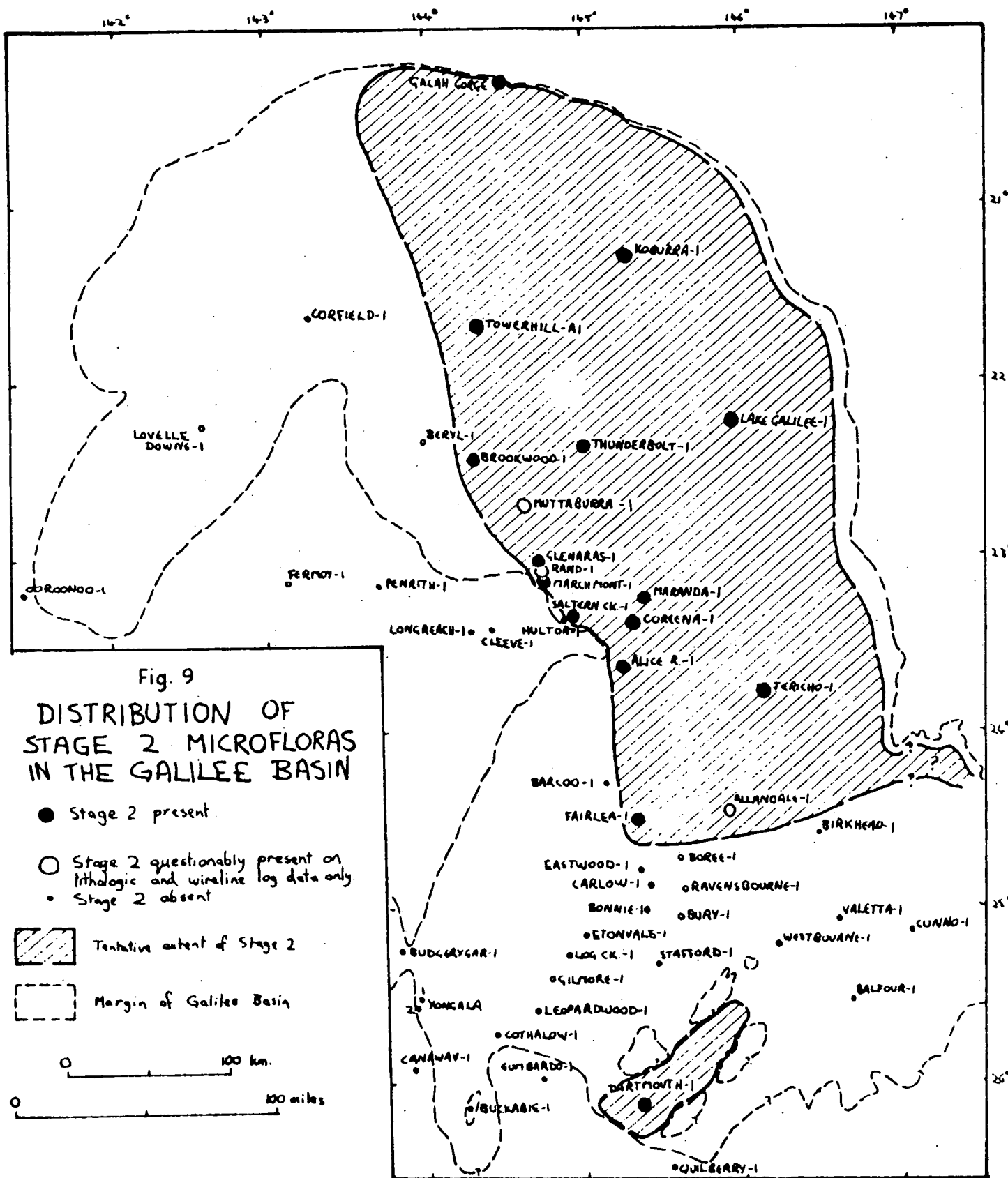
Evans (1967a, 1969) erected Stage 2 to include assemblages containing the first appearance of striate bisaccate pollen, together with new forms of Apiculatisporis, Lophotriletes and certain cingulate mesosporoids. He equated Stage 2 with his earlier spore units C2, P1a and P1b (Evans, 1964c, 1966a). Considerable difficulty was experienced when these spore units were applied to the Galilee Basin. As a result, a simple two-fold division of the stage was put forward (Norvick, 1971), which relied on the stratigraphic limits of selected spores, rather than on semi-quantitative criteria.

af

From Evans' (1966a) descriptions, it appears that spore units C2 and P1a form a palynologically closely related interval. He indicates that the ranges of Phyllothecotriletes sp.7 and Calamospora sp.4 do not extend above C2, and that Klausipollenites sp.82 and Monocolpate pollen sp.164 first occur in P1a. In Thunderbolt no. 1, Monocolpate pollen sp.164 has not yet been found, and Phyllothecotriletes sp. 7 and Calamospora sp.4 range to the top of Stage 2. In Alliance Jericho no. 1, Evans (1966a) found an assemblage intermediate between C2 and P1a (core 6, 1092 m, 3583 feet). In this, characteristic C1/C2 forms, such as Reticulatisporites sp.43, are associated with Klausipollenites sp.82 in the absence of Striatiti. He dated this sample as basal unit P1a or uppermost unit C2, as Klausipollenites sp.82 does not appear in Maranda no. 1 until unit P1a. The first occurrence of Klausipollenites sp.82 in Thunderbolt no.1 lies at the top of Stage 2, presumably upper P1b if the section is complete.

At the P1a/P1b boundary in Alice River no. 1 and Maranda no. 1, Evans (1966a) noted the disappearance of Vallatisporites sp.37 and Rugulatisporites sp.22; the first occurrences of Verrucosisporites pseudoreticulatus (sp.68), Marsupipollenites triradiatus (sp.152) and Protohaploxypinus aff. goraiensis (sp.187); and an increase in Striatiti and non-taeniate bisaccate pollen. Verrucosisporites pseudoreticulatus (sp.68) was not found in the Thunderbolt section. Of the other forms listed, Vallatisporites sp.37 has been found up to one sample below the P1a/P1b boundary (as given by Evans, in Amerada 1967), Marsupipollenites triradiatus (sp.152) does not appear until high in Stage 3, and Protohaploxypinus aff. goraiensis (sp.187) first appears in Lower Stage 2 samples. The morphological limits of Rugulatisporites sp.22 are in need of revision but it appears to be abundant at least to the top of Stage 2.

On present evidence, the base of Stage 2 is defined at the incoming of striate bisaccate pollen and its top is taken immediately below the base of Verrucosisporites pseudoreticulatus (sp.68). A lower division of Stage 2 is characterized by the appearance in small numbers of Striatiti, including Protohaploxypinus aff. goraiensis (sp.187), and by the continuation of several trilete spore species, which are also known from Stage 1. Thus cf. Vallatisporites sp.36, Verrucosisporites sp.910, Anapiculatisporites sp.17 and cf. Retusotriletes sp.12 all occur in typical Stage 1 assemblages, but are also known from samples which contain rare striate pollen. The base of Upper Stage 2 is marked by the disappearance of these species and the first appearance of Granulatisporites sp.59 (probably Microbaculispora tentula Tiwari), Lophotriletes spp.64 and 183, and Monocolpate pollen sp.186. Apiculatisporis spp.62 and 908 appear just below its base, while Granulatisporites micronodosus (sp.111) and Lophotriletes tereteangulatus



(sp.113) make their debut just afterwards. The microfloras that Evans (1964b) described from the Finke area, Northern Territory, can probably be dated Upper Stage 2.

Stage 2 can be correlated with two lithologic units in the Galilee Basin. A lower interbedded sandstone-shale sequence (unit B) has yielded Lower to Upper stage 2 microfloral assemblages. Above this, the predominantly fine clastic sediments of unit C have been dated as Upper Stage 2 on their pollen and spore content. Unit C is an easily recognisable interval on wireline logs and has been identified over much of the northern part of the basin (Vine, in press). All of the outcropping Boonderoo Beds above the basal coarse sandstone in the Galah Gorge can be correlated with this unit and these include rhythmically laminated shales, which have been interpreted as a varied sequence (Vine et al., 1964; Vine, in press). The basal sandstone probably equates with the uppermost part of unit B. During Stage 2, the area of sedimentation contracted slightly in the south (fig. 9), and expanded as far west as the Hulton-Rand structure in the northwest. The main depocentre for unit B (Vine's (in press) "early Permian sandstone, shale sequence") remained in the Koburra Trough, with a southwesterly lobe towards the Hulton-Rand structure. A small, short-lived sub-basin developed in the far south, in the vicinity of Dartmouth No. 1. By this time unit C was accumulating, sedimentation had contracted even further, the Koburra Trough had ceased to be active, and the thickest development was farther to the southwest. Vine (in press) and Allen (1974) showed that the Beryl Ridge and the Hulton-Rand structure formed the southwest limit of sedimentation at this time. Vine's (in press) "mid-lower Permian coal measure and varved shale sequence" (his Fig. 4) includes both units C and D.

Stage 2 is also associated with well developed glaciogenic sequences in other parts of Australia; in the Officer, Perth, Carnarvon and Canning Basins of West Australia, in the Cooper, Troubridge and Ackeringa Basins of South Australia, in the Bacchus Marsh district of Victoria, and in eastern Tasmania.

Stage 3

The base of Stage 3 was defined by Evans (1967a, 1969) at the incoming of Verrucosisporites pseudoreticulatus (sp.68), Granulatisporites trisinus (sp.703), new types of cingulate mesosporoids (including Kraeuselisporites sp.1112) and new types of Lophotriletes and Apiculatisporis. He also mentioned that at the same level, monosaccate pollen markedly declines in abundance and Striatiti show a corresponding increase. Marsupipollenites spp. rapidly become common at this level, although elsewhere (Evans, 1964c,

1966a) he noted their first occurrence in palynological unit P1b. Paten's (1969) definition of the Stage 2/Stage 3 boundary closely follows that of Evans (1967a, 1969), when he placed it below the first appearance of Verrucosisporites pseudoreticulatus. There is some ambiguity as to the lowest range of this species, in that Evans (1964c, 1966a) listed it from as low as unit P1b. Price (in Watson, 1973) also noted this discrepancy and the simplest way of avoiding further confusion is to define the stage base on the earliest occurrence of V. pseudoreticulatus (sp.68).

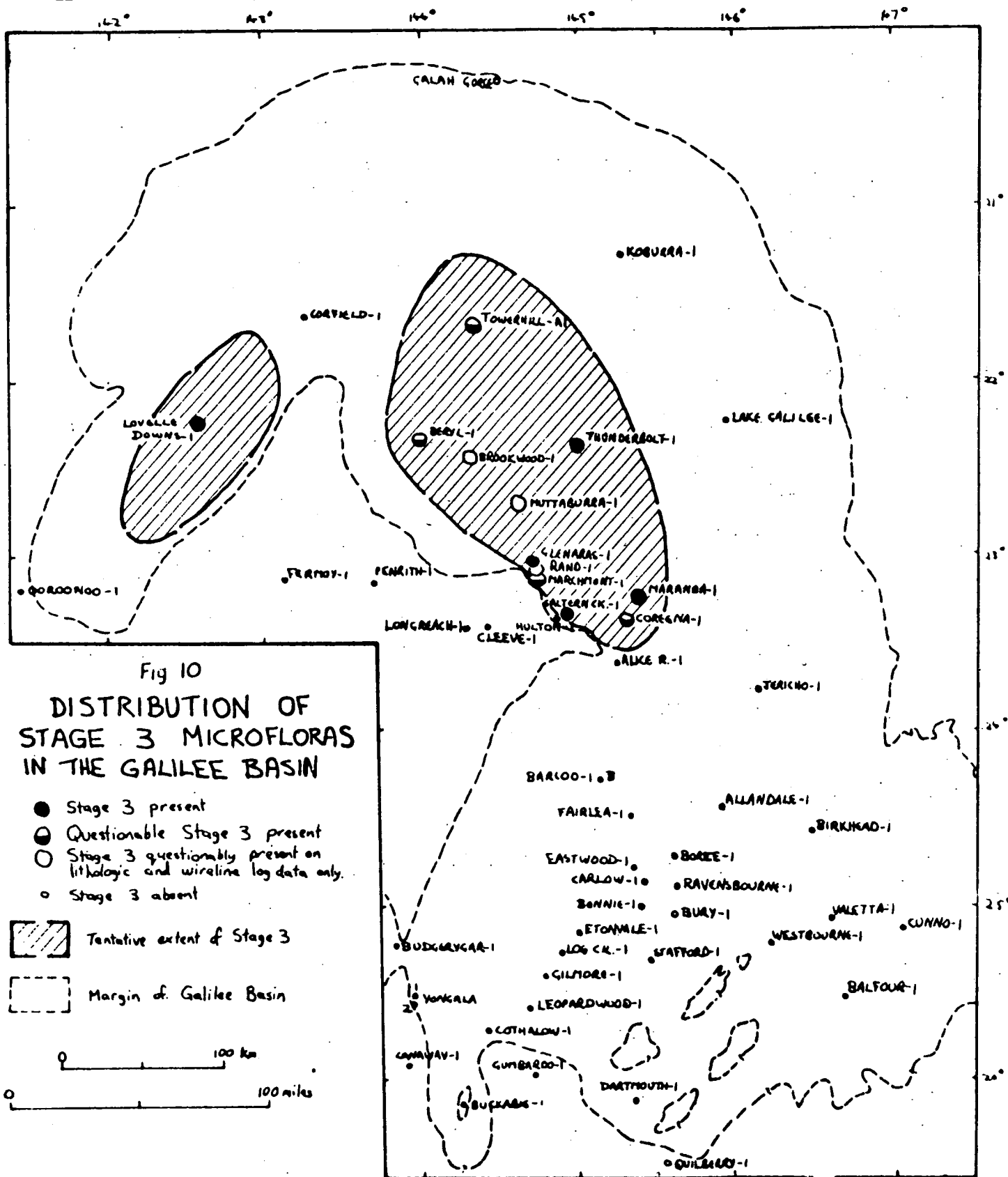
Stage 3 microfloras have been used to date a sequence of sandstone and shales with thin coal seams in the Galilee Basin (unit D). The presence of carbonaceous sediments indicates some climatic warming following the recession of the Gondwana glaciation. In his charts, Vine (in press) lumped the distribution of unit D (and Stage 3) with that of unit C, but they are shown here separately (Fig. 10). During Stage 3, sedimentation contracted even more than in previous times; to an area north and east of the Hulton-Rand structure. A second, smaller sub-basin in the northwest, around Lovelle Downs no. 1, may be related to a northeastern extension of the Cooper Basin at that time (Vine, pers. comm.). Contraction in the area of Stage 3 sedimentation could have been a prelude to the basin-wide hiatus which is thought to have followed.

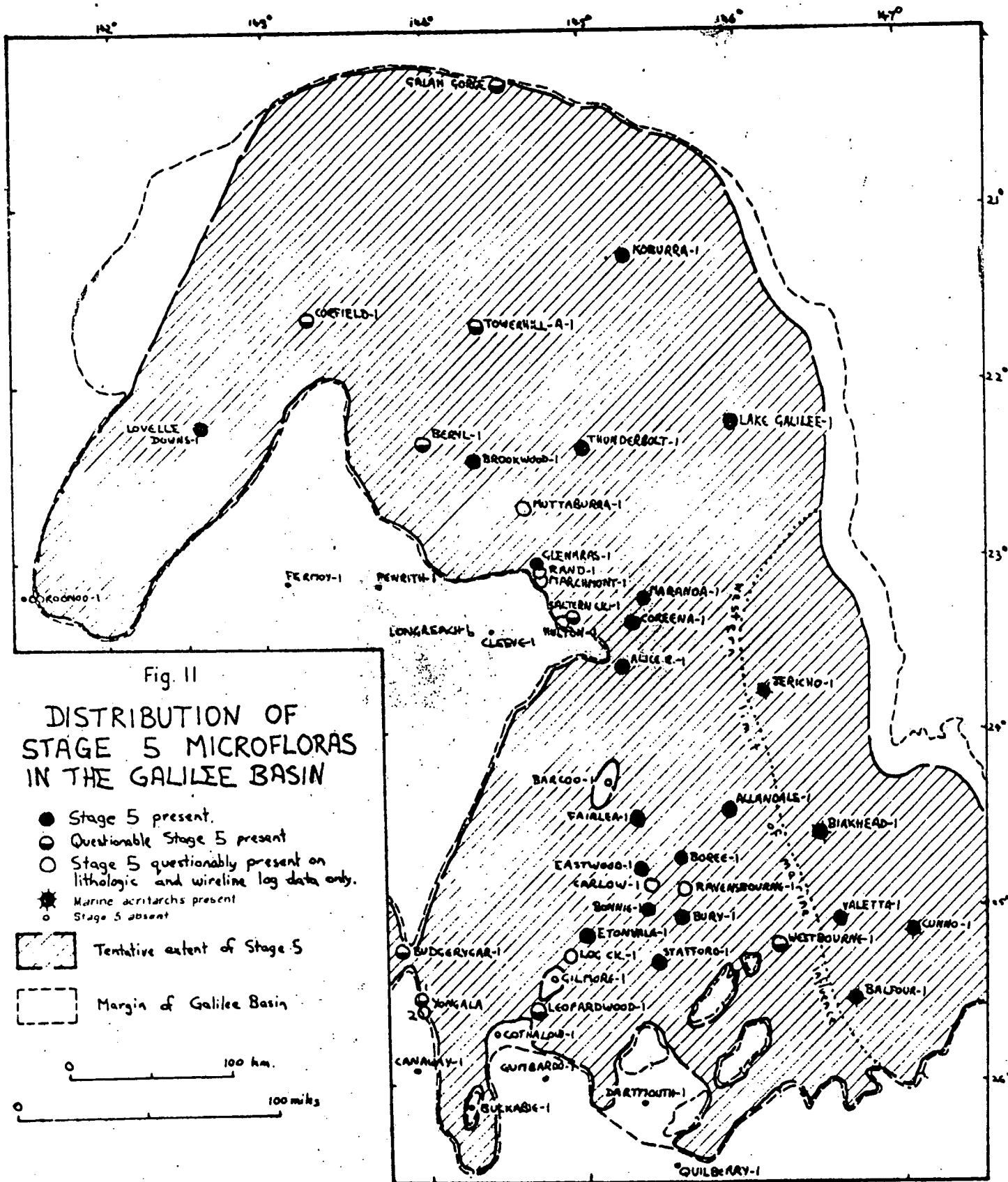
No Stage 4 or Lower Stage 5 microfloras have yet been identified from the Galilee Basin. A major hiatus is assumed covering this period, which was probably one of uplift and erosion. A lithologic break or a change on the wireline logs between unit D (Stage 3) and unit E (Upper Stage 5) is very hard to pick. Indeed Rigby (1973) thought that a facies effect was responsible for the lack of Stage 4 microfloras in the eastern part of the basin. However, the marked palynologic break in rocks of presumably similar facies, the complete absence of a number of Stage 4 and Lower Stage 5 indicator species, and the sudden change in the areal pattern of sedimentation all favour a regional disconformity.

Stage 4

Evans (1966a) experienced difficulty in correlating spore units above P1c outside the Denison Trough. This arose from their definition being based upon microplankton occurrences, which have relatively restricted geographical ranges. To overcome the problem he (Evans 1967a, 1969) formulated Stages 4 and 5, based entirely on spores and pollen, with the result that they have much wider application.

Stage 4 marks the first appearance of Polypodioidites cicatricosus (sp.134) and Apiculatisporis cornutus. Evans (1967a, 1969) also mentioned





the appearance of Didecitriletes ericianus (sp.115) in small numbers near the top of the stage. Paten (1969) used the incoming of Polypodiidites cicatricosus to define the base of the stage. He was able to further divide this interval into a lower and an upper unit in the Cooper Basin by the first occurrence of the polyplicate pollen Gnetaceaepollenites sinuosus (sp.151) at about the middle of Stage 4.

Stage 5

Evans' (1967a, 1969) Stage 5 is marked by the first appearance of species of Dulhuntyispora and a suite of other distinctive spores. It is characterized by the widespread development of coaly sedimentation and often overlaps older formations or is separated from them by a major disconformity. Evans (1967a, 1969) correlated Stage 5 with Balme's (1964) Dulhuntyispora Assemblage. Balme placed the Early/Late Permian boundary at the base of his Dulhuntyispora Assemblage, but Evans has found Stage 5 microfloras from below the macrofossil-dated Artinskian Ingelara Formation in the Bowen Basin. From this evidence the Dulhuntyispora Assemblage must be late Early to Late Permian in age.

Paten (1969) split Stage 5 into an upper and a lower subdivision in the Cooper Basin. He defined the base of his lower division on the appearance of Dulhuntyispora dulhuntyi (sp.122). Didecitriletes ericianus (sp.115) is sometimes present, together with certain members of the Upper Stage 4 microflora. These include Polypodiidites cicatricosus (sp.134) in small numbers. In his upper unit, Dulhuntyispora dulhuntyi becomes much less common and finally disappears. D. parvithola (sp.123) appears for the first time and is accompanied by abundant Didecitriletes ericianus (sp.115), D. uncinatus (sp.114), Lunulasporites colliensis (sp.132), Microreticulatisporites bitriangulatus (sp.121), Gnetaceaepollenites sinuosus (sp.151), and several species of Indospora. Striate bisaccate pollen and Marsupipollenites triradiatus (sp.152) reach their final acme in Upper Stage 5.

No Lower Stage 5 microfloras have yet been identified in the Galilee Basin and a continuation of the Stage 4 regional hiatus is assumed. However, during Upper Stage 5, sedimentation started again and spread over most of the basin (Fig. 11). As described by Vine (in press), Upper Stage 5 deposition is characterized by sandstones with coal measures (unit E). The succession is relatively thin compared with earlier units, but this period represents the greatest areal extent of the basin. In the south, a basal unit can be correlated with the Colinlea Sandstone of the Springsure Shelf (Mollan et al., 1969). Along the northern basin margin, a series of sandstones with coal seams outcrop as

the Betts Creek Beds in the Hughenden area (Vine et al., 1964). The southeastern part of the basin was drowned by the sea several times from the Springsure Shelf. Short-lived, brackish or shallow marine conditions are interpreted from the acritarchs recorded in Jericho no. 1, Birkhead no. 1, Cunno no. 1 and Balfour no. 1. The most widespread of these transgressions can be tentatively correlated with the P3c acritarch zone of the Springsure Shelf and Denison Trough (Evans, in Mines Administration, 1962), which has been identified in the outcropping Mantuan Productus Bed. To the west of the wells mentioned above, there is no evidence that marine conditions existed at any time in the Permian in any part of the Galilee Basin.

Palynological unit Tr1a and the Triassic/Permian boundary

Climatic conditions remained relatively stable throughout most of Australia during the Late Permian, and this stability is reflected in the ubiquity and constant character of the Upper Stage 5 microfloras. However, at the end of the Permian, spore-pollen assemblages show a fundamental change, related in places to marine invasions and the establishment of coastal plain vegetation, and in other areas to increased aridity and the dessication of the Late Permian coal swamps. These changes have their expression in the palynologic record as a series of assemblages transitional between Balme's (1964) late Permian Dulhuntyispora and Early Triassic Taeniaesporites microfloras. Characteristic Late Permian forms gradually became extinct through this transition zone and were progressively replaced by Early Triassic elements. At the same time, a number of distinctive species have been recorded only from the transition zone.

After comparing both macrofossil and palynologic evidence from marine formations, Balme (1969) concluded that the base of the Triassic in eastern Australia can be recognized at the final disappearance of a number of late Permian species, including Dulhuntyispora spp., Gnetaceae-pollenites sinuosus Marsupipollenites spp. and Protohaploxypinus spp.; and the first appearance of Taeniaesporites spp. This corresponds to the base of Evans' (1966a,e) spore unit Tr1b. In Laurasia, Taeniaesporites characteristically occurs in older, Permian strata, but its initial occurrence throughout Australia is in lower Triassic (Scythian) formations. In several Australian basins, several important Triassic species make their debut in association with a restricted Dulhuntyispora assemblage, prior to the appearance of Taeniaesporites.

Work by Evans (1966b,e) on the lower part of the Rewan Formation of the Denison Trough and Bowen Basin led him to erect spore unit Tr1a. This contained abundant Quadrisporites horridus (sp.211), in association with the

first appearance of new species of monosaccate pollen (he related them to 'Nuskoisporites' radiatus and aff. Trizonaesporites) and new striate bisaccate pollen. These occur together with reduced numbers of forms which are common in the Late Permian, such as Dulhuntyispora parvithola (sp.123), Marsupipollenites triradiatus (sp.152) Sulcatisporites ovatus (sp.138) and Protohaploxypinus spp. Palynologic unit Tr1a and the basal Rewan Formation in parts of the Denison Trough are now thought to be latest Permian in age (Balme, 1969). Higher parts of the Rewan Formation contain unit Tr1b and younger microfossils, which can be correlated with Balme's Taeniaesporites assemblage, of Early Triassic age. An hiatus is now suspected within the Rewan Formation (Balme, 1969) and the Lower Triassic unconformably oversteps uppermost Permian rocks, both to the east (De Jersey, 1970) and in the west. Spore unit Tr1a appears to be absent in the Galilee Basin and unit Tr1b rests directly on upper stage 5 in Maranda no. 1 (Evans, 1966a). Elsewhere only younger Triassic or Jurassic palynologic units overlie Upper Stage 5.

Spore unit Tr1a has also been recognised in the Sydney Basin. Hennelly (1959) described a microflora from the uppermost Illawarra Coal Measures and basal Narabeen Group, which Evans (1967b) subsequently placed in Tr1a. It contained rare Upper Stage 5 species, together with Quadrisporites horridus, 'Nuskoisporites' radiatus and Protohaploxypinus reticulatus. Helby (1972, 1973) recognised or inferred similar microfloras from the Sydney, Bowen, Cooper, Galilee, Bonaparte Gulf and possibly Canning Basins and placed them in his Protohaploxypinus reticulatus assemblage. In addition to the nominate species and small numbers of Upper Stage 5 forms, he also noted the first appearance of Alisporites australis and Guthoerlisporites cancellosus, together with some "distinctive cavate possibly lycopsid microspores". In the Cooper Basin, the "Paravittatina" assemblage zone of Price (in Watson, 1973) is probably also a correlate of palynologic unit Tr1a.

7. PALYNOSTRATIGRAPHY OF PERMIAN SECTIONS IN THE GALILEE BASIN

The palynological data on the 42 petroleum exploration wells, which intersected the Galilee Basin sequences, and on two outcrop sections are discussed below in alphabetical order of well name (see Fig. 2 and Table 1 for locations). For each well, tables are presented summarizing the rock stratigraphy and the position of samples studied for plant microfossils. Whenever possible assemblage slides in the BMR collections (prefixed by M.F.P. palynological laboratory numbers) have been re-examined. In the sample tables, the dating given by previous authors is presented. Where samples have been re-examined or where previous authors' species

information has supported a different or more refined dating, the revised stage is presented in the final column using Evans' (1967a, 1969) zonal scheme.

Farmout Drillers ALICE RIVER No. 1

Reference: Hare & Associates (1963)

Generalized section (from well completion report, with later emendations on the basis of palynology *):

AGE	FORMATION	DEPTH	
Tertiary	unnamed	surface - 18m	Surface - 60'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	18 - 510m	60' - 1672'
Triassic	Moolayember Shales	510 - 576m	1672' - 1890'
	Clematis Sandstone	576 - 753m	1890' - *2470'
	- unconformity -		
Up. Permian.	unnamed	753 - 856m	*2470' - *2810'
	- *unconformity -		
*Up. Carb.-Lr. Perm.	unnamed	856m - TD	*2810' - TD
Total Depth		1631m	5352'

Palynology: Hodgson (in Hare & Associates, 1963) originally examined seven cores from the Upper Carboniferous to Permian section in this well. Later, Evans (1964c, 1966a) emended the dating in terms of his palynologic units, and studied a further two cutting samples. The results of Evans and their revision into stage nomenclature are set out below.

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Given Spore Unit (Evans, 1966a)</u>	<u>Revised Stage</u>
Cutt.	771-4m 2530 - 40'	2726	P3-4	Up.Stage 5
Cutt.	805-8m 2640 - 50'	2727	P3-4	Prob.Up.Stage 5
Core 6	831-6m 2728 - 43'	2373	P3-4	Up.Stage 5
- unconformity -				
Core 7	910-6m 2984 - 3004'	2374	Barren	?
Core 8	1061m 3481' 2424	2424	C2	Lr.Stage 2
Core 9	1213m 3981' 2491	2491	Barren	?
Core 10	1352m 4436'	2492	C1	Stage 1
Core 11	1496m 4908'	2493	C1	Stage 1

The cutting samples from 771-4m and 805-8m (2530-40' and 2640-50') contain a rather corroded microflora, which has been briefly re-examined for this study. Assemblages are dominated by striate bisaccate pollen but also include Didecitriletes ericianus (sp. 115) and Gnetaceaepollenites sinuosus (sp.151). The sample from 771-4m (2530-40') also contains Dulhuntyispora parvithola (sp.123). From core 6 (831-6m, 2728-43') Hodgson (in Hare & Associates, 1963) reported a very similar flora, with abundant Striatiti associated with Dulhuntyispora parvithola (sp.123) and Gnetaceaepollenites sinuosus (sp.151).

Core 7 proved to be barren but Hodgson and later Evans (unpublished BMR data) identified a number of species in core 8 (1061m, 3481'). These included the following -

Phyllothecotriletes sp. 7

Retusotriletes diversiformis (sp. 6)

Calamospora sp. 4

Didecitriletes sp. 19

Rugulatisporites sp. 22

Verrucosisporites sp. 8

Vallatisporites sp. 37

Vestigisporites sp. 44

Parasaccites spp (common)

Striatiti (v. rare and fragmentary)

Further study by the present author has added cf. Retusotriletes sp. 12 to this list. The trilete spore assemblage is known from Stage 1 and Lower Stage 2, and the presence of a few striate bisaccate pollen restricts the assemblage to Lower Stage 2. There is a considerable gap in palynological control between this sample and the coal-bearing Upper Permian. This includes the major shale unit (unit C), which in other wells (e.g. Thunderbolt no. 1, Glenaras no. 1) has been dated as Upper Stage 2.

Another barren sample (core 9, 1213m, 3981') separates Lower Stage 2 from older assemblages. A species list for cores 10 (1352m, 4436') and 11 (1496m, 4908') (see below) has been compiled from Evans' identifications (unpublished BMR files).

	Core 10 (1352m, 4436')	Core 11 (1496m, 4908')
<u>Kraeuselisporites</u> sp. 35	X	X
<u>Phyllothecotriletes</u> sp. 7	X	X
<u>Verrucosisporites</u> sp. 8	X	
<u>Calamospora</u> sp. 4	?	X
<u>Rugulatisporites</u> sp. 22	X	X
<u>Reticulatisporites</u> sp. 43	?	X
cf <u>Retusotriletes</u> sp. 12	X	
<u>Parasaccites</u> spp.	X	X
<u>Vestigisporites</u> sp. 44	X	X
<u>Punctatisporites gretensis</u> (sp. 5)		X
<u>Retusotriletes diversiformis</u> (sp. 6)		?
<u>Didecitriletes</u> sp. 19		X
<u>Vallatisporites</u> sp. 37		X
cf <u>Calamospora</u> sp. 9		X
cf <u>Vestigisporites</u> sp. 45		X

Evans (1964c, 1966a) placed these samples in spore unit C1. The characteristic association of Phyllothecotriletes sp. 7, cf. Retusotriletes sp. 12, Vallatisporites sp. 37 and Calamospora sp. 4, in the absence of striatiti, indicates that they can now be dated Late Carboniferous (Stage 1).

Beaver-Pexa ALLANDALE No. 1

Reference: Leslie (1971)

This well was drilled in the southern Galilee Basin and intersected 933m (3062 ft) of Upper Carboniferous and Permian. It also penetrated a thick Devonian sequence transitional in character between that of the Adavale and Drummond Basins.

Generalized Section (formation names as in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 744m	Surface - 2442'
	- unconformity -		
Triassic	Moolayember Formation	744 - 979m	2442 - 3211'
	Clematis Sandstone	979 - 1036m	3211 - 3398'
	Rewan Formation	1036 - 1216m	3398 - 3988'
Permian	Bandanna Formation	1216 - 1313m	3988 - 4308'
& Up.	Colinlea Sandstone	1313 - 1652m	4308 - 5421'
Carboniferous	Joe Joe Formation	1652 - 2149m	5421 - 7050'
	- unconformity -		
Devonian	Adavale/Drummond Basin sequence	2149 - 3003m	7050 - 9853'
? Sil-Dev.	Basement volcanics	3003m - TD	9853' - TD
Total Depth		3004m	9856' (driller)

Palynology: Price (in Leslie, 1971) examined seven samples from this well, four of them from the Upper Carboniferous to Permian interval, and his results are summarized below. No samples from this well have been re-examined.

Sample	Depth		Age	Spore unit given	Revised Stage
Core 1	1303m	4275'	U. Permian	P3b-4	Up.Stage 5
Core 3	1679m	5510'	U. Carb. - L. Permian		
	1681m	5515'			(poor yield)
	1681m	5516'			

Core 1 contained abundant striate bissacate pollen, together with

Dulhuntyispora dulhuntyi

D. parvithola

Didecitriletes ericianus

Granulatisporites trisinus

Lophotriletes tereteangulatus

Retusotriletes diversiformis

Marsupipollenites triradiatus

Gnetaceaepollenites sinuosus

Neoraistrickia sp.

Verrucosisporites sp.

Kraeuselisporites sp.

Price correlated this core with upper Lower to Upper Permian sediments in the Denison Trough (Ingelara Formation to the top of the Bandanna Formation) and placed the assemblage in Evans' (1966a) spore unit P3b-4. On independent stratigraphic information he suggested that it probably represents an upper, rather than a lower part of P3b-4. The association of Dulhuntyispora spp., Didecitriletes ericianus and Gnetaceaepollenites sinuosus is typical of Evans (1967a, 1969) Stage 5, and on the presence of Dulhuntyispora parvithola it belongs to Paten's (1969) upper division.

The three samples from core 3 yielded a restricted and poorly preserved flora. From the association of Parasaccites spp., Punctatisporites spp. and bisaccate pollen, Price suggested a correlation with the Upper Carboniferous to Lower Permian Joe Joe Formation. A more refined stratigraphic interpretation is not possible on the available data.

Amoseas BALFOUR No. 1

Reference: Gerrard (1966a)

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Tert - Rec.		Surface - 34m	Surface - 110'
Jur.-Cret.	Eromanga Basin sequence	34 - 1036m	110 - 3398'
	- unconformity -		
Triassic	Moolayember Shale	1036 - 1183m	3398 - 3882'
	Clematis Sandstone	1183 - 1338m	3882 - 4391'
Permian	Bandanna Formation		
	equiv.	1338 - 1387m	4391 - 4550'
	Peawaddy Formation		
	equiv.	1387 - 1401m	4550 - 4597'
?Up. Carb.- Perm.	Joe Joe Formation	1401 - 1671m	4597 - 5481'
	- unconformity -		
Pre ?Up Carb.	basement intrusives	1671m - TD	481' - TD
Total Depth		1695m	5560'

Palynology: A total of 21 samples from the Upper Carboniferous to Permian interval in Balfour No. 1 well have been variously examined by Drugg, De Jersey, Playford and Evans (all in Gerrard, 1966a). Some of the samples have been re-examined (asterisked in table) and all these results and a re-interpretation in terms of Evans' (1967a, 1969) stage terminology are summarized below.

Sample	Depth		M.F.P.	Given Age	Author	Revised Stage
SWC	1356m	4450'		Up. Permian	Playford	Upper Stage 5
Cutt.	1362m	440'	4134	P3d-4	Evans	Upper Stage 5
Cutt.	1366m	4480'	4135*	P3d	Evans	Upper Stage 5
Cutt.	1372m	4500'	4136*	P3d	Evans	Upper Stage 5

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Given Age</u>	<u>Author</u>	<u>Revised Stage</u>
Cutt.	1378m	4520'	4137	P3c	Evans	Upper Stage 5
SWC	1379m	4525'		Up. Permian	Playford	Upper Stage 5
SWC	1381m	4531'	4129	P3c	Evans	Upper Stage 5
- unconformity -						
Core 5	1410m	4627'	4126*	C1-2	Evans	Biozone C - Early St. 2? Probably Stage 1
"	1411m	4628'		Artinsk.- Kungurian	Playford	?
SWC	1422m	4665'	4130*	C1-2	Evans	Probably Stage 1 ✓
SWC	1433m	4700'		Early Perm.	Playford	?
SWC	1476m	4844'		Early Perm.	Playford	?
SWC	1503m	4932'	4131*	C1	Evans	Stage 1 ✓
SWC	1514m	4967'		Early Perm.	Playford	?
SWC	1530m	5020'	4132*	C1	Evans	unidentifiable microfossils
Core 6	1552m	5092'	4127	C1	Evans	Stage 1 ✓
"	1552m	5093'		Early Perm.	Playford	?
SWC	1570m	5150'	4133*	C1	Evans	Stage 1 ✓
Core 7	1641m	5383'	4128*	C1	Evans	Stage 1 ✓
Core 8	1661-4m	5450-60'		Sakmarian/ Artinskian	Drugg	?
"	"	"		Lr Permian	De Jersey	Probably Stage 1

Evans examined a series of cuttings and side wall core samples from between 1356m and 1381m (4450 and 4531'). Using the distribution of somewhat rare acritarch species, he was able to subdivide the section and identify units P3c and P3d, which he correlated with the Black Alley Shale in the Denison Trough. In addition to sparse marine microplankton, Evans found Dulhuntyispora parvithola (sp. 123), Didecitriletes ericianus (sp. 115), Gnetaceaepollenites sinuosus (sp. 151), Marsupipollenites triradiatus (sp. 152), together with abundant Sulcatissporites spp. and Striatiti. Similar assemblages were recorded by Playford from side wall cores at 1356m (4450') and 1379m (4525'). This association is characteristic of Upper Stage 5.

Playford examined core 5 (1411m, 4628') and dated it Artinskian-Kungurian on a mixture of early and late Permian palynomorphs. Evans studied material from the same horizon and stated

"Dr Playford's 'Artinskian-Kungurian' age is not confirmed. Assemblages from both core 5 and the nearby SWC 1422m (4665 feet) were abundant and very similar to ones from the outcropping Joe Joe Formation, as sampled by BMR 7-9 (Springsure) shallow bores. If considered to be Permian, these assemblages are no younger than 'Sakmarian', but I would prefer to consider them of Late Carboniferous age."

The abundant, well preserved assemblages from core 5 (1410m, 4627') and the side wall core at 1422m (4665') have now been briefly re-examined and yielded

Phyllothecotriletes sp. 7 MFP 4126

cf. Phyllothecotriletes sp. 10

Calamospora sp. 4

Calamospora sp. 58

Anapiculatisporites sp. 17

Verrucosisporites sp. 910

Verrucosisporites sp. 8

Verrucosisporites sp. 28

Rugulatisporites sp. 22

Didecitriletes sp. 19

Reticulatisporites sp. 43

Kraeuselisporites sp. 35

Vallatisporites sp. 37

Punctatisporites gretensis (sp. 5)

Retusotriletes diversiformis (sp. 6)

Parasaccites spp.

Vestigisporites sp. 44.

This association of trilete spores is known from the Lower Carboniferous and from Stage 1 to Lower Stage 2 in other parts of the basin. However, in view of the presence of saccate pollen (Parasaccites spp., Vestigisporites sp. 44) and the absence of striatiti, the samples are probably of Stage 1 age. Cores and side wall cores from lower in the well (1433m to 1641m, 4700' to 5383') were examined by Evans and by Playford but only contained impoverished microfloras. Evans' species lists from 1503m, 1570m and 1641m (4932', 5150' and 5383') include only

Phyllothecotriletes sp. 7

Calamospora sp. 4

Didecitriletes cf. sp. 19

Punctatisporites gretensis (sp. 5)

Vestigisporites spp. 44, 193

Parasaccites sp. 50.

He dated these assemblages C1, which is equivalent to Stage 1.

Drugg examined core 8 and reported the presence of the genera Nuskoisporites, Apiculatisporites, Lunatisporites, Vestigisporites and cf. Potonieisporites. By comparison with the work of Balme on other Australian assemblages, he assigned a probable Lower Permian age to the sample. The same core was also studied by De Jersey, who found the trilete genera Anapiculatisporites, Apiculatisporites, Cyclogranisporites, Kraeuselisporites, Punctatisporites, Retusotriletes, Rugulatisporites, Stenozonotriletes and Verrucosisporites, together with the saccate pollen Parasaccites and Vestigisporites. He stated that

"...The significant species, from the aspect of correlation, are Parasaccites sp. and Vestigisporites sp. nov. The association of these species is characteristic of a section in the Phillips-Sunray Etonvale 1 well (comprising Cores 7 and 9 in that well), which has been assigned to the Lower Permian. Assemblages of similar character have also been obtained from the section between 1433m and 1554m (4700 feet and 5100 feet) in the Oil Development Maranda 1 well, which was likewise regarded as Lower Permian (De Jersey et al., 1963). Accordingly a Lower Permian age is favoured for the sediments of this core from Amoseas Balfour 1."

I have re-examined the intervals mentioned by De Jersey in Maranda no. 1 and Etonvale no. 1 wells and they do indeed contain Lower Permian Stage 2

microfloras. However, core 8 in Balfour no. 1 is thought to represent a somewhat older section. Its stratigraphic position below confirmed Stage 1 microfloras and its lack of striate bisaccate pollen limits its age to Late Carboniferous or older. The association of monosaccate pollen, Vestigisporites and possible Potonieisporites indicates a Late, rather than Early Carboniferous age. Consequently it is tentatively placed in Stage 1.

A problem still remains concerning the interval correlated with the Peawaddy Formation (1387 - 1401m, 4550 - 4597') by Gerrard (1966a). No palynological studies have been made to date on this part of the well section.

Sun Oil BARCOO No. 1

Reference: Garrett & Petersen (1968b).

Generalized section (taken from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1071m	Surface - 3515'
	- unconformity -		
Triassic	Clematis Sandstone	1071 - 1187m	3515 - 3895'
	- unconformity -		
Up.Carb.- Lr. Perm.	unnamed	1187 - 1710m	3895 - 5609'
	- unconformity -		
?Devonian	basement metamorphics	1710m - TD	5609' - TD
Total Depth		1716m	5631'

Palynology: Kemp and Paten (both in Garrett & Patersen, 1968b) have studied the microfloras of cores 1 to 4. Kemp's assemblage slides have been briefly re-examined and her datings are confirmed. Paten's results from the same cores, are quoted without comment (see table below).

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Given Age</u>	<u>Author</u>	<u>Revised Stage</u>
Core 1	1216m	3988'	4708	Late C1	Kemp	Stage 1
"	1216m	3988.5'		Barren	Paten	?
Core 2	1334m	4378'	4721	C1	Kemp	Stage 1
"	"	"		?Stage 1	Paten	?Stage 1
Core 3	1426m	4680'	4735	C1	Kemp	Stage 1
"	"	"		Stage 1	Paten	Stage 1
Core 4	1532m	5026'		Barren	Paten	?

From Core 1, Kemp found the following species (where her specimens could be located from slide co-ordinates, confirmatory or emended identifications are shown in brackets).

Punctatisporites gretensis (sp. 5)

Parasaccites cf. gondwanensis

Parasaccites sp. 191

Parasaccites sp. indet.

Calamospora cf. diversiformis (=Retusotriletes diversiformis, sp.6)

Granulatisporites spp.

Pityosporites sp. indet. (=Vestigisporites sp. 44)

Potonieisporites sp. cf. neglectus (=sp. 192)

Verrucosisporites sp. cf. gobbetti (=V. sp. 28)

Hymenozonotriletes sp. (=Vallatisporites sp. 36)

Kraeuselisporites sp.

Monosaccate sp. indet.

Botryococcus sp.

Further examination found Phyllothecotriletes sp. 7, Rugulatisporites sp. 22 and cf. Retusotriletes sp. 12. Punctatisporites gretensis and Parasaccites spp. make up 50% of the microflora (from specimen counts made by Kemp) and, in the absence of Striatiti, this assemblage can be placed in Stage 1 of Evans (1967a, 1969).

Core 2 contained a small yield of palynomorphs (both Paten and Kemp commented on their rarity). Paten questionably dated the assemblage as Stage 1 and recorded the following species.

?Punctatisporites gretensis

cf. Foveosporites sp.

Parasaccites sp. (abundant)

?Vestigisporites sp.

Kemp's species list is given below with bracketed comments as for core 1.

Punctatisporites gretensis (common) (sp. 5)

Calamospora diversiformis

Parasaccites spp. (confirmed)

Potonieisporites sp. (= cf. Vestigisporites sp. 193)

Kraeuselisporites sp. (sp. 35)

Bisaccate sp. indet. (= Vestigisporites sp. 44)

Botryococcus sp. (confirmed).

The slides also contained Rugulatisporites sp. 22 and Phyllothecotriletes sp. 7. A late Carboniferous, Stage 1 age is again confirmed for core 2.

From core 3, Kemp identified the following forms.

Parasaccites sp. (confirmed)

Potonieisporites sp. (= cf. Vestigisporites sp. 193)

Granulatisporites sp.

Punctatisporites sp. cf. gretensis (= ?sp. 5).

This list can now be extended to include

Rugulatisporites sp. 22

Calamospora sp. 4

Vestigisporites sp. 44

Potonieisporites neglectus (sp. 192)

Phyllothecotriletes sp. 7.

Paten gave an essentially similar species list (the unpublished species cannot of course be directly compared with BMR numbered species) and gave core 3 a Stage 1 dating.

Associated Australian Oilfields BERYL No. 1

Reference: Mines Administration (1964).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1000m	Surface - 3280'
	- unconformity -		
Up. Permian	Bandanna Formation	1000 - 1109m	3280 - 3640'
	- unconformity -		
Lr. Permian	unnamed	1109 - 1237m	3640 - 4060'
	- unconformity -		
?Devonian	metamorphic basement	1237m - TD	4060' - TD
Total Depth		1266m	4154'

Palynology: Evans (in Mines Administration, 1964) examined eleven samples from this well, ten of them from the Permian section. His results are set out below. Burger & Kemp (1972) also briefly reviewed Evans' results. Only cutting samples were available and palynological work showed that extensive caving had contaminated most of the assemblages with younger spores and pollen from higher in the well. Consequently zone identification had to be based on final appearances of microfossils, and in most cases this proved very difficult.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Age Given (Evans)</u>	<u>Revised Stage</u>
Cutt.	1006m	3300'	3315	?Permian	?Permian
Cutt.	1018m	3340'	3327	P3d-4	?Stage 5
Cutt.	1021m	3350'	3316	Permian (undiff.)	Permian (undiff.)
Cutt.	1033m	3390'	3321	Permian (undiff.)	Permian (undiff.)
Cutt.	1055m	3460'	3328	Permian (undiff.)	Permian (undiff.)
Cutt.	1079m	3540'	3329	?P3-4	?Stage 5

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Age Given (Evans)</u>	<u>Revised Stage</u>
Cutt.	1100m	3610'	3317	?P3-4	?Stage 5
Cutt.	1158m	3800'	3318	P1	Up. Stage 2-3
Cutt.	1189m	3900'	3319	P1	?Stage 3
Cutt.	1219m	4000'	3320	P1	Up. Stage 2-3

Evans report is quoted below:

"Cuttings 1006m (3300 feet) yielded an abundant microflora of Mesozoic forms with a few specimens (from) the Permian:

Protohaploxypinus limpidus

P. amplus

Marsupipollenites triradiatus

Apiculati gen. et sp. nov.

The latter, unnamed form is characteristically a P3d/P4 species. The rarity of these forms tends to reduce their potential significance as indicators of an Upper Permian age for the sample because the possibility of them having been reworked from underlying Permian into basal Jurassic sediments cannot be ruled out. Several instances of such a phenomenon have now been documented in the Great Artesian Basin".

A richer P3-4 microflora was reported from cuttings at 1018m (3340'). Evans species list includes:

Protohaploxypinus amplus

Protohaploxypinus limpidus

Striatopodocarpites cancellatus

Leiotriletes directus

Calamospora sp.

Lophotriletes sp.

Gnetaceaepollenites cf. G. sinuosus

Didecitriletes ericianus

He also reported rare Mesozoic palynomorphs, which he considered to be caving contaminants. The microflora is tentatively placed in Stage 5. The cuttings from 1021m, 1033m and 1055m (3350', 3390' and 3460') were heavily contaminated with Cretaceous and Jurassic specimens. Evans could not date the floras on the Permian forms present and no reinterpretation is attempted here. However, from their position between more distinctive assemblages, an Upper Permian age seems likely. Evans obtained a rich microflora from 1100m (3610'), which was dominated by Striatiti. He reported Camptotriletes biornatus from this horizon and in the absence of any Lower Permian species he dated it ?P3-4. It is here tentatively transferred to Stage 5.

Evans' description of the lowermost samples in Beryl no. 1 is quoted in full.

"Cuttings 1158m (3800 feet) yielded a moderate number of spores and pollen, mainly of Mesozoic type, and several good specimens of Parasaccites (al. Nuskoisporites) spp. which are typically abundant in the Lower Permian (P1). In view of the content of the underlying cuttings from 1189m (3900 feet), cuttings 1158m (3800 feet) are probably of Lower Permian (P1) age. Cuttings 1189m (3900 feet) contained:

Parasaccites spp. (common)

Verrucosisporites pseudoreticulatus

aff. Protohaploxylinus goraiensis

Protohaploxylinus spp. (fairly common)

V. pseudoreticulatus indicates an age no younger than P2. Its association with abundant Parasaccites spp. and aff. Protohaploxylinus goraiensis suggests a P1 age, possibly about P1c, i.e., similar to that of the Boonderoo Beds in the Hughenden Area and to the 'lower' Permian, of Exoil Brookwood no. 1. A similar microflora was found in cuttings at 1219m (4000 feet)."

The cuttings from 1189m (3900') have been re-examined and Evans' report of V. pseudoreticulatus (sp. 68) is confirmed. Also present are Granulatisporites sp. 59, Gnetaceaepollenites sinuosus (sp. 151) (probably a caving contaminant), Marsupipollenites triradiatus (sp. 152) and several Mesozoic forms. Verrucosisporites pseudoreticulatus (sp. 68) makes its first appearance at the base of Stage 3 and Marsupipollenites triradiatus (sp. 152) is very rare below that level. It should be noted that no restricted species characteristic of either Upper or Lower Stage 2 could be found. However, the allocation of this assemblage

to Stage 3 must be tempered with caution in view of the possibility of caving.

South Pacific BIRKHEAD No. 1

Reference: Grissett (1957).

Birkhead no. 1 well was drilled in 1957 and at that time little was known about the subsurface stratigraphy of this part of Queensland. Grissett (1957) divided the section into Jurassic, Triassic, Permian, Carboniferous and Devonian units, using lithological and wireline log characteristics but without the benefit of any palaeontologic control. Since then, several palynological studies have been reported (see below) and the stratigraphy of the well has undergone considerable revision. The most up to date interpretation is that of Exon et al. (1972) and this is quoted below.

Generalized section (after Exon et al., 1972):

AGE	FORMATION	DEPTH	
Jurassic	Eromanga Basin sequence	Surface - 372m	Surface - 1220'
	- unconformity -		
Triassic	Moolayember Formation	372 - 585m	1220 - 1920'
	Clematis Sandstone	585 - 713m	1920 - 2340'
	Dunda Beds	713 - 797m	2340 - 2615'
	Rewan Formation	797 - 872m	2615 - 2860'
Permian	Blackwater Group	872 - 893m	2860 - 2930'
	Black Alley Shale	893 - 988m	2930 - 3240'
	Colinlea Sandstone	988 - 1036m	3240 - 3400'
Carb.- Lr. Perm.	Joe Joe Formation	1036 - 1359m	3400 - 4460'
	- unconformity -		
Devonian	Etonvale Formation	1359m - TD	4460' - TD
Total Depth		1580m	5185'

Palynology: Many core and cutting samples have been studied from the Devonian to Jurassic strata of this well. Their palynostratigraphy was first reported by Evans (1961b) and later revised (Evans, 1962a). A third revision of the Upper Carboniferous to Permian section was made by Evans (1966a), who described selected assemblages in terms of his spore units. This discussion was later incorporated by Evans & Burger, essentially unchanged, as an appendix in the report of the Tambo/Augathella area (Exon et al., 1972). In addition, a sample from core 5 (1565m, 5136') was examined by De Jersey (1962). The results of all the palynological work to date on the Palaeozoic samples from Birkhead no. 1 are summarized below. None of these samples has been re-examined and the revised stage stratigraphy is interpreted from existing assemblage lists.

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Age Given</u>	<u>Report</u>	<u>Revised Stage</u>
Cutt.	884m	2900'	1116	P3-4	Evans 1966a Prob.Up.Stage 5
Cutt.	930m	3050'	1975	P3-4	Evans 1966a Prob.Up.Stage 5
Cutt.	960m	3150'	1976	P3-4	Evans 1966a Prob.Up.Stage 5
Cutt.	991m	3250'	1977	P3c	Evans 1966a Prob.Up.Stage 5
Core 4	1097m	3600'	1112	C1	Evans 1966a Stage 1
Cutt.	1128m	3700'	1300	Caving contam.	Evans 1962a ?
Cutt.	1158m	3800'	1301	Caving contam.	Evans 1962a ?
Cutt.	1189m	3900'	1302	Caving contam.	Evans 1962a ?
Cutt.	1219m	4000'	1303	V. poor	Evans 1961b ?
Cutt.	1250m	4100'	1304	V. poor	Evans 1961b ?
Cutt.	1280m	4200'	1305	Caving contam.	Evans 1962a ?
Cutt.	1311m	4300'	1306	Caving contam.	Evans 1962a ?
Cutt.	1341m	4400'	1307	Caving contam.	Evans 1962a ?
Cutt.	1372m	4500'	1308	Barren	Evans 1961b ?

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Age Given</u>	<u>Report</u>	<u>Revised Stage</u>
Cutt.	1402m	4600'	1309	Caving contam.	Evans 1962a	?
Cutt.	1433m	4700'	1310	V. poor	Evans 1961b	?
Cutt.	1463m	4800'	1311	Barren	Evans 1961b	?
Cutt.	1477m	4845'	1312	Barren	Evans 1961b	?
Cutt.	1494m	4900'	1313	V. poor	Evans 1961b	?
Cutt.	1524m	5000'	1314	Pre-Perm.	Evans 1966a	?Devonian
Cutt.	1535m	5035'	1315	Pre-Perm.	Evans 1966a	?Devonian
Core 5	1565m	5136'		Devonian	De Jersey 1962	Devonian

The confusion surrounding the initial dating of these samples (Evans, 1961b) resulted from the heavy caving contamination of most of the cuttings. The presence of Mesozoic spores in the interval 884 to 991m (2900 to 3250') and Upper Permian palynomorphs below 1128m (3700') led Evans to erroneously place the Triassic-Permian boundary below core 4 (1097m, 3600'). Later Evans (1962b) was able to identify a small in situ Lower Permian microflora in core 4 and could thus dismiss the Upper Permian spores below that horizon as caving contaminants. Bearing in mind these problems, it is now possible to subdivide the well in terms of Evans' (1967a, 1969) stage nomenclature. Full species lists for the critical samples have appeared in Evans (1966a) and Evans & Burger (in Exxon et al., 1972) and will not be repeated here.

In addition to Mesozoic caving contaminants, the cutting samples from 884 to 991m (2900 to 3250') contain a Stage 5, probably Upper Stage 5 microflora, characterised by Dulhuntyispora parvithola (sp. 123), Dulhuntyispora dulhuntyi (sp. 122), Gnetaceaepollenites sinuosus (sp. 151), Didecitriletes ericianus (sp. 115) and striate bisaccate pollen. The presence of abundant marine acritarchs at 991m (3250') allowed Evans (1966a) to correlate this level with his microplankton-based unit P3c in the Denison Trough. Birkhead no. 1 represents the westernmost margin of Upper Permian marine or brackish water conditions in this part of the Galilee Basin and is consequently also the westerly limit of the possible application of his microplankton-based units. Core 4 (1097m, 3600') contained an assemblage of trilete spores known

from Stage 1 and Lower Stage 2, including

Phyllothecotriletes sp. 7

Calamospora sp. 4

cf. Phyllothecotriletes sp. 10

cf. Retusotriletes sp. 12

Rugulatisporites sp. 22

Kraeuselisporites sp. 35

Vallatisporites sp. 37

Reticulatisporites sp. 43

The presence of monosaccate pollen and the apparent absence of striatiti allows us to date this sample as Late Carboniferous, Stage 1. By default, the cutting samples between 1128 and 147m (3700 and 4845'), although they contain variable numbers of Late Permian caving contaminants, must be at least as old as Stage 1. Evans (1962a) found rare, poorly preserved, possibly pre-Permian spores in the cuttings from 1524m and 1535m (5000' and 5035'), together with ubiquitous younger contaminants. From their proximity to the in situ Devonian assemblage described by De Jersey (1962) from core 5 (1565m, 5136'), they were questionably dated as Devonian.

Phillips-Sunray BONNIE No. 1

Reference: Kyranis (1966b).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1319m	Surface - 4327'
	- unconformity -		
Triassic	Clematis Sandstone	1319 - 1422m	4327 - 4665'
	- unconformity -		
Up. Permian	unnamed	1422 - 1506m	4665 - 4940'
	- unconformity -		
Lr. Permian	unnamed	1506 - 1707m	4940 - 5600'
	- unconformity -		
Dev.-Lr. Carb.	Adavale Basin sequence	1707 - TD	5600 - TD
Total Depth		2745m	9005'

Palynology: De Jersey (in Kyranis, 1966b) examined two side wall cores from this well (see below).

<u>Sample</u>	<u>Depth</u>	<u>Age Given</u>	<u>Revised Stage</u>
SWC	1476m 4844'	Up. Permian	Prob. Up. Stage 5
SWC	1605m 5267'	Lr. Permian	?Stage 1

The side wall core from 1476m (4844') (erroneously quoted as 4855' in report) yielded a microflora with abundant striate bisaccate pollen. De Jersey's list included the following species (*generic names changed to present usage).

*Didecitriletes uncinatus

Alisporites sp.

*Didecitriletes ericianus

Apiculatisporis sp.

Cycadopites sp.

Cyclogranisporites sp. (common)

Granulatisporites sp.

Kraeuselisporites sp.

Leiotriletes directus

Parasaccites sp.

Punctatisporites sp.

Protohaploxypinus sp. (common)

P. amplius (common)

P. limpidus (common)

Striatopodocarpites cancellatus (common)

S. fusus (common)

striate bisaccate pollen (common)

Vittatina sp.

The marker species Dulhuntyispora parvithola was not reported, but the presence of Didecitriletes ericianus and D. uncinatus mean that the assemblage probably belongs in Upper Stage 5. D. ericianus is known from Stage 5 and possibly Upper Stage 4, while D. uncinatus has so far only been found in Upper Stage 5. An Upper Stage 5 dating is also supported by regional stratigraphic evidence.

From the side wall core at 1605m (5267') (quoted as 5268') De Jersey reported the following palynomorphs.

Cirratriradites sp. cf. C. splendens

Cyclogranisporites spp. (common)

Dibolisporites sp.

Inaperturopollenites sp.

Leiotriletes sp.

Parasaccites sp. (common)

Punctatisporites spp. (common)

Verrucosisporites sp.

Indeterminate bisaccate pollen

De Jersey placed this sample in the Lower Permian but the abundance of monisaccate pollen and the apparent absence of Striatiti would rather support an Upper Carboniferous, Stage 1 dating. Unfortunately descriptions of many stage 1 and stage 2 spores and pollen species are unpublished and consequently it is often very difficult to accurately compare assemblages with those studied within the BMR.

Amoseas BOREE No. 1

Reference: Gerrard (1964b).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 1023m Surface - 3356'

AGE	FORMATION	DEPTH	
Triassic	Clematis Sandstone equivalent	1023 - 1154m	3356-3786'
Up. Permian	unnamed	1154 - 1222m	386 - 4009'
	- unconformity -		
Lr. Permian	unnamed	1222 - 1358m	4009 - 4457'
	- unconformity -		
?Sil.-Dev.	Adavale Basin sequence	1358 - 2676m	4457 - 8779'
?Silurian	economic basement (arkose)	2676m - TD	8779' - TD
Total Depth		2676m	8781'

Palynology: Two samples from the Permian interval were examined by Evans (in Gerrard, 1964b), with the results listed below. In addition, previously unreported cutting and side wall core samples, held in the BMR collections, have now been examined.

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Age Given</u>	<u>Revised stage</u>	
Core 7	1212-15m	3978-86'	3105	P3-4	Prob. Up. Stage 5
Cutt.	1213-16m	3980-90'	3835	not reported.	Up. Stage 5
Cutt.	1216-19m	3990-4000'	3836	not reported.	Up. Stage 5
Cutt.	1219-22m	4000-4010'	3837	not reported.	Up. Stage 5
SWC	1241m	4070'	3186	not reported.	Barren
SWC	1274m	4180'	3187	not reported.	Barren
SWC	1302m	4272'	3188	not reported.	Barren
Core 8	1327m	4355'	3106	P1a	Stage 1
SWC	1334m	4375'	3189	not reported.	Barren

The sample from core 7 (1212-15m, 3978-86') gave a poor yield but Evans recorded

Leiotriletes directus

Granulatisporites micronodosus

*Didecitriletes ericianus (fragments only)

*Lophotriletes tereteangulatus

Striatiti spp. (amplus and limpidus types)

(*generic names amended to present usage). He could only give an approximate age (P3-4) to this sample, based on the potentially somewhat doubtful indentifications of Didecitriletes ericianus. Assemblages from three cutting samples at and immediately below the level of core 7 are much richer. They were not studied by Evans but a recent examination by the present author yielded

Dulhuntyispora parvithola (sp. 123)

Didecitriletes ericianus (sp. 115)

D. uncinatus (sp. 114)

Gnetaceaepollenites sinuosus (sp. 151)

Marsupipollenites triradiatus (sp. 152)

Leiotriletes directus (sp. 207)

Retusotriletes diversiformis (sp. 6)

Lophotriletes tereteangulatus (sp. 113)

Lophotriletes sp. 183

Baculatisporites sp. 109

Granulatisporites micronodosus (sp. 111)

Granulatisporites sp. 59

Kraeuselisporites sp. 1112

Protohaploxypinus spp. (v. abundant, chiefly P. amplus-limpidus types)

Striatopodocarpites spp. (incl. S. phaleratus, sp. 210)

Sulcatisporites ovatus (sp. 138)

Limitisporites spp.

Botryococcus sp. (possibly caving contaminant).

If one assumes that extensive uphole caving has not occurred, then these assemblages can be confidently dated as Upper Stage 5. By superposition and from its rather sparse microflora, core 7 can then be given a probable Upper Stage 5 dating.

Core 8 (1327m, 4355') is the only sample to have yielded spores from the lower part of the supposed Permian section in Boree no. 1. Evans (in Gerrard, 1964b) originally assigned it to spore unit Pla but later (Evans, 1966a) gave a revised species list and dating. In the latter he recorded (*generic names amended to present usage)

Punctatisporites gretensis (sp. 5)

Calamospora sp. 4

Retusotriletes diversiformis (sp. 6)

*Phyllothecotriletes sp. 7

*cf. Phyllothecotriletes sp. 10

Verrucosisporites sp. 173

Verrucosisporites cf. sp. 171

Verrucosisporites sp. 30 (probably Rugulatisporites sp. 22)

Vallatisporites sp. 37.

He noted "the apparently complete absence of saccate pollens" and dated it C1. Under his later stage nomenclature this can now be altered to Stage 1.

Exoil BROOKWOOD No. 1

References: Pemberton (1963).

Generalized section: (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - ?911m	Surface - ?2988'
	- unconformity -		
Triassic	Brookwood Beds	?911 - 1042m	?2988 - 3417'
Up. Permian	Betts Creek Beds	1042 - 1264m	3417 - 4147'
	- unconformity -		

AGE	FORMATION	DEPTH	
Lr. Permian	Joe Joe Formation	1264 - 1462m	4147 - 4796'
	- unconformity -		
?	granite basement	1462m - TD	4796' - TD
Total Depth		1465m	4806'

The Permian interval in Brookwood no. 1 can be correlated with other wells to the south using wireline logs (Muttaborra no. 1 and Glenaras no. 1 are the nearest). Unfortunately palynological control is lacking across the critical section but the Upper/Lower Permian regional unconformity is thought to be rather higher than shown by Pemberton (1963), and is now tentatively placed at or near 1140m (3740'). If this horizon is taken as the boundary, then the underlying 125m (410') can be identified as a correlate of the coal-bearing Stage 3 sandstones and shales (unit D) in Glenaras no. 1 and Marchmont no. 1, where a similar thickness is developed. This is in turn underlain by a markedly thinner section of the major stage 2 shale (unit C). In Brookwood no. 1 this unit is only 30m (100') thick, compared with 107m (350') in Glenaras no. 1 and 192m (630') in Rand no. 1. A sequence of interbedded sandstones and shales makes up the lower part of the section in Brookwood no. 1. This is equated with similar intervals (unit B), dated Lower to Upper Stage 2, in wells to the south.

Palynology: Palynological samples from four cores, recovered from the Permian interval in Brookwood no. 1, were studied by Evans and by De Jersey (both in Pemberton, 1963). Their results were reviewed by Evans (1964c) and again by Burger & Kemp (1972). Palynologic stage nomenclature was applied in the latter paper and this has not been changed in the present study. The results are summarized below.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Spore Unit Given</u>	<u>Author</u>	<u>Revised Stage</u>
Core 9	1078m	3537'		Up.Perm.	De Jersey	Up. Stage 5
"	1079m	3539'	2245	P3 - 4	Evans, 1964c	Up. Stage 5
Core 10	1169m	3834'	2246	Barren	Evans, 1964c	?
Core 12	1352m	4437'	2247	Pla-b	Evans, 1964c	Stage 2 (undiff.) Upper 2 (lower part)
Core 13	1446m	4744'	2248	Pla-b	Evans, 1964c	Stage 2 (?Up. 2)

Evans (in Pemberton, 1963) could not describe a diagnostic microflora from core 9 (1079m, 3539'). He reported common Striatiti and Sulcatisporites ovatus but the trilete spores listed only constituted long ranging forms.

However De Jersey (in Pemberton, 1963) described another, much more diverse assemblage from the same core (1078m, 3537'). This included Dulhuntyispora parvithola and Didecitriletes ericianus, which confidently date the sample as Upper Stage 5. Day (in Pemberton, 1963) also listed three species of the plant macrofossil Glossopteris from core 9 (G. indica Schimper, G. browniana Brongniart and G. angustifolia Brongniart). He stated "the species represented are widespread, long-ranging forms and it is not possible to give a more precise age determination than Permian."

Core 10 (1169m, 3834') was examined by Evans (in Pemberton, 1963) and proved to be barren. Its stratigraphic position is from within the coal-bearing sequence (unit D), which can be tentatively correlated with a similar interval in wells to the south using wireline logs. In Glenaras no.1 and Thunderbolt no. 1 unit D has been dated as stage 3.

Evans (in Pemberton, 1963) dated cores 12 (1352m 4437') and 13 (1446m, 4744') as Lower Permian and later (Evans, 1964c) emended this to spore unit Pl_a-b. Burger and Kemp (1972) reassigned these samples to Stage 2. Specimens listed on BMR sample cards have now been re-examined and a Stage 2 dating is confirmed for both samples. Core 12 (1352m, 4437') yielded a very sparse microflora and the following forms were identified by the present author.

Punctatisporites gretensis (sp. 5)

Phyllothecotriletes sp. 7

Retusotriletes diversiformis (sp. 6)

Rugulatisporites sp. 22

Kraeuselisporites sp. 35

Apiculatisporis cf. sp. 62 (a single very questionable specimen)

Klausipollenites sp. 82

Parasaccites spp.

Protohaploxypinus rugatus (sp. 198)

Quadrисporites horridus (sp. 211).

This assemblage is dated Stage 2 but any further subdivision cannot be justified, owing to its low diversity. Core 13 (1446m, 4744') contained the species listed below (after Evans, with new data)

Rugulatisporites sp. 22

Apiculatisporis sp. 62

Calamospora sp. 58

Monocolpate pollen sp. 186

Parasaccites spp. (the commonest genus)

Trisaccate pollen

Potonieisporites neglectus (sp. 192)

Protohaploxylinus aff. goraiensis (sp. 187)

Protohaploxylinus rugatus (sp. 198)

Protohaploxylinus sp. 904.

This can also be placed in Stage 2 on the presence of striate pollen and the abundance of Parasaccites spp. The presence of Apiculatisporis sp. 62, Monocolpate pollen sp. 186 and Protohaploxylinus sp. 904 indicate a position within Upper Stage 2. However, many of the common Upper Stage 2 spores, notably Granulatisporites sp. 59, Lophotriletes tereteangulatus (sp. 113) and Lophotriletes sp. 183 are not present. If this core came from Upper Stage 2, as is tentatively suggested, then it must represent the basal part of the unit. In Thunderbolt no. 1, Upper/Lower Stage 2 boundary lies between 143 and 169m (470 and 555') below the base of the major shale unit mentioned above (unit C). In Brookwood no. 1 this questionably Upper Stage 2 microflora comes from 154m (505') below the base of the same shale unit.

Alliance BUDGERYGAR No. 1

Reference: Cadart (1969).

Budgerygar no. 1 was drilled in 1968 very close to the western flank of the Canaway Ridge, which separated the Cooper and Galilee infrabasins. It technically lies within the Cooper Basin, but penetrated a thin Permian section which is very similar to that in the Yongala wells. Geophysical and stratigraphic data, supported by the results of drilling Budgerygar no. 1, indicate that the subsurface Canaway Ridge was partly breached for a short time in the Late Permian. For these reasons the palynologic data on the Permian section is included here.

Generalized section (quoted from well completion report):

AGE	FORMATION	DEPTH	
Jur. - Cret.	Eromanga Basin sequence	Surface - 1558m	Surface - 5111'
	- unconformity -		
Triassic	unnamed	1558 - 1612m	5111 - 5288'
Up. Permian	unnamed	1612 - 1617m	5288 - 5306'
	- unconformity -		
?Early Palaeoz.	granodiorite basement	1617m - TD	5306' - TD
Total Depth		1631m	5350'

Palynology: Paten (in Cadart, 1969) examined the pollen and spores in three samples from Budgerygar no. 1. One of these (cuttings from 1615m, 5300') came from the Permian interval and was dated as ?Upper Permian (?Stage 5). Paten's report on this sample is quoted fully below, without changes to his species or genus names.

"Cuttings 1615m, 5300"

Yield: common, broken and poorly preserved plant microfossils.

Marsupipollenites triradiatus

"M" sinuosus

Parasaccites sp.

Protohaploxypinus limpidus

P. amplus

Striatopodocarpites sp. cf. S. fusus

The assemblage from cuttings 1615m (5300') contained an abundance of striate bisaccate pollen with relatively few other forms. The presence of "M". sinuosus gives an age range of Lower (but not lowest) to Upper Permian for the microflora. In the Cooper Basin this species appears a short distance above the base of the Middle Member of the Gidgealpa Formation and ranges through the Upper Member of that formation.

"In view of the abundance of striate bisaccate pollen and the absence of species typical of the Middle Member, the sample is probably from sections equivalent to part of the Upper Member of the formation. It is not uncommon to recover from the Upper Member, assemblages dominated by striate pollen without the species which are normally characteristic of that part of the section. Assignment to the Upper Member would probably imply an Upper Permian age and would identify the sampled horizon with a level towards the top of palynologic Stage 5 of Evans (1967a)."

Paten (1969) subsequently assigned the Upper Member of the Gidgealpa Formation (=Toolachee Formation of Gatehouse, 1972) to Upper Stage 5. So following his correlations, the cuttings from 1615m (5300') Budgerygar no. 1 can be given a ?Upper Stage 5 dating.

Phillips - Sunray BURY No. 1

Reference: Patterson (1966).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1178m	Surface -3866'
	- disconformity -		
Triassic	Clematis Sandstone	1178 - 1305 m	3866 - 4280'
	- disconformity -		
Up. Permian	unnamed	1305 - 1402m	4280 - 4600'
	- disconformity -		
"Lr. Permian"	unnamed	1402 - 1604m	4600 - 5264'
	- unconformity -		
?Lr.M. Dev.	Adavale Basin sequence	1604m - TD	5264' - TD
Total Depth		2744m	9004'

Palynology: Evans (in Patterson, 1966) studied eleven samples from this well, including four (see below) from the Upper Carboniferous to Permian interval.

Sample	Depth		M.F.P.	Age Given	Revised Stage
SWC	1336m	4383'	4063	P3b-4	Upper Stage 5
SWC	1339m	4393'	4070	P3b-4	Prob. Up. Stage 5
SWC	1437m	4715'	4064	C1	Stage 1
SWC	1551m	5088'	4065	C1	Stage 1

The side wall core from 1336m (4383') has been re-examined and contains a poorly preserved microflora dominated by Striatiti and Sulcatisporites ovatus (sp. 138). Identifiable trilete spores include Dulhuntyispora parvithola (sp. 123), Didecitriletes uncinatus (sp. 114) and Gnetaceaepollenites sinuosus (sp. 151) and the assemblage can be placed in Evans' (1967a, 1969) Upper Stage 5. The microflora from side wall core 1339m (4393') shows much better preservation but contains a more restricted microflora. Again it contains Striatiti in flood abundance, so that other pollen and spores are relatively rare. The presence of Gnetaceaepollenites sinuosus (sp. 151) shows that it is not older than Upper Stage 4. Although no unequivocal markers could be identified, the presence of Indospora sp. 911 and Lunulasporites colliensis suggest a probable Upper Stage 5 dating.

Evans (in Patterson, 1966) assigned the side wall cores from 1437m and 1551m (4715' and 5088') to spore unit C1. He listed the following species (data from BMR files).

	SWC 1437m(4715')	SWC 1551m(5088')
<u>Phyllothecotriletes</u> sp. 7	x	x
<u>Calamospora</u> sp. 4	x	x
<u>Reticulatisporites</u> sp. 43	x	x
<u>Verrucosisporites</u> sp. 28	x	x
<u>Rugulatisporites</u> sp. 22	x	
<u>Retusotriletes diversiformis</u> (sp. 6)	x	
<u>Didecitriletes</u> sp. 19		x
<u>Vallatisporites</u> sp. 37	?	x
<u>Punctatisporites gretensis</u> (sp. 5)		x
<u>Verrucosisporites</u> sp. 8		x
<u>Vestigisporites</u> sp. 44	x	x
<u>Parasaccites</u> spp.	x	x

These samples have not been restudied but this association of trilete spores and monosaccate pollen, taken together with the absence of *Striatiti*, confirms his determination of spore unit C1. They can now be placed in Stage 1, of Late Carboniferous age.

Phillips - Sunray CARLOW No. 1

Reference: Kyranis (1966a).

Generalized section (after well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1213m	Surface - 3980'
Triassic	Moolayember Formation	1213 - 1265m	3980 - 4150'
	Clematis Sandstone	1265 - 1390m	4150 - 4561'
"Permian"	unnamed	1390 - 1690m	4561 - 5546'
	- unconformity -		
Devonian	Adavale Basin sequence	1690 - 3423 m	5546 - 11,230'
Lr. Dev. or Pre-Dev.	"basement"	3423m - TD	11,230' - TD
Total depth		3666m	12,028'

Palynology: De Jersey (in Kyranis, 1966a) examined a sample from core 6 (1678m, 5506.6') and described a restricted microflora including

Alisporites sp.

Apiculatisporis sp.

Convolutispora sp.

Densosporites sp.

Endosporites sp.

Leiotriletes sp.

Polypodiisporites sp.

Punctatisporites sp.

Stenozonotriletes sp.

He stated

"This assemblage is lacking in distinctive species known from either the Permian or Devonian of Queensland. The presence of Alisporites and Polypodiisporites favours a Permian or Late Carboniferous, rather than a Devonian age; furthermore none of the typical species of the Devonian of the Adavale Basin has been observed".

De Jersey went on to compare the assemblage with that from core 8 (1327m, 4355') of Amoseas Boree no. 1, which was given a C1 dating by Evans (1966a) and which is now considered to belong in Stage 1. In view of the occurrence of Alisporites and the lack of Striatiti, and taking the forementioned correlation into account, the microflora from core 6 in Carlow no. 1 can be questionably placed in Stage 1.

To date there is no palynological control on the upper part of the alleged Permian succession in this well. However, Upper Permian (Upper Stage 5) microfloras are known from a number of other wells drilled in close proximity to Carlow no. 1 (e.g. Bury no. 1, Boree no. 1, Etonvale no. 1). Lithological and electric log comparisons suggest that Upper Permian sediments may also be present here.

Beaver - Pexa COREENA No. 1

Reference: Leslie (1970b).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 303m	Surface - 994'
Triassic	Moolayember Formation	303 - 415 m	994 - 1360'
	Clematis Sandstone	415 - 509m	1360' - 1670'
	Rewan Formation	509 - 668m	1670 - 2193'
	- unconformity -		
Up. Permian	Bandanna Formation	668 - 742m	2193 - 2436'
	Colinlea Sandstone	742 - 809m	2436 - 2653'
	- unconformity -		

AGE	FORMATION	DEPTH	
Up. Carb. - Lr. Perm.	Reid's Dome Beds	809 - 872m	2653 - 2860'
	Joe Joe Formation	872 - 1579m	2860 - 5181'
	- unconformity -		
Siluro- Devonian	igneous basement	1579m - TD	5181' - TD
Total depth		1587m	5208'

Palynology: Paten (in Leslie, 1970b) examined four cuttings samples and one conventional core sample from Coreena no. 1. His results are summarized below.

<u>Sample</u>	<u>Depth</u>		<u>Stage Given</u>	<u>Revised Stage</u>
Cutt.	671m	2200'	Stage 5	Up. Stage 5
Cutt.	814m	2670'	caving contam.	?
Cutt.	899m	2950'	Stage 2 - 3	Stage 2 - 3
Core 3	1388m	4555'	Stage 2	Stage 2 (undiff.)
Cutt.	1567m	5140'	?Stage 1	?Stage 1

The cuttings from 671m (2200') contained the following species (*generic names changed to present usage).

Didecitriletes ericianus

Dulhuntyispora parvithola

Kraeuselisporites spp.

Granulatisporites micronodosus

Granulatisporites trisinus

Microreticulatisporites bitriangularis

*Lunulasporites colliensis

Marsupipollenites triradiatus

Marsupipollenites striatus

*Gnetaceaepollenites sinuosus

Parasaccites sp.

Striatopodocarpites fusus

Striatiti spp.

Paten referred this assemblage to Stage 5. He stated that "it is not possible from present palynologic knowledge to specify the position within Stage 5. From the stratigraphic evidence however, it is likely that the interval sampled represents an horizon towards the top of Stage 5 (Upper Permian)". Paten's species list supports this statement. The presence of Dulhuntyispora parvithola, Microreticulatisporites bitriangularis and Didecitriletes ericianus, together with the supplementary species Gnetaceaepollenites sinuosus and Lunulasporites colliensis, indicate that in the absence of caving the sample can be dated Upper Stage 5.

Paten found that the cuttings from 814m (2670') were contaminated by caving. He could not identify sufficient in situ spores to date that horizon. From 899m (2950') he identified the following assemblage.

Leiotriletes directus

Punctatisporites spp.

Punctatisporites gretensis

Granulatisporites micronodosus

Kraeuselisporites spp.

Verrucosisporites sp. cf. V. pseudoreticulatus

cf. Polypodiidites hamatus

Marsupipollenites triradiatus

Marsupipollenites striatus

cf. Podocarpidites sp.

Parasaccites sp.

Vestigisporites sp.

Cycadopites sp. cf. C. cymbatus

Protohaploxypinus amplus

Striatopodocarpites cancellatus

Striatoabietites multistriatus

Striatiti spp.

Quadrisporites horridus.

Of this sample, Paten stated "it is Lower Permian in age and a position towards the top of Stage 2 or in the lower part of Stage 3 is indicated". Verrucosisporites pseudoreticulatus first appears at the base of Stage 3. However Paten's record is only a cf. determination and even then may represent cavings from a higher stratigraphic level. Consequently a more refined stage allocation cannot be given.

From core 3 (1388m, 4555') Paten listed a small microflora including

Granulatisporites sp.

Cyclogranisporites sp.

Rugulatisporites sp. (=R. sp. 22 of Evans, 1964b).

Kraeuselisporites sp.

Retusotriletes diversiformis

Parasaccites spp.

Vestigisporites sp. 193 (of Evans, 1964b)

Protohaploxypinus goraiensis

?Monocolpate pollen sp. indet.

Paten placed this assemblage in Stage 2. He thought that the presence of Rugulatisporites sp. 22 suggested an early Stage 2 age (spore units C2-P1a), and cited Evans' (1966a) comparative C2-P1a microfloras from core 15 (1356m, 4450') and core 18 (1542m, 5060') in Maranda no. 1 well. The range and taxonomy of Rugulatisporites sp. 2 are still under investigation but it appears to range at least upto Stage 3. The two horizons in Maranda no. 1 have been re-examined and are now dated as Upper Stage 2 and Stage 2 (undifferentiated) respectively. At present core 3 in Coreena no. 1 cannot be more accurately placed than Stage 2 (undifferentiated).

The cuttings from 1567m (5140') were dated by Paten as questionably Stage 1. His discussion of this sample is quoted below.

"Cuttings (from) 1567m (5140') gave an assemblage with a prominent proportion of large monosaccate pollen. A number of undescribed species of spores was present, including Rugulatisporites sp. (=R. sp. 22 of Evans, 1966a) and apiculate mesosporids. The assemblage is typical of the late Carboniferous to early Permian sediments (Joe Joe Formation) of the Galilee Basin (Stage 1 - 2 of Evans, 1969). It is likely that the striate bisaccate pollen and Marsupipollenites triradiatus, which are very rare, were derived

"from cavings of younger Permian strata. If this is so, a late Carboniferous (Stage 1) rather than an early Permian (Stage 2) age is favoured for the interval sampled. This assemblage is similar to, but slightly older in character than that recorded as Stage 2 from core 3 (1388m, 4555') from this well".

Magellan CORFIELD No. 1 Bore

Reference: Harris (1960).

In 1960 a water bore at Corfield was deepened by Magellan Petroleum Corporation in a subsidized operation to obtain stratigraphic information. The bore was initially drilled to 802m (2630') and wireline logs were run by the Bureau of Mineral Resources to 747m (2450') (Jewell, 1960). The deepened hole entered granite basement at 1368m (4488') and was discontinued at a total depth of 1374m (4507') (Harris, 1960). Preliminary palynological results were reported by Evans (1961a) and these were revised in a later record (Evans, 1962b).

Generalized section (after Evans, 1962b):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1085m	Surface - 3560'
	- disconformity -		
?Triassic	unnamed	1085 - 1250m	3560 - 4100'
Up. Permian	unnamed	1250 - 1368m	4100 - 4488'
	- unconformity -		
Pre-Permian	granite basement	1368m - TD	4488' - TD
Total Depth		1374m	4507' (driller)

Palynology: Evans (1962b) described two assemblages from the Permian interval. He dated them Upper Permian and his comments are quoted verbatim, without taxonomic changes.

"Cuttings, 1250-51m (4100 - 4105 feet) (Coal) (M.F.P. 2149)
 Apiculati sp. (fairly common)
 Striatiti spp. (common)

"Core 4, 1299 - 1303m (4262 - 4276 feet) (Coal) (M.F.P. 1170)

Laevigatosporites vulgaris

Acanthotriletes spp. incl. A. tereteangulatus

Alisporites ovatus

Klausipollenites sp.

Striatiti spp. (very common) incl. Lunatisporites
amplus, L. limpidus

Circulisporites cf. parvus

Marsupipollenites triradiatus striatus

Evans (1961a) concluded that core 4 was possibly of Lower Triassic age. However, the better spore yield from reprocessed material indicates that the core is of very young Permian age. The association of L. vulgaris and very common Striatiti is an unusual one apparently confined to the highest coals of the Upper Bowen beds of the Surat and the southern Bowen Basins: for example, the highest coals in the Bandanna Formation of Reid's Dome, A.A.O. No. 7 (Arcadia) and Cabawin No. 1.

Although not as varied as that in core 4, the assemblage from cuttings, 1250 - 51m (4100 - 4105 feet), is considered on the same premises to be of Permian age."

From Evans' description these two samples can possibly be assigned to Stage 5. The assemblages are certainly Permian (from the presence of Striatiti, Marsupipollenites and Lophotriletes tereteangulatus). However, Lunulasporites colliensis (sp. 132) is not restricted to Stage 5. It is also known from Stage 4 (Evans, 1967a, 1969) and from Stage 3 (e.g. in Maranda no. 1 and Lovelle Downs no. 1). Its association in Corfield no. 1 with abundant striate bisaccate pollen is certainly suggestive of Stage 5, as exemplified by other samples in the Galilee Basin, and this is supported by regional stratigraphic evidence.

Phillips-Sunray COTHALOW No. 1

References: Lewis (1961) and Phillips Petroleum Co. (1965).

Cothalow no. 1 was drilled in 1961 on a seismically defined anticline, to test Mesozoic and older formations (Lewis, 1961). It was plugged and abandoned at a depth of 1836m (6025') in red beds of the Buckabie Formation. After the discovery of gas in the nearby Phillips-Sunray Gilmore no. 1, the

well was reopened and deepened to test the Devonian sediments of the Adavale infrabasin (Phillips Petroleum Co., 1965). It was drilled to volcanic basement and again plugged and abandoned at a total depth of 2613m (8573'). During this second operation the stratigraphy of the entire well was reviewed and brought up to date. This is set out below.

Generalized section (after Phillips Petroleum Co., 1965):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1543m	Surface - 5061'
	- unconformity -		
Lr. Permian	unnamed	1543 - 1600m	5061 - 5250'
	- unconformity -		
Dev.-?Carb.	Adavale Basin sequence	1600 - 2565m	5250 - 8414'
unknown	basement volcanics	2565m - TD	8414' - TD
Total Depth		2613m	8573'

Palynology: No palynological studies have been reported on the supposed Lower Permian interval in this well. A set of three cutting samples in the BMR collections (1545-48m, 5070-80'; 1576-79m, 5170-80'; 1594-97m, 5230-40') were examined for this study. They are all heavily contaminated by Mesozoic palynomorphs, presumably from cavings. The slides also contain very rare and carbonised spores, whose mode of preservation suggests a pre-Mesozoic origin. These could not be identified specifically and no dating can be given for the samples. The complete lack of striate bisaccate pollen may indicate the absence of the Permian (but not Stage 1). In view of the possible diagenetic degradation of the spores mentioned above, this negative evidence should be treated with utmost caution.

Amoseas CUNNO No. 1

Reference: Gerrard (1966b).

Generalized section (formations as quoted in well completion report):

AGE	FORMATION	DEPTH	
Recent		Surface - 6m	Surface - 20'
	- unconformity -		
Jurassic	Eromanga Basin sequence	6 - 367m	20 - 1205'
Triassic	Moolayember Shale	367 - 636m	1205 - 2085'
	Clematis Sandstone	636 - 744m	2085 - 2440'
Permian	Bandanna Formation	744 - 800m	2440 - 2625'
	Peawaddy Formation	800 - 833m	2625 - 2733'
	unnamed basal sandstone	833 - 848m	2733 - 2781'
	- unconformity -		
Pre-Permian	Volcanic basement	848m - TD	2781' - TD
Total Depth		862m	2828'

Palynology: Drugg (in Gerrard, 1966b) examined one Triassic (core 2, 554-55m, 1817-22') and one Permian sample (core 4, 791-92m, 2594-98') for marine/nonmarine affinities, but he did not discuss the age of the sediments. Evans (unpublished BMR data) studied 13 conventional and side wall core samples and his findings and their reinterpretation in terms of his stage nomenclature are set out below.

Sample	Depth		M.F.P.	Given Spore Unit	Revised Stage
SWC	744m	2440'	4233	P3d/P4	Prob.Up. Stage 5
SWC	750m	2460'	4234	P3d/P4	Up. Stage 5
SWC	759m	2490'	4235	P3d	Up. Stage 5
SWC	765m	2510'	4236	P3b/P3d	Prob.Up.Stage 5
Core 4	792m	2597'	4204	P3b/P3d	Up. Stage 5
SWC	800m	2624'	4237	Barren	?
SWC	824m	2702'	(Unsuitable for processing)		
SWC	826m	2710'	4197	P3b/P3d	Prob.Up. Stage 5
SWC	829m	2720'	4198	P3b	Up. Stage 5
SWC	833m	2734'	4199	Barren	?
SWC	839m	2754'	4200	Barren	?
SWC	841m	2760'	4201	Barren	?
SWC	846m	2774'	4202	Barren	?

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The lower four samples (side wall cores from 833m, 2734': 839m, 2754'; 841m, 2760'; and 846m, 2774') came from the unnamed basal sandstone. They contained no microfossils and thus could not be dated. Evans provided a species list for the remaining seven fossiliferous samples. He found that long ranging forms, such as Punctatisporites gretensis (sp. 5), Retusotriletes diversiformis (sp. 6), Cyclogranisporites sp. 107 and Leiotriletes directus (sp. 207), occur with

Baculatisporites sp. 109 (Stage 3 to 5)

Lophotriletes tereteangulatus (sp. 113) (Up. Stage 2 to 5)

Kraeuselisporites apiculatus (sp. 127)

Marsupipollenites triradiatus (sp. 152) (Up. Stage 2 to 5)

Granulatisporites trisinus (sp. 703) (Stage 2 to 5)

Vitreisporites pallidius (sp. 135)

Sulcatisporites ovatus (sp. 138)

and abundant Protohaploxypinus spp. and other Striatiti. The association of the above species with

Dulhuntyispora parvithola (sp. 123)

Didecitriletes ericianus (sp. 115)

Microreticulatisporites bitriangularis (sp. 121)

Lunulasporites vulgaris (sp. 132)

Bascanisporites undosus (sp. 139)

conclusively indicates that the samples can be placed in Upper Stage 5.

Evans' subdivision of spore unit P3 in this well is based on the distribution of certain acritarch species. The P3a-d zonation was originally worked out in the Denison Trough and its application to this part of the Galilee Basin still requires more detailed study. Two other observations in Cunno no. 1 need to be mentioned. Calamospora sp. 4 has been recorded from 2720', in a sample dated as Upper Stage 5. Elsewhere in the basin it does not occur above the lower part of Stage 3. A questionable identification of Phyllothecotriletes sp. 7 at 826m (2710') holds similar complications, as this form only occurs in Stages 1 and 2 in other wells.

Phillips-Sunray DARTMOUTH No. 1

Reference: Knuth (1967).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1387m	Surface - 4552'
	- disconformity -		
Lr. Permian	unnamed	1387 - 1556m	4552 - 5104'
	- unconformity -		
M. Devonian	Adavale Basin sequence	1556m - TD	5104' - TD
Total Depth		3051m	10,010'

Palynology: Evans and De Jersey (both in Knuth, 1967) have studied three samples from the Permian section and their results are set out below.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Age Given</u>	<u>Author</u>	<u>Revised Stage</u>
SWC	1395m	4578'	4142	P1a	Evans	Up. Stage 2
SWC	1423m	4670'	4143	P1a	Evans	Up. Stage 2
Core 2	1550m	5085'		Lr. Permian	De Jersey	Stage 2 — no greater precision possible

In the side wall core from 1395m (4578') Evans found

Calamospora sp. 4

Punctatisporites gretensis (sp. 5)

Retusotriletes diversiformis (sp. 6)

*Phyllothecotriletes cf. sp. 7

*Didecitriletes cf. sp. 19

*Rugulatisporites sp. 22

*Vestigisporites sp. 44

Apiculatisporis sp. 62

*Klausipollenites sp. 82

aff. Cristatisporites sp. 174

Lophotriletes cf. sp. 183

Monocolpate pollen sp. 186

Protohaploxylinus aff. goraiensis (sp. 187)

Parasaccites sp.

(*names changed to present usage)

The side wall core from 1423m (4670') (also after Evans) contained a somewhat less diverse microflora including

Calamospora sp. 4

Retusotriletes diversiformis (sp. 6)

*Phyllothecotriletes cf. sp. 7

*Didecitriletes sp. 19

*Rugulatisporites sp. 22

Apiculatisporis sp. 62

Protohaploxylinus aff. goraiensis (sp. 187)

Parasaccites sp.

The association of Calamospora sp. 4, Didecitriletes sp. 19, Vestigisporites sp. 44 and Protohaploxylinus aff. goraiensis, together with the absence of Verrucosisporites pseudoreticulatus (sp. 68), Granulatisporites trisinus (sp. 703) and more diverse striatiti, indicate that these samples belong in Stage 2. In Thunderbolt no. 1, Apiculatisporis sp. 62 and Monocolpate pollen sp. 186 do not appear until half way through the stage. Consequently the samples are dated as Upper Stage 2.

De Jersey examined a sample from core 2 (1550m, 5085') and he listed the following species.

Converrucosisporites sp.

Cycadopites sp.

Endosporites sp.

Granulatisporites sp.

Leiotriletes sp.

Marsupipollenites aff. sinuosus

Parasaccites sp.

Punctatisporites spp.

Verrucosisporites sp.

Bisaccate pollens (indet.)

Striate bisaccate pollen (indet.)

This assemblage, coming as does from below Evans Upper Stage 2 samples, is inconsistent in containing "Marsupipollenites aff. sinuosus." Typical Gnetaceaepollenites sinuosus (sp. 151) does not appear until the base of Upper Stage 4. If this contradictory occurrence is set aside, the presence of Striatiti and its superposition by definite Upper Stage 2 microfloras indicate that this sample is also of Stage 2 age.

The Permian interval in Dartmouth no. 1 is relatively thin (only 168m (552') according to Knuth, 1967). It is bracketed by a Jurassic palynological determination at 1367m (4484') and a Devonian one at 1663m (5457') (Evans in Knuth, 1967). Elsewhere in the southwestern Galilee Basin, only Upper Stage 5 and/or Stage 1 is present. This occurrence of Stage 2 probably represents a local downwarping which was quite isolated from other areas of contemporary deposition.

Associated Australian Oilfields EASTWOOD No. 1

Reference: Mines Administration (1970).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Quaternary	alluvium	Surface - 9m	Surface - 30'
	- unconformity -		
Cret.-Jur.	Eromanga Basin sequence	9 - 1506m	30 - 4940'
	- unconformity -		
Triassic	Moolayember Formation	1506 - 1519m	4940 - 4985'
	Clematis Sandstone	1519 - 1654m	4985 - 5428'
	- unconformity -		

AGE	FORMATION	DEPTH	
Up. Permian	unnamed	1654 - 1701m	5428 - 5582'
	- unconformity -		
"Lr. Permian"	Joe Joe Fm. equivalent	1701 - 2058m	5582 - 6753'
Carb.-Dev.	Adavale Basin sequence	2058m - TD	6753' - TD
Total Depth		3385m	11,106'

Palynology: A total of 21 cutting and conventional core samples were studied by Paten (in Mines Administration, 1970). Of these, 6 were from the Upper Carboniferous to Permian interval (see below). Nothing can be added to Paten's discussion and his report is quoted below.

<u>Sample</u>	<u>Depth</u>		<u>Age</u>	<u>Palyn. Stage</u>	<u>Remarks</u>
Cutt.	1655m	5430'	?Up.Permian	?Up.Stage 5	Low yield, mainly cavings
Cutt.	1667m	5470'	Up. Permian	Up. Stage 5	
Cutt.	1707m	5600'	Up. Permian	Up. Stage 5	
		- unconformity -			
Cutt.	1786m	5860'	?	?	cavings
Cutt.	1844m	6050'	?	?	cavings
Cutt.	2021m	6630'	Up.Carb/ Lr.Perm.	Stage 1-2	
		- unconformity -			

"Upper Permian"

Cuttings 1655m, 1667m, 1707m (5430', 5470', 5600').

The assemblages contain abundant striate bisaccate pollen and a variety of pteridophyte spores including D. parvithola. They are Upper Permian in age and are referred to Stage 5 (P3b-P4) of Evans (1969). Similar assemblages have been recorded from A.S.O.

"Fairlea no. 1 (Paten in Garrett & Petersen, 1968a), Amoseas Boree no. 1 (Evans in Gerrard, 1964b) and S.P.L. Birkhead no. 1 (Evans 1966a).

In the Bowen Basin, Stage 5 is subdivided into a number of units based on the distribution of microplankton. The thin Stage 5 sequence at Eastwood, in common with that at Boree and Fairlea contains no microplankton and so cannot be precisely correlated with the Bowen Basin sequence on palynology alone.

In Eastwood and Boree, the Stage 5 sequence is predominantly shale and on general E-log character there seems to be little doubt that the same rock unit is represented in both wells. At Birkhead the apparent lithologic correlate of this unit contains the P3c acritarch swarm at its base (Evans 1966a). On the Springsure Shelf, and in the Denison Trough further to the east, P3c occurs at the base of the Black Alley Shale. It is therefore concluded that the Stage 5 sequence at Eastwood is the equivalent of part of the Black Alley Shale.

Upper Carboniferous to Lower Permian

Cuttings 2021m (6630').

This sample produced a small yield of microfossils consisting mainly of large monosaccate pollen. It can be referred to either Stage 1 or Stage 2 of Evans (1969) on this character. Evans believed Stage 1 to be Late Carboniferous and Stage 2 Early Permian in age. In the Galilee Basin, Stages 1 and 2 have been identified with the Joe Joe Formation by Evans (1969)".

Phillips-Sunray ETONVALE No. 1

Reference: Lewis & Kyranis (1962).

Generalized section:

Etonvale no. 1 was one of the first wells to intersect a full section of Silurian to Lower Carboniferous Adavale Basin sediments. The stratigraphic nomenclature has thus developed somewhat since the well was drilled but the following section is taken from Lewis & Kyranis (1962).

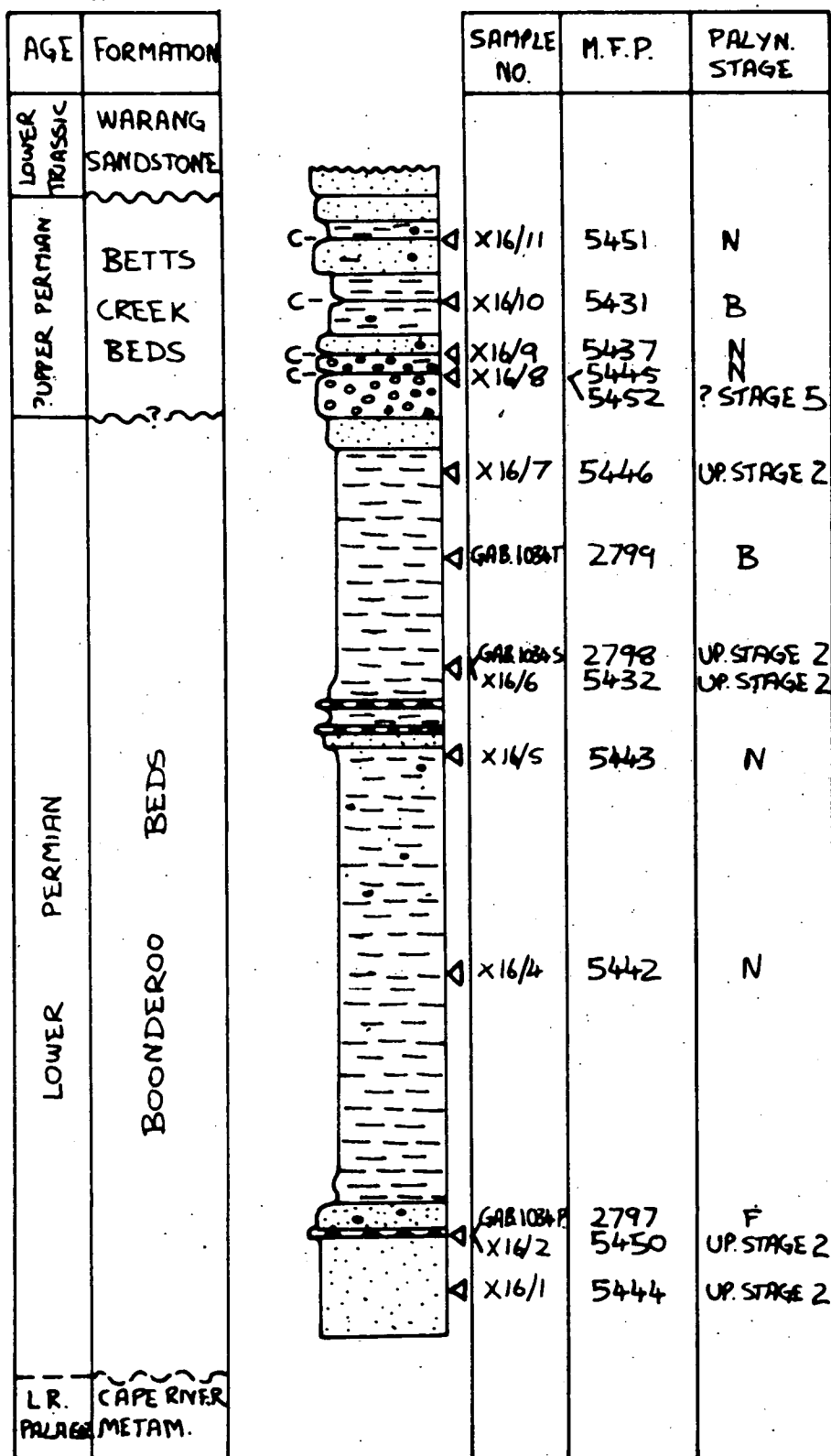
AGE	FORMATION	DEPTH	
Recent		Surface - 7m	Surface - 22'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	7 - 1687m	22 - 5534'
	- unconformity -		
Up. Permian	unnamed	1687 - 1721m	5534 - 5646'
	- unconformity -		
"Lr. Permian"	unnamed	1721 - 1910m	5646 - 6267'
	- unconformity -		
Sil.-?Carb.	Adavale Basin sequence	1910 - 3402m	6267 - 11,160'
	- unconformity -		
Up. Silurian	granite basement	3402m - TD	11,160' - TD
Total Depth		3465m	11,368'

Palynology: Evans and De Jersey (both in Lewis & Kyranis, 1962) independently examined a large number of samples from this well, spanning the Mesozoic, Permian, Devonian and Silurian. Results of their work on the Permian part of the section and its reassessment are summarized below.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Given Age</u>	<u>Author</u>	<u>Revised Stage</u>
Core 6	1715m	5627'	1663	Up. Permian	Evans	Up. Stage 5
"	1716m	5629'	1664	Up. Permian	Evans	Prob. Up. Stage 5
"	1717m	5632'		Up. Permian	De Jersey	Up. Stage 5
				- unconformity -		
Core 7	1729m	5674'		L. Permian	De Jersey	Prob. Stage 1
"	1730m	5676'	1762	L. Permian	Evans	Stage 1
SWC	1745m	5725'	1825	L. Permian	Evans	Stage 1
Core 9	1847m	6059'		L. Permian	De Jersey	?
"	1848m	6063'	1763	L. Permian	Evans	Stage 1

SAMPLE LOCATIONS OUTCROP SECTION X16 HUGHENDEN SHEET

Lithology after Vine et al., 1964.



- Shale
- Sandstone
- Conglomerate
- Tillite

- C: Coal Seam
- F: Insufficient for zonation
- N: Indeterminate microfossils
- B: Barren

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Given Age</u>	<u>Author</u>	<u>Revised Stage</u>
SWC	1901m 6238'	1826	L. Permian	Evans	Stage 1
SWC	1915m 6284'	1827	Barren	Evans	?
SWC	1916m 6285'	1828	Barren	Evans	?
Core 10	1998m 6554'	1760	Barren	Evans	?
"	" 6555'		Barren	De Jersey	?
SWC	2034m 6673'	1829	Barren	Evans	?
Core 12	(2120m, 6955') downwards dated Up. Silurian to Devonian				

Core 6 has yielded abundant spores and pollen and Evans and De Jersey found

Dulhuntyispora parvithola (sp. 123)

Didictriletes ericianus (sp. 115)

Didictriletes uncinatus (sp. 114)

Gnetaceaepollenites sinuosus (sp. 151)

Marsupipollenites triradiatus (sp. 152)

Leiotriletes directus (sp. 207)

Cirratriradites splendens

Lophotriletes tereteangulatus (sp. 113)

Apiculatisporites spp.

Retusotriletes diversiformis (sp. 6)

Granulatisporites spp.

Sulcatisporites ovatus (sp. 138)

Abundant striate bisaccate pollen

During a brief re-examination of samples held in the BMR, the present author also found Baculatisporites sp. 109 and Marsupipollenites sp. 896. This association, containing the key fossils Dulhuntyispora parvithola, Didictriletes ericianus and Gnetaceaepollenites sinuosus, can be confidently dated as Upper Stage 5.

The side wall cores from 1745m and 1901m (5725' and 6238') together with cores 7 and 9, were dated by both Evans and De Jersey as Lower Permian. The four samples represented in the BMR collections (those with an M.F.P. number in the table above) were briefly re-examined and contained rather impoverished microfloras dominated by smooth trilete spores. Species present included

Phyllothecotriletes sp. 7

cf. Phyllothecotriletes sp. 10

Punctatisporites gretensis (sp. 5)

Calamospora sp. 4

Retusotriletes diversiformis (sp. 6)

cf. Retusotriletes sp. 12

Rugulatisporites sp. 22

Verrucosisporites sp. 28

Kraeuselisporites sp. 35

Vallatisporites sp. 37

Reticulatisporites sp. 43

Vestigisporites sp. 44

Parasaccites spp.

The species listed above cannot be taxonomically compared directly with that given by Evans (in Lewis & Kyranis, 1962). He studied these samples prior to his formulation of the present BMR species numbering system and most of the taxa involved are new species. Evans' identification of striate bisaccate pollen in core 9 (1848m, 6063') is crucial to the definition of the Stage 1/Stage 2 boundary but could not be confirmed. All saccate pollen grains in the vicinity of the slide co-ordinate, given on the BMR sample card, can be assigned to Vestigisporites sp. 44. De Jersey also lists a striate species from core 9 ("Lunatisporites limpidus"), and this also could not be checked. In all other respects however, the rather poorly diverse assemblage of trilete spores are characteristic of Stage 1 and they are provisionally assigned to that stage.

Core 10 and side wall cores from 1915m, 1916m and 2034m (6284', 6285' and 6673') have all proved barren. De Jersey found Devonian (?Middle Devonian) spores in core 12 and favoured a Devonian age for the barren core 10. Unfortunately more refined palaeontological identification of the Devonian-Carboniferous boundary (placed at 1910m (6267') by Lewis & Kyranis, 1962) cannot be given at present.

Sun Oil FAIRLEA No. 1

Reference: Garrett & Petersen (1968a).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1224m	Surface - 4015'
	- unconformity -		
Triassic	Moolayember Shale	1224 - 1238m	4015 - 4062'
	Clematis Sandstone	1238 - 1366m	4062 - 4480'
	- disconformity -		
Up. Permian	unnamed	1366 - 1455m	4480 - 4773'
	- disconformity -		
Lr. Permian	unnamed	1455 - 2021m	4773 - 6630'
	- unconformity -		
Devonian	Adavale Basin sequence	2021 - 3036m	6630 - 9959'
?Lr. Devonian	economic basement (metamorphic)	3036m - TD	9959' - TD
Total Depth		3120m	10,235'

Palynology: Paten (in Garrett & Petersen, 1968a) examined two core samples from the Permian interval and his results are set out below.

Sample	Depth	Age Given	Revised Stage
Core 5	1417m 4650'	Up. Permian:Stage 5	Upper Stage 5
Core 6	1489m 4886'	Lr. Permian:Stage 2	Stage 2 (undiff.)

Paten's species list from core 5 (1417m, 4650') comprised the following forms:

Laevigatosporites vulgaris

Didecitriletes ericianus

Dulhuntyispora parvithola

Kraeuselisporites sp.

Marsupipollenites triradiatus

Striatoabietites multistriatus

Striatiti (abundant).

He dated this core as Stage 5, but the association of Dulhuntyispora parvithola with Didecitriletes ericianus allows further restriction of the assemblage to Upper Stage 5.

Core 6 (1489m, 4886') contained "....a fairly well preserved assemblage dominated by large monosaccate pollens. Striate bisaccate pollens were present in rare proportions". The sample yielded

Parasaccites spp. (dominant)

?Striomonosaccites sp.

aff. Alatisporites sp.

?Potonieisporites sp.

Protohaploxypinus sp. cf. P. goraiensis.

Paten's date of Stage 2 for this assemblage is supported here.

GALAH GORGE Outcrop Sections, Hughenden Sheet

Reference: Vine, Casey & Johnson (1964).

Stratigraphy: Permian and Triassic strata outcrop sporadically along the northern margin of the Galilee Basin and well exposed sections occur in Galah Gorge (or Porcupine Creek), north of Hughenden. The Hughenden area was examined during the 1963 BMR regional geological mapping program and Vine et al. (1964) described the following units.

AGE	FORMATION	THICKNESS	
Cretaceous	Wilgunya Formation	183m	600'
	Gilbert River Formation	1 - 12m	2 - 38'
Jur.-(?)Cret.	Blantyre Sandstone	38 - 122m	125 - 400'
Triassic	Warang Sandstone	0 - 221m+	0 - 724'+
Permian	Betts Creek Beds	0 - 411m	0 - 1350'
	Boonderoo Beds	213m+	700'+

The most complete section of the Permian Boonderoo Beds is exposed in the axis of a small anticline near the northern end of Galah Gorge (section X16, fig. 12). A basal coarse clastic unit rests with probable unconformity (the contact is not exposed) on ?Upper Precambrian Cape River Metamorphics. Coarse and in places pebbly sandstones are associated with thin beds of polymict conglomerate, which have been interpreted as tillites. A contorted carbonaceous shale from one of these possible tillite horizons has yielded fragmentary glossopterid plant macrofossils (White, 1964); the strati-

graphically oldest occurrence of the Glossopteris flora in Australia. The coarse clastics pass up into a thick sequence of mudstones, pebbly siltstones and finely laminated, possibly varved lutites. The Boonderoo Beds as a whole can probably be interpreted as a fluvioglacial sequence. In contrast, the disconformably overlying Betts Creek Beds contain thin coal seams, which are crowded with fossil leaves and which indicate deposition under probably warmer climatic conditions. The coal seams are separated by sandstones and mudstones. An angular unconformity separates the Betts Creek Beds from the clean, white quartz arenites of the Lower Triassic Warang Sandstone. A second section through the upper part of the Betts Creek Beds is exposed lower down Galah Gorge (section X23, fig. 13). Here they consist of a series of silty sandstones and pale grey siltstones, and their angular contact with the Warang Sandstone is clearly seen. Neither the Boonderoo Beds nor the base of the Betts Creek Beds are visible at this locality.

Palynology: Samples collected during the initial survey of the area were examined palynologically by Evans (1964a). He concluded that the Betts Creek Beds were Late Permian in age; correlating them with the upper Bandanna Formation of the Springsure Shelf and with strata containing similar microfloras in Corfield no. 1 bore. Samples from the Boonderoo Beds of section X16 were placed by Evans in spore unit P1c. One of these (GAB 1034P) came from the horizon containing Glossopteris leaf fragments. The Warang Sandstone was dated as Triassic (possibly Lower Triassic) on the basis of spore pollen assemblages from Whitecliff no. 2 bore (reg. no. 15415), 12 km SSW of the Galah Gorge sections.

In 1970 the present author revisited the Galah Gorge sections and collected additional material from the Permian sequences. The sections were not remeasured and samples were placed stratigraphically using the columnar sections of Vine et al. (1964). Evans' slides were also studied and the results obtained from all the samples examined are summarized on figs. 12 and 13.

Section X16

The distribution of selected spore and pollen species in section X16 is shown diagrammatically in Figure 14. Evans (1964a) reported the following assemblage in GAB 1034P, the bed in the basal coarse clastic unit from which White (1964) identified glossopterid fragments.

Conbaculatisporites sp.

Punctatisporites sp.

Vesicaspora sp.

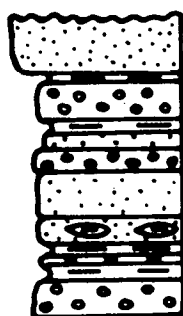
Nuskoisporites triangularis

Fig. 13

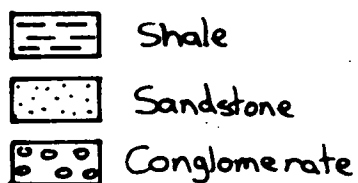
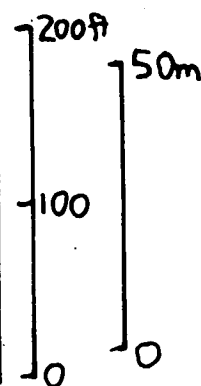
SAMPLE LOCATIONS OUTCROP SECTION X23 HUGHENDEN SHEET

Lithology after Vine et al., 1964.

AGE	FORMATION
LR. TRIAS	WARANG SANDSTONE
?UP. PERMIAN	BETTS CREEK BEDS



SAMPLE NO	M.F.P.	PALYN. STAGE
X23/1	5448	F
X23/2	5449	F
X23/3	5447 5430	N ?STAGE 5
GAB1073A	2794	?STAGE 5



F: Insufficient for zonation
N: Indeterminate microfossils

OUTCROP SECTION X16
GALAH GORGE

RANGE CHART FOR SELECTED SPECIES

B Barre.
N Indeterminate microdossus
F Insufficient for testing

- 1 Evans (1984 a)
- 2 Present study

Sample No.	N.F.P.	Author	Index	Formation	Stage	cf. RETU APICULA cf. LYCOSA RUGULATA MONOCOL PHYLLOTT GRANULATA APICULA CALAMID RETUSO PUNCTA cf. GRANA BOTRYO CALAMOS MONOCOL SCHIZOS LEIOTRIL NEORAN GRANULA GINKGOO cf. RETU MONOCOL APICULA RICASPO QUADRIS LOPHOTT LOPHOTT VERRUC MARSUP APICULA LOPHOTT cf. LOPH LUNULA BACULA GNETAC CYCLOGE	MONOCOL POTONIE STRIATE PARASAC POTONIE PARASAC PARASAC POTONIE cf. VEST PARASAC KLAVIS VITREIS VESTIG PROTHO ALISPOR PROTHO SULTRIAT
				WARANG SS	LR TRIASSIC		
x 16/11	5451	2	N				
x 16/10	5431	2	B	BETTS			
x 16/9	5437	2	N	CREEK	? STAGE 5		
x 16/8	5445	2	N	BEDS			
"	5452	2			?		
x 16/7	5446	2					
CAB 1034 T	2799	1.2	B				
CAB 1034 S	2798	1.2					
x 16/6	5432	2		BOONDEROO	UPPER		
x 16/5	5443	2	N		STAGE 2		
x 16/4	5442	2	N	BEDS			
CAB 1034 P	2797	1.2	F				
x 16/2	5450	2					
x 16/1	5444	2					
				CAMP RIVER PRECAMB BASEMENT			

Assemblage cards in BMR files also contain reference to Calamospora sp. 58, C. sp. 4, Klausipollenites sp. 82 and fragmentary specimens of Parasaccites cf. sp. 190. A second sample from the same level, collected in 1970 (X16/2), contained a richer microflora dominated by Parasaccites spp. Potonieisporites neglectus (sp. 192) and the alga Botryococcus. The presence of Calamospora sp. 4 and Phyllothecotriletes sp. 7, together with the saccate pollen mentioned above, indicate that these samples should be dated Stage 2, rather than Plc (or Stage 3), as suggested by Evans (1964a). Palynomorphs from the lowest horizon examined support this revision. X16/1 lacks Striatiti, but the association of Phyllothecotriletes sp. 7, Calamospora sp. 4, Apiculatisporis sp. 62 and Granulatisporites sp. 59 is typical of Upper Stage 2. Microfloras from the mudstones and varved siltstones higher in the sequence are of the same age. Evans listed a diverse assemblage from sample GAB 1034S and similar associations were obtained from X16/6 (the same level) and X16/7. These samples contain common Granulatisporites sp. 59, Apiculatisporis sp. 62 and Monocolpate pollen sp. 186. Also present are Phyllothecotriletes sp. 7, Calamospora sp. 4, C. sp. 58, Lophotriletes sp. 64, L. sp. 183 and Ricaspora sp. 1113, which together are diagnostic of Upper Stage 2. Monosaccate pollen, Potonieisporites neglectus (sp. 192) and several species of Striatiti (including Protohaploxypinus aff. goraiensis (sp. 187)) make up the second part of the flora. Ricaspora sp. 1113 is limited to assemblage B of Upper Stage 2 in Thunderbolt no. 1, but more work is needed before that subdivision can be confidently identified elsewhere. Of particular interest is the occurrence of Quadrисporites horridus (sp. 211) in GAB. 1034S, one of its oldest known records.

The Betts Creek Beds of X16 were much less productive and only one sample collected by the author, S16/8 (M.F.P. 5452) from the lowest coal seam, yielded recognisable microfossils. This contained abundant Striatiti, together with Marsupipollenites triradiatus (sp. 152), Lophotriletes spp., Lunulasporites colliensis (sp. 132) and Baculatisporites sp. 109. Also present is an atypically small form of Gnetaceaepollenites sinuosus (sp. 151). Apart from the latter, the assemblage is not really diagnostic within the interval Stage 3 to 5. However, the abundance of Striatiti, the presence of G. cf. sinuosus, and regional stratigraphic correlations all favour placing this sample in Stage 5.

Section X23

Two horizons in this section were sampled in 1970; both were from high in the Betts Creek Beds, close to its angular contact with the Warang Sandstone (fig. 13). Samples X23/2 and X23/1 yielded very few palynomorphs, chiefly smooth trilete spores and indeterminate saccate pollen fragments.

Plant microfossils were also rare and poorly preserved in sample X23/3 (M.F.P. 5430) but the following species could be identified.

Apiculatisporis spp. 62 and 908

Granulatisporites sp. 59

Lophotriletes tereteangulatus (sp. 113)

Lophotriletes sp. 183

Didecitriletes ericianus (sp. 115)

Punctatisporites gretensis (sp. 5)

Retusotriletes diversiformis (sp. 6)

Leiotriletes directus (sp. 207)

Sulcatisporites sp. indet.

Striatiti (fragments)

Monosaccate pollen (rare fragments).

The occurrence of Didecitriletes ericianus (sp. 115) is suggestive of an Upper Permian age. Elsewhere it is known to have a range from Upper Stage 4 to Upper Stage 5. However, the rest of the assemblage is not diagnostic. Punctatisporites gretensis (sp. 5), is thought to be confined to Stage 3 and older units. Its presence in this sample may be due to reworking.

Evans (1964a) described a somewhat richer assemblage from lower in the same section (sample GAB 1073A). His species list is quoted below without taxonomic amendment.

Leiotriletes directus

Marsupipollenites triradiatus striatus

M. sinuosus

Chomotriletes sp. (aff. Circulisporites parvus De Jersey)

Laevigatosporites cf. L. vulgaris

Striatiti spp. (limpidus, cancellatus and amplus types) (v. common)

Evans stated

"This assemblage of common striate pollens with occasional Laevigatosporites and a general absence of acanthine pteridophyte

"spores closely resembles the Upper Permian assemblages of Magellan Corfield No. 1 (Evans, 1962b). The Corfield Permian differs in that it includes rare Acanthotriletes spp. and some non-striate disaccate pollens".

His slides have been re-examined and his specimens of Gnetaceaepollenites sinuosus proved to be the same as the stunted form which occurs in the Betts Creek Beds of section X16. For the same reasons, sample GAB 1073A is given a tentative Stage 5 age.

Sufficient evidence is now available to place the whole of the stratotype Boonderoo Beds in Upper Stage 2. Lithological comparisons suggest that the varved siltstones and mudstones, which constitute the main part of the formation, are correlates of the major Upper Stage 2 shale unit in Thunderbolt no. 1 and Glenaras no. 1. This has now been recognised in many well sections in the northern part of the Galilee Basin as unit C. The basal sandstone in Galah Gorge can probably be equated with the upper part of the interbedded sandstones and shales of unit B in the wells to the south. Unit B has been dated Lower Stage 2 at its base to Upper Stage 2 at its top. The Betts Creek Beds are probably of Upper Permian age and are tentatively assigned to palynological Stage 5. They closely resemble the coal-bearing strata which have wide areal extent in the Galilee Basin as unit E. Upper Stage 5 microfloras are well documented from this unit. Thus the outcropping Permian of the Hughenden area shows a severely truncated section, when compared with the much thicker sections to the south. Rock types are quite similar but large parts of the sequence are missing. Unit A and the lower part of unit B (representing the time interval of palynologic Stage 1, Lower Stage 2, and possibly the early portion of Upper Stage 2) are not represented and uppermost unit B rests unconformably on Precambrian metamorphic basement. Unit D (i.e. palynological Stage 3) was either not deposited or was removed by erosion. The major regional unconformity below the high Lower to Upper Permian coal-bearing strata (unit E) now rests directly on the Upper Stage 2 shales of unit C.

Phillips - Sunray GILMORE No. 1

Reference: Lewis & Kyranis (1965).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 1768m
	- unconformity -	
Permian	unnamed	1768 - 1964m
		5800 - 6445'

AGE	FORMATION	DEPTH	
Lr. Dev. - Carb.	Adavale Basin sequence	1964m - TD	6445' - TD
Total Depth		4346m	14,260'

Palynology: De Jersey (in Lewis & Kyranis, 1965) examined two samples from the Permian interval of Gilmore no. 1. He dated both of them as Lower Permian but they have not been re-examined and an accurate stage identification cannot be made from the species lists available. His results are summarized below.

Sample	Depth		Age Given	Suggested Stage
Core 2	1771m	5810'	?Lr. Permian	Stage 1 to 2
SWC	1833m	6015'	Lr. Permian	Stage 1 to 2

Core 2 gave a low yield of smooth and ornamented azonate spores, zonate spores, monosaccate pollen and non-striate bisaccate pollen. He compared this assemblage with those from cores 7 and 9 in Etonvale no. 1, which have been independently dated as Stage 1.

The sidewall core from 1833m (6015') contained a similar but more diverse assemblage, with abundant monosaccate pollen, Vestigisporites spp. and Punctatisporites gretensis. As with core 2, he likened this assemblage to that from Etonvale no. 1, cores 7 and 9, but also compared it with the interval between 1372m and 1676m (4500' and 5500') in Maranda no. 1. Assemblages from this section in Maranda no. 1 range from Stage 1 to Stage 2. In conclusion, the Gilmore samples have a general Stage 1 and 2 aspect. The association of common monosaccate pollen and Vestigisporites, and the apparent absence of Striatiti, seem to marginally favour their allocation to Stage 1, but more work is needed to substantiate this.

Phillips - Sunray GLENARAS No. 1

Reference: McDonagh (1967).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 877m	Surface - 2876'
	- unconformity -		
Up. Perm.	Bandanna Formation equivalents	877 - 991m	2876 - 3250'

AGE	FORMATION	DEPTH
	- unconformity -	
Lr. Perm.	"Reids Dome Beds" equivalents	991 - 1088m 3250 - 3570'
Up.Carb. - Lr. Perm.	Joe Joe Formation	1088 - 1629m 3570 - 5346'
	- unconformity -	
?	volcanic basement	1629m - TD 5346' - TD
Total Depth		1637m 5371'

Palynology: The Permian interval in Glenaras no. 1 has been relatively well sampled for palynology and 14 conventional and side wall cores were dated by Evans (in McDonagh, 1967). This borehole might provide a useful reference section for the Permian zonal succession, but unfortunately a brief re-examination of Evans' slides showed that the assemblages are generally poorly preserved and spore yields are low. Evans' biostratigraphic results are set out below, together with their reinterpretation into stages. In the species lists which follow, Evans' and my own observations are combined.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Spore Unit Given</u> <u>(Evans)</u>	<u>Revised</u> <u>Stage</u>
SWC 21	878m	2879'	4159	P3b-4	Up. Stage 5
SWC 19	882m	2893'	4153	P3b-4	Up. Stage 5
SWC 17	886m	2905.5'	4160	P3b-4	Prob.Up.Stage 5
Core 1	906m	2971'	4161	P3b-4	Prob.Up.Stage 5
Core 2	937m	3074'	4162	P3b-4	Up. Stage 5
SWC 16	1015m	3331.5'	4163	Plc	Stage 3 OK
SWC 15	1017m	3336.5'	4154	Plc	?
SWC 13	1033m	3388'	4155	Plc	?
SWC 9	1181m	3876'	4156	Plb	Up. Stage 2 OK
Core 4	1213m	3981'	4165	Barren	?
SWC 4	1528m	5012'	4166	P1?	Stage 2 (undiff.) Lr. 2
SWC 3	1561m	5120'	4157	Pla	Prob.Lr.Stage 2
SWC 2	1592m	5222'	4164	Pla	Stage 2 (?Lr.2)
SWC 1	1615m	5300'	4158	C2/Pla	Lr.Stage 2 OK

Assemblages from side wall cores at 878m and 882m (2879' and 2893'), and core 2 (937m, 3074') are dominated by bisaccate pollen, particularly Striatiti. They also contain Dulhuntyispora parvithola (sp. 123), Didecitriletes ericianus (sp. 115) and Gnetaceaepollenites sinuosus (sp. 151); together with Baculatisporites sp. 109 Lophotriletes tereteangulatus (sp. 113), Lophotriletes spp. 64 and 183, Kraeuselisporites sp. 1112, Didecitriletes cf. uncinatus (?sp. 114) and Indospora sp. 911. Evans (in McDonagh, 1967) placed these samples in spore unit P3b-4 and they can now be dated as Upper Stage 5. The assemblages from sidewall core 17 (886m, 2905.5') and core 1 (906m, 2971') are very poor and comprise only long-ranging spores. However, their stratigraphic position between well dated samples enables them to be given a probable Upper Stage 5 age.

Side wall core 16 (1015m, 3331.5') contained a moderately well preserved microflora with abundant Protohaploxypinus spp., Sulcatisporites ovatus (sp. 138) and monosaccate pollen. The presence of the marker species Verrucosisporites pseudoreticulatus (sp. 68) and Monocolpate pollen sp. 186 limits it to Stage 3. The identification by Evans (in McDonagh, 1967) of the major regional unconformity between Lower Permian Stage 3 (his Plc) at 1015m (3331.5') and Upper Permian Stage 5 (his P3b-4) at 937m (3074') is confirmed. Evans also dated the side wall cores at 1017m and 1033m (3336.5' and 3388') as Plc. Both samples contain very sparse, poorly preserved and fragmentary palynomorphs of long-ranging types. Consequently, no stage identifications are given for these horizons.

Side wall core 9 (1181m, 3876') contained a rich microflora and yielded the following species.

- Granulatisporites sp. 59
- Rugulatisporites sp. 22
- Apiculatisporis spp. 62 and 908
- Calamospora sp. 58
- Leiotriletes directus (sp. 207)
- Phyllothecotriletes sp. 7
- Monocolpate pollen sp. 186
- Parasaccites spp.
- Protohaploxypinus rugatus (sp. 198)
- non-striate bisaccate pollen.

The association of Monocolpate pollen sp. 186, Phyllothecotriletes sp. 7 and Granulatisporites sp. 59 indicates an Upper Stage 2 position for this assemblage. No further subdivision into assemblage A or B is possible, as has been done in Thunderbolt no. 1. Core 4 (1213m, 3981') is barren, and the side wall core from 1528m (5012') contains a very poor microflora. The latter was dated P1? by Evans (in McDonagh, 1967) and an undifferentiated Stage 2 age is given here, from its position between Lower and Upper Stage 2 microfloras.

Relatively few spores and pollen were present in side wall core 3 (1561m, 5120') but the following species could be identified.

Phyllothecotriletes sp. 7

Calamospora spp. 4 and 58

cf. Retusotriletes sp. 1105

Verrucosisporites sp. 8

Vallatisporites sp. 37 = E.

Parasaccites spp.

Potonieisporites neglectus (sp. 192)

indet. striate bisaccate pollen.

The presence of Striatiti, Phyllothecotriletes sp. 7, Calamospora sp. 4 and Vallatisporites sp. 37 limits its age to Stage 2. No Upper Stage 2 markers were found and a probable position within the lower division of the stage is favoured. The next sample below (SWC 1592m, 5222') contains an even more impoverished assemblage and is questionably assigned to Lower Stage 2. The presence of monosaccate pollen, Protohaploxypinus cf. goraiensis (sp. 187), Phyllothecotriletes spp. 7 and 10, Punctatisporites gretensis (sp. 5) and Vestigisporites sp. 44 supports this dating. A specimen of Apiculatisporis sp. 62 in this sample is puzzling, because elsewhere it does not range below Upper Stage 2.

Evans (in McDonagh, 1967) dated the lowest sample from Glenaras no. 1 (SWC 1615m, 5300') as Upper Carboniferous or Lower Permian (spore unit C2/P1a). Under his later zonation (Evans, 1967a, 1969), spore unit C2 becomes part of Stage 2 and the presence of Striatiti in this stage allows us to date it earliest Permian. The side wall core contained a small flora including

Phyllothecotriletes sp. 7

Calamospora sp. 4

cf. Calamospora sp. 9

Punctatisporites gretensis (sp. 5)

Anapiculatisporites sp. 17 = *A. carolinensis*

Rugulatisporites sp. 22

Reticulatisporites sp. 43 = *R. bitrans*

Parasaccites spp.

Vestigisporites sp. 44

Protohaploxylinus aff. goraiensis (sp. 187)

The presence of Anapiculatisporites sp. 17 and Reticulatisporites sp. 43 supports a Lower Stage 2 dating.

Longreach Oil HULTON No. 1

Reference: Mott & Associates (1964a).

Generalized section (taken from well completion report):

AGE	FORMATION	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 558m
	- unconformity -	Surface - 1830'
Permian	Mantuan & Up. Colinlea equivalent	558 - 627m
	- unconformity -	1830 - 2058'
Dev.-Carb.	Drummond Group	627m - TD
		2058' - TD
Total Depth		661m
		2169'

Palynology: Playford (in Mott & Associates, 1964a) examined two cores for pollen and spores. The upper core (C. 2, 1440 - 50') contained Jurassic palynomorphs but the lower one (C. 3, 1862 - 72'), from the supposed Permian interval, was barren. Evans (1964c) examined the following six cutting samples, all from the section identified on lithological evidence as Permian by Mott & Associates (1964a).

Cutt.	576-79m	1890 - 1900'	M.F.P. 3388
Cutt.	582-85m	1910 - 20'	M.F.P. 3389
Cutt.	594-97m	1950 - 60'	M.F.P. 3371
Cutt.	607-10m	1990 - 2000'	M.F.P. 3390
Cutt.	616-19m	2020 - 30'	M.F.P. 3372
Cutt.	622-25m	2040 - 50'	M.F.P. 3391

He stated that "....all yielded abundant Mesozoic spores and pollens, many determined as Lower Cretaceous. A few Permian Parasaccites sp. were found at 607m and 622m (1990 and 2040 feet)". He questionably dated this collection as Permian. It is obvious that caving has resulted in extensive contamination of these cutting samples and no stage identification is possible.

The "Permian" section in Hulton no. 1 is interesting in its severely truncated nature (only 69m, 228 feet). Saltern Creek no. 1, only 5 km to the northeast, penetrated over 600m of Permian section. A major fault zone, the Hulton - Rand structure, was active in Permian times and separated the Galilee Basin from the Maneroo Platform. To the southwest of the fault zone, several wells have intersected a normal Eromanga Basin Mesozoic sequence resting on crystalline basement. To the northeast, a line of wells, including Saltern Creek no. 1, Marchmont no. 1, Rand no. 1 and Glenaras no. 1, proved the existence of a thick section of Permian sediments below the Eromanga Basin section. Hulton no. 1 was drilled near the edge of the Maneroo Platform and close to the depositional edge of the Permian.

Alliance JERICHO No. 1

Reference: Benedek (1965).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH
Triassic	Moolayember Formation	Surface - 174m
	Clematis Sandstone	174 - 348m
	Rewan Formation	348 - 396m
	- unconformity -	1142 - 1300'

AGE	FORMATION	DEPTH
Permian	Bandanna Formation	396 - 484m 1300 - 1588'
	Peawaddy Formation	484 - 518m 1588 - 1698'
	Colinlea Sandstone	518 - 575m 1698 - 1886'
	- unconformity -	
Up. Carb. - Lr. Perm.	Joe Joe Formation	575 - 1679m 1886 - 5507'
	- unconformity -	
Lr. Carboniferous	Ducabrook Formation	1679 - 2704m 5507 - 8870'
?Pre-Carb.	unnamed	2704 - 2757m 8870 - 9044'
	economic basement (agglomerate)	2757m - TD 9044' - TD
Total Depth		2786m 9142'

Palynology: Evans (in Benedek, 1965) initially examined five core samples and three cutting samples from the Upper Carboniferous and Permian strata of this well. Later (Evans, 1966a), he looked at a further seven sets of cuttings. Evans' findings are summarized below, with interpreted stages according to his later zonal system.

Sample	Depth	M.F.P.	Spore Unit Given	Revised Stage
Core 1	369m1	1212'	3582 Tr2a	Triassic
		- unconformity -		
Cutt.	405-08m	1330-40'	3991	Prob.Up. Stage 5
Cutt.	439-42m	1440-50'	3992	Prob.Up. Stage 5
Cutt.	463-66m	1520-30'	3993	Prob.Up. Stage 5
Cutt.	479-82m	1570-80'	3997	Prob.Up. Stage 5
Cutt.	482-85m	1580-90'	3998	Prob.Up. Stage 5
Cutt.	485-88m	1590-1600'	3999	Prob.Up. Stage 5
Cutt.	488-91m	1600-10'	4000	Prob.Up. Stage 5
Cutt.	503-06m	1650-60'	3994	Prob.Up. Stage 5

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Spore Unit Given</u>	<u>Revised Stage</u>
Cutt.	515-18m	1690-1700'	3995	Prob.Up. Stage 5
Cutt.	518-21m	1700-10'	3996	Prob.Up. Stage 5
Core 2	522m	1714'	3583 P3-4	?Stage 5
- unconformity -				
Cutt.	600-04m	1970-80'	3838 Plb	✓ Prob.Up. Stage 2
Cutt.	604-07m	1980-90'	3839 Plb	✓ Prob.Up. Stage 2
Cutt.	607-10m	1990-2000'	3840 Caving contam.	?
Core 6	1092m	3583'	3584 C2/Pla	Stage 1/Lr.Stage 2
Core 7	1219m	4000'	3585 C1 D = Stage 1 of Kemp et al	Stage 1
Core 9	1397m	4582'	3586 C1 C-D = S. yberti	Stage 1
Core 10	1548-50m	5080-85'	3587 C1 = S. yberti	Stage 1
- unconformity -				
Core 11	1681-82m	5516-19'	not proc. ?Dev/Lr.Carb.	?

Full species lists have not previously appeared for the cuttings from 405m to 521m (1330 to 1710') and they have been briefly re-examined for this study. The cutting samples from 405-08m, 439-42m, 463-66m, 479-82m and 482-85m (1330-40', 1440-50', 1520-30', 1570-80' and 1580-90') contain well-preserved microfloras with very abundant Striatiti (chiefly Protohaploxypinus of the P. amplus - limpidus group) and Sulcatisporites ovatus (sp. 138). Saccate pollen occurs in such major proportions that other microfossils are relatively rare and form a relatively restricted assemblage. Trilete, mono-colpate and polyplicate palynomorphs identified included

Gnetaceaepollenites sinuosus (sp. 151)

Marsupipollenites triradiatus (sp. 152)

Marsupipollenites sp. 896

Leiotriletes directus (sp. 207)

Retusotriletes diversiformis (sp. 6)

Cyclogranisporites sp. 107

Baculatisporites sp. 109

Granulatisporites sp. 59

Granulatisporites micronodosus (sp. 111)

Lophotriletes tereteangulatus (sp. 113)

Lophotriletes spp. 183, 64 and 702

Didecitriletes ericianus (sp. 115)

Kraeuselisporites sp. 1112.

Botryococcus, marine acritarchs, and monosaccate pollen fragments occur rarely. Cutting samples from between 485m and 521m (1590' and 1710') contain very similar assemblages, but with bisaccate pollen in slightly lower proportions. The rest of the microflora is essentially the same as above, except that Dulhuntyispora parvithola (sp. 123) occurs at 485-88m, 515-18m and 518-21m (1590 - 1600', 1690' - 1700' and 1700 - 10'). Bascanisporites undosus (sp. 139) was also identified at 518-21m (1700-10'). The association of abundant Striatiti, Gnetaceaepollenites sinuosus (sp. 151), Didecitriletes ericianus (sp. 115) and, most important, Dulhuntyispora parvithola (sp. 123), allows tentative dating of the whole section between 405m and 521m (1330' and 1710') as Upper Stage 5. The possibility of caving contamination having affected this section cannot be completely ruled out, especially as Lower Stage 5 microfloras are almost identical to those from Upper Stage 5. However, the complete absence of Triassic or Lower Permian palynomorphs suggests that the assemblages have not become mixed by caving.

Evans found the following species in core 2 (522m, 1714') (generic names have been amended to present usage where indicated*)

*Cyclogranisporites sp. 107

Granulatisporites sp. 110

Lophotriletes tereteangulatus (sp. 113)

Anapiculatisporites sp. 117

Vitreisporites pallidus (sp. 135)

Striatopodocarpites cancellatus (sp. 143)

Protohaploxypinus amplius (sp. 147)

Protohaploxypinus sp. 148

Marsupipollenites triradiatus (sp. 152)

Striatoabietites sp. 209

Striatiti spp. undiff.

He placed the sample in spore unit P3-4 (Evans, 1966a and Evans in Benedek, 1965), which can be correlated with Lower to Upper Stage 5 under the new zonal scheme. This assemblage as listed, is known possibly from Upper Stage 2 and certainly from Stage 3 to Upper Stage 5 in other parts of eastern Australia. Indeed Evans (in Benedek, 1965) noted that the Upper Stage 4 and Stage 5 markers Dulhuntyispora and Gnetaceaepollenites sinuosus (sp. 151) could not be found. However, from the prominence of large Protohaploxypinus spp. and from wireline log correlations (Vine, pers.comm.), it seems more likely that this represents an impoverished Stage 5 microflora.

Cutting samples from 600-04m and 604-07m (1970-80' and 1980-90') were studied by Evans (in Benedek, 1965), who dated them spore unit Plb and reported the following species.

Retusotriletes diversiformis (sp. 6)

Striatopodocarpites sp. 48

Klausipollenites sp. 82

Monocolpate pollen sp. 91

Monocolpate pollen sp. 186

Apiculatisporis sp. 101

Parasaccites sp. 190 (common)

*Protohaploxypinus rugatus (sp. 198)

Calamospora sp. 4

*Phyllothecotriletes sp. 7

Lophotriletes sp. 183

*Striatoabietites multistriatus (sp. 163)

This assemblage is very similar to that found in Thunderbolt no. 1 and can be placed in Upper Stage 2.

The microfloras from cores 6, 7, 9 and 10 have been fully studied by Evans, and his report (in Benedek, 1965) is quoted in full below. The only changes made are where generic names have been emended and these are asterisked. Complete species lists are not given but may be found in Evans (1965a, Table 5).

"Upper Carboniferous (C1):

Core 10 (1548-50m, 5080-5085 feet). The available samples from this core consisted of a chocolate brown mudstone and grey sandstone and siltstone, all of which were much slickensided. A small yield of carbonised spores was obtained from this core, the assemblage including *Reticulatisporites sp. 43, Kraeuselisporites sp. 35, and *cf. Phyllothecotriletes sp. 10, which are known to first appear in Unit C1. There appears to be a general lack of saccate pollens, although Potonieisporites neglectus may be present. One well preserved specimen of Leiozonotriletes naumovae was observed. This is a characteristic Upper Devonian species in Western Australia and is thought to be derived.

"Core 9 (1397m, 4582 feet) yielded a greater number and variety of species, including Punctatisporites gretensis (sp. 5), Vallatisporites sp. 37, *Vestigisporites sp. 44, and Parasaccites sp. 50, which are typical of Unit C1. It will be seen from the table that all these species continue to range as high as Core 6.

Core 7 (1219m, 4000 feet) yielded an even greater number of species. cf. Retusotriletes sp. 12, which was only found in Core 7, occurred in Alice River no. 1 well at 1352m (4435 feet), in BMR 9 (Springsure), and in South Pacific Birkhead no. 1 well at 1097m (3600 feet). The apparently restricted vertical range of this species may prove to be of some stratigraphic value in determining positions within Unit C1.

Upper Carboniferous or Lower Permian (C2 or Pl1a):

Core 6 (1092m, 3583 feet) yielded a very similar assemblage to the underlying core 7, but it contained Klausipollenites sp. 82, which is elsewhere known to make its first appearance in Unit Pl1a. The assemblage still contained *Reticulatisporites sp. 43 and Cyclogranisporites sp. 14, but did not seem to include any striate pollens. In consequence, the age of Core 6 is regarded as either basal Unit Pl1a or perhaps it is not younger than Unit C2.

Units C1 - 2 and Pl1a are associated in the northeastern Eromanga Basin region with the Joe Joe Formation."

Cores 7, 9 and 10 can now be assigned to Evans' (1967a, 1969) Stage 1. Core 6 cannot be dated any more accurately than Stage 1 or Lower Stage 2. It should be noted that cf. Retusotriletes sp. 12 has been reported from upto the top of Lower Stage 2 in Thunderbolt no. 1 (Norvick, 1971). Its

lower limit may still be of value for subdivision of Stage 1. Evans full species list for core 6 includes Anapiculatisporites sp. 17 and Monocolpate pollen sp. 106. The former has the same occurrence in Thunderbolt no. 1 as cf. Retusotriletes sp. 12. However, Monocolpate pollen sp. 106 ranges from the top of Lower Stage 2 to the top of Upper Stage 2 in the Thunderbolt well. This information could be taken to indicate a Lower Stage 2 dating for core 6. However, in the absence of striate bisaccate pollen the less exact determination is preferred.

Flinders KOBURRA No. 1

Reference: Pemberton & Brereton (1970).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Lr.Cret.	Eromanga Basin sequence	Surface - 149m	Surface - 490'
Triassic	Moolayember Formation	149 - 818m	490 - 2685'
	Clematis Sandstone	818 - 1104m	2685 - 3622'
	Rewan Formation	1104 - 1330m	3622 - 4365'
	- unconformity -		
Up. Permian	unnamed	1330 - 1445m	4365 - 4740'
	- unconformity -		
Lr.Perm. - Up. Carb.	unnamed	1445 - 2967m	4740 - 9735'
	- unconformity -		
Pre.-Up.Carb.	unnamed Drummond Basin sequence	2967m - TD	9735' - TD
Total Depth		3259m	10,693'

Palynology: A total of 28 samples from Koburra no. 1 were examined by Price (in pemberton & Brereton, 1970), 15 of them from the Permian part of the well (table 2). These samples have not been re-examined; Price's report is accepted fully and is quoted below. Species numbers marked by an asterisk are not the same as those in use by BMR.

<u>Sample</u>	<u>Depth</u>		<u>Age</u>	<u>Stage Given</u>
SWC	1322m	4336'	Lower Triassic	Tr1b-Tr2b
		- hiatus -		
Cutt.	1333m	4374'	Upper Permian	Upper Stage 5
Core 1	1342m	4401'4"	?	? (barren)
SWC	1436m	4712'	?Upper Permian	?Upper Stage 5
SWC	1441m	4728'	Upper Permian	Upper Stage 5
SWC	1446m	4744'	?	?(indet. micro-fossils)
		- hiatus -		
SWC	1463m	4800'	Lower Permian	Stage 2
SWC	1479m	4852'	Lower Permian	Stage 2
SWC	1482m	4862'	Lower Permian	Stage 2
SWC	1489m	4884'	Lower Permian	Stage 2
SWC	1491m	4892'	Lower Permian	Stage 2
SWC	1524m	5000'	Lower Permian	Stage 2
SWC	1585m	5200'	Lower Permian	Stage 2
SWC	1660m	5445'	Lower Permian	Stage 2
SWC	1690m	5546'	Lower Permian	Stage 2
SWC	1711m	5615'	Lower Permian	Stage 2
Core 7	3248m	10,655'	?	?(indet. micro-fossils).

"Core 7/3248m (10,655')"

Core 7 yielded highly carbonised microfossils that could not be identified with any certainty but included possible thick walled verrucate and rugulate spores. This, together with the absence of recognizable saccate pollen, perhaps suggests a pre-Upper Carboniferous age. However, the extremely poor state of preservation precludes reliable judgement of the age of this part of the sequence.

"Stage 2 (Lower Permian)

The samples taken from 1463m to 1711m (4800 feet to 5615 feet) yielded assemblages characterized by an abundance of Parasaccites spp. together with pteridophytic elements including Rugulatisporites sp. 124*. Striate bisaccate pollens, including Protohaploxypinus goraiensis were rare in most samples. These assemblages are characteristic of Stage 2 (Evans, 1967a) (palynologic unit C2-P1b of Evans, 1966a) and have been recorded from the Joe Joe Formation of the Galilee Basin. The section sampled is therefore correlated with some part of this Formation. Evans (1966a) identified the basal section of the Joe Joe Formation as palynologic unit C1 (Stage 1). Thus the oldest part of the Joe Joe Formation, if present, was not sampled at Koburra.

It is noteworthy that the samples from SWC 1463m to 1489m (4800 feet to 4884 feet) contained an abundance of exceptionally large and distinctive form of the monsaccate pollen Parasaccites not observed elsewhere in the section.

Upper Stage 5 (Upper Permian)

The assemblages from cuttings 1333m (4374 feet) and SWC 1441m (4728 feet) included an abundance of striate bisaccate pollen, "Marsupipollenites" sinuosus and diverse pteridophytic elements including Didecitriletes ericianus. These assemblages characterize Upper Stage 5 (Paten, 1969) (palynologic units P3b-P4 of Evans, 1966a) and are regarded as Upper Permian in age.

SWC 1436m (4712 feet) yielded an assemblage similar to those from 1333m and 1441m (4374 feet and 4728 feet) but lacked diagnostic species. It is included in Upper Stage 5 because of its stratigraphic position relative to the positively identified samples.

Sections with P3b-P4 affinities have been recorded from the Galilee Basin by Evans (1966a) as Colinlea Sandstone-Bandanna Formation."

<p>Table 2: Flinders KOBURRA No. 1 Permian Microfloral Distribution</p>		1333m, 4374' cutt.	1436m, 4712' SWC	1441m, 4728' SWC	1463m, 4800' SWC	1479m, 4852' SWC	1482m, 4862' SWC	1489m, 4884' SWC	1491m, 4892' SWC	1524m, 5000' SWC	1585m, 5200' SWC	1660m, 5445' SWC	1690m, 5546' SWC	1711m, 5615' SWC
<u>Marsupipollenites triradiatus</u>		X	X	X										
<u>"Marsupipollenites" sinuosus</u>		X	X	X										
<u>Didecitriletes ericianus</u>		X		X										
<u>Neoraistrickia ramosa</u>		X			cf.	X			?					
<u>Acanthotriletes tereteangulatus</u>		X	cf.											
<u>Cyclogranisporites</u> sp.		X												X
<u>Verrucosisporites</u> spp.		X	X						X					X
<u>Acanthotriletes filiformis</u>		X												
<u>Striatiti</u> spp.		X	X	X	X	X	X	X	X	X	X	X	X	X
<u>Parasaccites</u> spp.		X	X	X	X	X	X	X	X	X	X	X	X	X
<u>Kraeuselisporites</u> spp.		X			X	X								
<u>Microreticulatisporites</u> sp.			X											
<u>Granulatisporites</u> sp.			X		X				X					X
<u>Leiotriletes directus</u>				X	X				X	cf.		cf.		cf.
<u>Quadrисporites</u> sp.					X				X					
<u>Granulatisporites micronodosus</u>					X				X					
<u>Punctatisporites gretensis</u>					X				X					
<u>Rugulatisporites</u> sp. 124*					X									X
<u>Cycadopites cymbatus</u>					cf.				X					
<u>Limitisporites</u> sp.					X				X					
<u>Quadrисporites horridus</u>					X				X	X				
<u>Protohaploxypinus goraiensis</u>					cf.				X	X				X
<u>Apiculati</u> spp.					X		X		X	X		X	X	X
<u>Apiculatisporis levis</u>									X					
<u>Sulcatisporites ovatus</u>									X					
<u>Retusotriletes diversiformis</u>										X				
<u>Apiculatisporis cornutus</u>														?
<u>Raistrickia radiosa</u>														X
<u>Verrucosisporites</u> sp. cf. gobbetti														X
<u>Verrucosisporites asperatilis</u>														X
<u>Grandispora</u> sp.														X
<u>Cirratriradites</u> sp.														?

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Exoil-Transoil LAKE GALILEE No. 1

Reference: Pemberton (1965).

Generalized section (formations as quoted in well completion report):

AGE	FORMATION	DEPTH	
Cainozoic	unnamed	Surface - 53m	Surface - 175'
	- unconformity -		
Triassic	Moolayember Formation equivalent	53 - 335m	175 - 1100'
	Clematis Sandstone equivalent	335 - 539m	1100 - 1770'
	Rewan Formation equivalent	539 - 862m	1770 - 2828'
Up. Permian	unnamed	862 - 1059m	2828 - 3476'
	- unconformity -		
Lr. Perm. - ?Carb.	unnamed	1059 - 2841m	3476 - 9320'
Devonian	unnamed Drummond Basin sequence	2841m - TD	9320' - TD
Total Depth		3406m	11,175'

Palynology: The results of palynological work by Evans and Playford (both in Pemberton, 1965) on the Upper Carboniferous to Permian section in Lake Galilee no. 1 are listed below.

Evans (1966a) gave species lists (not repeated here) and discussed the microfloras in relation to the Galilee Basin palynostratigraphy, as it was then known. In addition a number of samples yielded Devonian and Triassic plant microfossils.

	Sample	Depth	M.F.P.	Age Given	Author	Revised stage
	Core 11	867m 2846'	3287	?(barren)	Evans	?
	Core 12	964m 3162'	3288	P3-4	Evans	Stage 5 (undiff.)
5	"	" 3164'	3289	?(barren)	Evans	?
	Core 13	1056m 3464'	3290	P3-4	Evans	Stage 5 (undiff.)
Probably Zone E = Upper 2	Core 14	1061m 3480'	3291	?(barren)	Evans	?
	"	1063m 3486'	3345	P1b	Evans	Up. Stage 2
	Core 15	1167m 3829'	3292	P1b	Evans	Up. Stage 2
	Core 20	1610m 5281'	3308	?(barren)	Evans	?
Probably Zone C = Early 2	Core 23	1879m 6165'		Lr. Permian	Playford	?Lr.Stage 2
	"	1880m 6167'	3309	C1-2	Evans	?Lr.Stage 2
	Core 24	1986m 6515'		?(barren)	Playford	?
	"	" "	3310	?(barren)	Evans	?
	Core 25	2077m 6814'		Lr. Permian	Playford	Prob.Stage 1
	"	2078m 6817'	3311	C1	Evans	Stage 1
	Core 26	2152m 7060'	3312	C1	Evans	Stage 1
	"	2154m 7068'		Lr. Permian	Playford	Stage 1
	Core 27	2243m 7359'	3313	C1	Evans	Stage 1
	Core 28	2345m 7693'		?(indet.)	Playford	?
	Core 29	2430m 7973'	3606	C1	Evans (1966a)	Stage 1
	"	" 7974'		Lr. Permian	Playford	Stage 1
	Core 30	2493m 8180'		?Lr.Permian	Playford	?Stage 1
	Core 31	2608m 8558'		?(indet.)	Playford	?
	"	" "	3607	?(barren)	Evans (1966a)	?
	SWC	2619m 8594'		?(indet.)	Playford	?
	SWC	2636m 8647'		?Lr.Permian	Playford	?Stage 1
	Core 32	2668m 8752'		?(barren)	Playford	?
	Core 33	2687m 8816'		?(barren)	Playford	?
	Core 36	2842m 9325'		Up.Dev./Lr. Carb.	Playford	Up.Dev./Lr. Carb.

The lowest sample to yield saccate pollen was the side wall core from 2636m (8647'). From this level, Playford reported a poorly preserved microflora with possible representatives of Calamospora and Punctatisporites. He also found one specimen which he attributed to Nuskoisporites triangularis. With the proviso that this was not a contaminant, he suggested an Early Permian age for the sample. This side wall core is underlain by a microflora which lacks saccate pollen and from which Playford identified several Upper Devonian to Lower Carboniferous trilete spores (core 36, 2842m, 9325'). It is succeeded by definite Upper Carboniferous samples with monosaccate pollen (e.g. core 29, 2430m, 7973'). For these reasons side wall core 8647' is tentatively assigned to Stage 1. A similar, rather doubtful association was recorded by Playford from core 30 (2493m, 8180').

Spore unit C1 was identified by Evans (1966a, and in Pemberton, 1965) in cores 25, 26 and 27 (2078m, 6817'; 2152m, 7060'; and 2243m, 7359' respectively). Cores 25 and 26 yielded poor microfloras dominated by trilete spores, Phyllothecotriletes sp. 7 being particularly important. He also reported Retusotriletes diversiformis (sp. 6), Kraeuselisporites sp. 35, cf. Phyllothecotriletes sp. 10, and Rugulatisporites sp. 22. The only saccate pollens were fragmentary and questionable Potonieisporites neglectus (sp. 192) in core 25. On the basis of this increase in Phyllothecotriletes sp. 7 and decrease in saccate pollen, Evans related these samples to similar microfloras from the base of Stage 1 (spore unit C1) in core 24 (1946m, 6384') in Maranda no. 1. By contrast, cores 27 and 29 (2243m and 2430m, 7359' and 7973') in Lake Galilee no. 1 contained abundant saccate pollen and relatively few trilete spores. Thus core 29 yielded Parasaccites sp., Vestigisporites sp. 44, Phyllothecotriletes sp. 7 and Retusotriletes diversiformis (sp. 6); while core 27 only contained monosaccate pollen and Vestigisporites sp. 44. Similar assemblages were listed by Playford. His reference to a striate bisaccate pollen in core 29 was only tentative.

Both Evans and Playford found quite abundant palynomorphs in core 23 (1879m and 1880m, 6165' and 6167'). Evans gave the following species list.

Phyllothecotriletes sp. 7

cf. Phyllothecotriletes sp. 10

Retusotriletes diversiformis (sp. 6)

Kraeuselisporites sp. 35

Verrucosisporites sp. 28

Vallatisporites sp. 37

Reticulatisporites sp. 43

Parasaccites spp. (common)

Vestigisporites sp. 44

Potonieisporites cf. neglectus (?sp. 192).

He placed the sample in spore unit C1-2 but favoured a C1 dating. Playford also recorded a single striate bisaccate specimen, which he assigned to 'Lueckisporites' amplus. The trilete spore association given by Evans is typical of both Stage 1 and Lower Stage 2. As Striatiti do not appear until the base of Stage 2 according to Evans' (1967a, 1969) definition, core 23 is tentatively dated Lower Stage 2.

Cores 14 and 15 (1063m and 1167m, 3486' and 3829') contained the assemblages listed below, which Evans placed in spore unit P1b (=Stage 2).

Phyllothecotriletes sp. 7 (core 15 only)

Retusotriletes diversiformis (sp. 6) (core 15 only)

cf. Granulatisporites sp. 59 (core 15 only)

Apiculatisporis sp. 61 (probably conspecific with sp. 62)
(core 15 only)

Monocolpate pollen sp. 186 (core 14 only)

Parasaccites spp. (common)

Potonieisporites neglectus (sp. 192) (core 15 only)

Vestigisporites sp. 193 (core 15 only)

Protohaploxypinus aff. gorainesis (sp. 187) (core 14 only).

The presence of Monocolpate pollen sp. 186 in core 14 and the tentative occurrences of Granulatisporites sp. 59 and Apiculatisporis sp. 62 in core 15 point to a position in Upper Stage 2. Core 14 came from immediately below the regional unconformity which separates Upper and Lower Permian strata throughout the Galilee Basin. If that sample can indeed be dated Upper Stage 2, then Stage 3 is absent in this well. A similar situation occurs in Koburra no. 1 and Jericho no. 1, all of which were drilled in the same part of the basin. In both of these wells, probable Upper Stage 2 microfloras are overlain by samples containing Stage 5 fossils and Stage 3 is not represented.

Evans identified P3-4 in cores 12 and 13 (964m, 3162' and 1056m, 3464' respectively). Both horizons contained abundant Striatiti, together with Sulcatisporites ovatus (sp. 138), and S. splendens (sp. 137). The presence of Dulhuntyispora dulhuntyi (sp. 122) allows dating of core 13 as Stage 5. A subdivision of Stage 5 is not possible as D. dulhuntyi is known from both the

lower and the upper parts of the stage. Core 12 yielded Gnetaceaepollenites sinuosus (sp. 151), which ranges from Upper Stage 4 to the top of the Permian. From its stratigraphic position however, this sample is also placed in Stage 5.

Phillips-Sunray LEOPARDWOOD No. 1

Reference: McDonagh, Knuth & Patterson (1966).

Generalized section (taken from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1675m	Surface - 5497'
	- unconformity -		
Permian	unnamed	1675 - 1680m	5497 - 5513'
	- unconformity -		
Dev.-?Carb.	Adavale Basin sequence	1680m - TD	5513' - TD
Total Depth		4184m	13,727'

Palynology: Only 5m (16 feet) of Permian sediments were penetrated in this well. De Jersey (in McDonagh et al., 1966) examined a side wall core sample from 1680m (5512') and noted "a relative abundance of striate bisaccate pollens including the genus Striatopodocarpites". He suggested a Permian age for this sample. Lack of species lists precludes a more refined dating but regional stratigraphic evidence supports a Late Permian (probably Upper Stage 5) age.

Phillips - Sunray LOG CREEK No. 1

Reference: Kyranis & McDonagh (1966).

Generalized section (taken from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1816m	Surface - 5957'
	- unconformity -		
Up. Perm.	unnamed	1816 - 1851m	5957 - 6073'
	- unconformity -		

AGE	FORMATION	DEPTH	
Lr. Permian	unnamed	1851 - 2056m	6073 - 6746'
Lr. Dev. - ?Carb.	Adavale Basin sequence	2056m - TD	6746' - TD
Total Depth		4440m	14,566'

Palynology: There is no palynologic control of the alleged Permian section in this well. De Jersey (in Kyranis & McDonagh, 1966) examined two samples but they were from Jurassic and Devonian intervals. Core 3 (1835-39m, 6019-33') is from the supposed Upper Permian and contains thin carbonaceous bands. Core 4 (2020-23m, 6627-37'), from the "Lower Permian" is mainly composed of sandstone with a few irregular shale bands. Identification of Permian strata must rest at the moment on this lithological information.

Hematite LOVELLE DOWNS No. 1

Reference: Watson (1973).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1381m	Surface - 4530'
Triassic	unnamed	1381 - 1486m	4530 - 4876'
Up. Permian	unnamed	1486 - 1601m	4876 - 5251'
	- unconformity -		
Lr. Permian	unnamed	1601 - 2007m	5251 - 6585'
	- unconformity -		
Pre-Permian	metamorphic basement	2007m - TD	6585' - TD
Total Depth		2028m	6652'

Palynology: Palynologic control for Lovelle Downs no. 1 was provided by Price (Permian and early Mesozoic) and by Burger (Jurassic and Cretaceous samples) (both in Watson, 1973). Price examined 15 samples from the Permian interval. His results are summarized below and his report is quoted in full, without any changes in taxonomy. It should be noted that the species numbers marked by an asterisk (table 3) are not the same as those in use by the BMR.

<u>Sample</u>	<u>Depth</u>		<u>Age</u>	<u>Stage Given</u>
SWC 11	1498m	4915'	high Lr. to Up. Permian	Upper Stage 5
SWC 2b	1509m	4950'	?	?(barren)
Cutt.	1536-39m	5040-50'	?high Lr. to Up. Permian	?Upper Stage 5
Cutt.	1618-22m	5310-20'	Lower Permian	Stage 3
Core 1	1647m	5403'	Lower Permian	Stage 3
SWC 10	1657m	5435'	?	?(barren)
SWC 9	1666m	5465'	Lower Permian	Stage 3
SWC 8	1681m	5515'	?	?(barren)
SWC 7	134m	5690'	Lower Permian	Undiff. (indet.)
SWC 6	1770m	5808'	?	?(barren)
SWC 5	1832m	6012'	Lower Permian	Stage 3 ✓ OK
SWC 3	1864m	6115'	?	?(barren)
SWC 2	1974m	6475'	?	?(barren)
SWC 1b	2010m	6595'	?	?(barren)
SWC 1	2021m	6630'	?	?(barren)

"SWC 1/2021m (6630 ft), 1b/2010m (6595 ft), 2/1974m (6475 ft), and 3/1864m (6115 ft) failed to yield identifiable miospores and thus no opinion can be given as to their biostratigraphic affinities based upon palynology.

The assemblage from SWC 5/1832m (6012 ft) was highly carbonised with relatively few forms being recognised. Only the relatively thick walled more robust forms, such as Verrucosisporites pseudoreticulatus, Apiculatisporis levis and Granulatisporites trisinus, could be identified.

The absence of other forms such as bisaccate pollen (including Striatiti) and Marsupipollenites triradiatus most probably reflects the poor preservation rather than the antiquity of the microflora.

"Evans (1967a) indicates that Verrucosisporites pseudoreticulatus first appears in Stage 3 and that the base of this unit coincides with the base of P1c of Evans (1964c) (see Evans 1967a, page 6). However, some ambiguity exists in the interpretation of P1b and P1c of Evans (1964c) in this context. Unit P1c is broadly distinguished by a significant increase in Striatiti which becomes a major constituent of the assemblage, the persistent and common occurrence of Marsupipollenites spp. together with a decline in the importance of monosaccate pollen. In the initial interpretation of Evans' (1964c) units V. pseudoreticulatus was considered to first appear in unit P1b, (see Evans 1964c and 1966a) together with Marsupipollenites triradiatus. Recent studies indicate that V. pseudoreticulatus first appears within P1b (or older) equivalents rather than P1c as inferred by Evans (1967a).

In view of this, and the difficulty of adhering consistently to the semi-quantitative parameters indicated above in highly carbonised assemblages, the base of Stage 3 is arbitrarily taken as being at the first appearance of V. pseudoreticulatus. Accordingly, the assemblage at 6012 ft is assigned to Stage 3 of Evans (1967a) as reinterpreted above. In terms of Evans' 1964c nomenclature, the assemblage may be as old as P1b (or possibly slightly older) as no reliance can be placed upon the observed absences of Marsupipollenites spp. or Striatiti under these conditions of poor preservation.

SWC 9/1666m (5465 ft), Core 1/1647m (5403 ft) and Cuttings 1618-22m (5310-20 ft.) yielded better preserved and more diverse assemblages. These assemblages were characterised by the presence of striate and non-striate bisaccate pollen, Marsupipollenites triradiatus, M. striatus, Apiculatisporis spp. and Verrucosisporites pseudoreticulatus. As such they are assignable to Stage 3 of Evans (1967a) or P1c of Evans (1964c).

"Marsupipollenites" sinuosus, which is characteristic of the younger Permian section (Upper Stage 4 - Stage 5) was observed in the cuttings from 1618-22m (5310-20 ft). No biostratigraphic significance is placed upon the presence of this form in this sample as it appears to be out of character with the rest of the assemblage. Its presence, together with some Mesozoic forms such as Classopollis classoides, Microcachyridites antarcticus, Ischyosporites sp. and Podosporites sp., is probably a result of the inclusion in the cuttings of younger sediment from higher in the well section.

"Within the sequence assigned to Stage 3, several samples (SWC 6/1770m (5808 ft), SWC 8/1681m (5515 ft) and SWC 10/1657m (5435 ft)) failed to yield any identifiable miospores. Thus these samples, together with SWC 7/1734m (5690 ft), which yielded only long ranging Permian forms, could contribute little to the biostratigraphic subdivision of the section encountered.

Cuttings sample 1536-39m (5040-50 ft) yielded a distinctive and diverse assemblage which included Striatiti (common), Dulhuntyispora parvithola, Granulatisporites trisinus, Microbaculispora villosa and "Marsupipollenites" sinuosus. The presence of D. parvithola in this association is suggestive of Upper Stage 5 of Paten (1969) (that is P3b-4 of Evans, 1964c).

Verrucosisporites pseudoreticulatus, a form not generally encountered in Upper Stage 5 microfloras, was also observed in the residue recovered from this sample. However, this species has been recovered from the basal part of Upper Stage 5 in the Bowen Basin (Price, unpubl.) but the microfloras encountered there were significantly different. It seems probable therefore that this form has been recycled from the underlying Lower Permian. It should be noted, however, that it is also possible, but perhaps less likely, that V. pseudoreticulatus is in fact endemic (thus implying an older Permian age) and that the younger forms were present by contamination of the cuttings by sediments from higher in the sequence. In view of this the assignment to Upper Stage 5 must be treated as being tentative.

No recognisable palynomorphs were recovered from SWC 2b/1509m (4950 ft.). Thus no opinion as to the biostratigraphic relationship of the sampled horizon can be given based upon palynological evidence.

The microflora recovered from SWC 11/1498m (4915 ft) included a relatively high proportion of striate bisaccate pollen, "Marsupipollenites" sinuosus and Dulhuntyispora parvithola. On the basis of this association the sampled horizon is assigned to Upper Stage 5 of Paten (1969) or P3b-4 of Evans (1964c).

In The Galilee Basin and in the Bowen Basin, Upper Stage 5 microfloras represent the youngest Permian assemblages described so far. They range from late Lower to Upper Permian. Younger assemblages assigned to the Permian have been recovered from some areas in the Cooper Basin.

"Neither Stage 4 nor Lower Stage 5 microfloras were recognized in this study. Their absence between those assigned to Stage 3 and Upper Stage 5 suggests a major depositional break between 1618m (5310 ft) and 1498m (4915 ft) or possibly 1539m (5050 ft). However, the sample gap at this level of almost 300 ft (90m) precludes any definite conclusion being drawn in this regard."

Table 3:
Hematite LOVELLE DOWNS No. 1
Permian Microfloral Distribution

	SWC 11/1498m (4915 ft)	Cutt. 1536-39m (5040-50 ft)	Cutt. 1618-22m (5310-20 ft)	Core 1/1647m (5403 ft) (Coal)	Core 1/1647m (5403 ft)	SWC 9/1666m (5465 ft)	SWC 7/1734m (5690 ft)	SWC 5/1832m (6012 ft)
<u>Alisporites</u> spp.	X	X	X		X	X		
<u>Protohaploxypinus</u> spp.	X	X	X			X	X	
<u>Striatopodocarpites</u> spp.	X	X	X	X		X		
<u>Hamiapollenites</u> sp.	X							
<u>"Marsupipollenites" sinuosus</u>	X	X	X					
<u>Marsupipollenites striatus</u>	X	X				X		
<u>Dulhuntyispora parvithola</u>	X	X						
<u>Granulatisporites trisinus</u>	X				X	X		X
<u>Retusotriletes diversiformis</u>	X	X						
<u>Apiculatisporis</u> sp.	X							
<u>Marsupipollenites triradiatus</u>		X	X		X			?
<u>Microbaculispora villosa</u>		X						
<u>Dulhuntyispora</u> sp. (301*)		X						
<u>Granulatisporites</u> sp. (206*)		X						
<u>Kraeuselisporites</u> spp.		X	X		X	X		
<u>Granulatisporites micronodosus</u>		X			X	X	X	?
<u>Tuberculatisporites modicus</u>		X			X			
<u>Sulcatisporites</u> spp.		X	X		X			
<u>Parasaccites</u> spp.		X	X			X	X	
<u>Laevigatisporites colliensis</u>		X			X			
<u>Leiotriletes directus</u>		X	X	X				
<u>Punctatisporites gretensis</u>		X	X	X	X	X		
<u>Verrucosisporites pseudoreticulatus</u>		X			X			X
<u>Microbaculispora</u> sp. cf. <u>M. villosa</u>		X						
<u>Acanthotriletes tereteangulatus</u>		X	X	X	X			
<u>Converrucosisporites</u> sp.		X						
<u>Neoraistrickia ramosa</u>		X			X	X	X	X
<u>Verrucosisporites</u> sp. (191*)		X			X	X		
<u>Apiculatisporis cornutus</u>			X			X		
<u>A. levis</u>			X					X
<u>A. filiformis</u>				X		X	X	
<u>Microbaculispora</u> sp. (276*)					X	X		
<u>Striatoabietites multistriatus</u>					X	X		
<u>Verrucosisporites</u> sp. (94*)					X			
<u>Apiculatisporis</u> sp.					X			
<u>Potonieisporites</u> spp.						X		
<u>Vittatina</u> sp.						X		
<u>Vestigisporites</u> spp.						X		

Oil Development MARANDA No. 1

Reference: Le Blanc (1963).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Quaternary	unnamed	Surface - 12m	Surface - 40'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	12 - 262m	40 - 858'
	- ?disconformity -		
Triassic	Moolayember Formation	262 - 417m	858 - 1367'
	Clematis Sandstone	417 - 538m	1367 - 1764'
	- ?disconformity -		
	Rewan Formation	538 - 730m	1764 - 2396'
Permian	Bandanna Formation	730 - 805m	2396 - 2640'
	Colinlea Formation	805 - 1772m	2640 - 5815'
	- ?disconformity -		
Lr. Permian -			
Up. Carb.	Joe Joe Creek Formation	1772 - 1971m	5815 - 6465'
	- unconformity -		
Lr. Palaeozoic basement or Precambrian		1971m - TD	6465' - TD
Total Depth		1978m	6491'

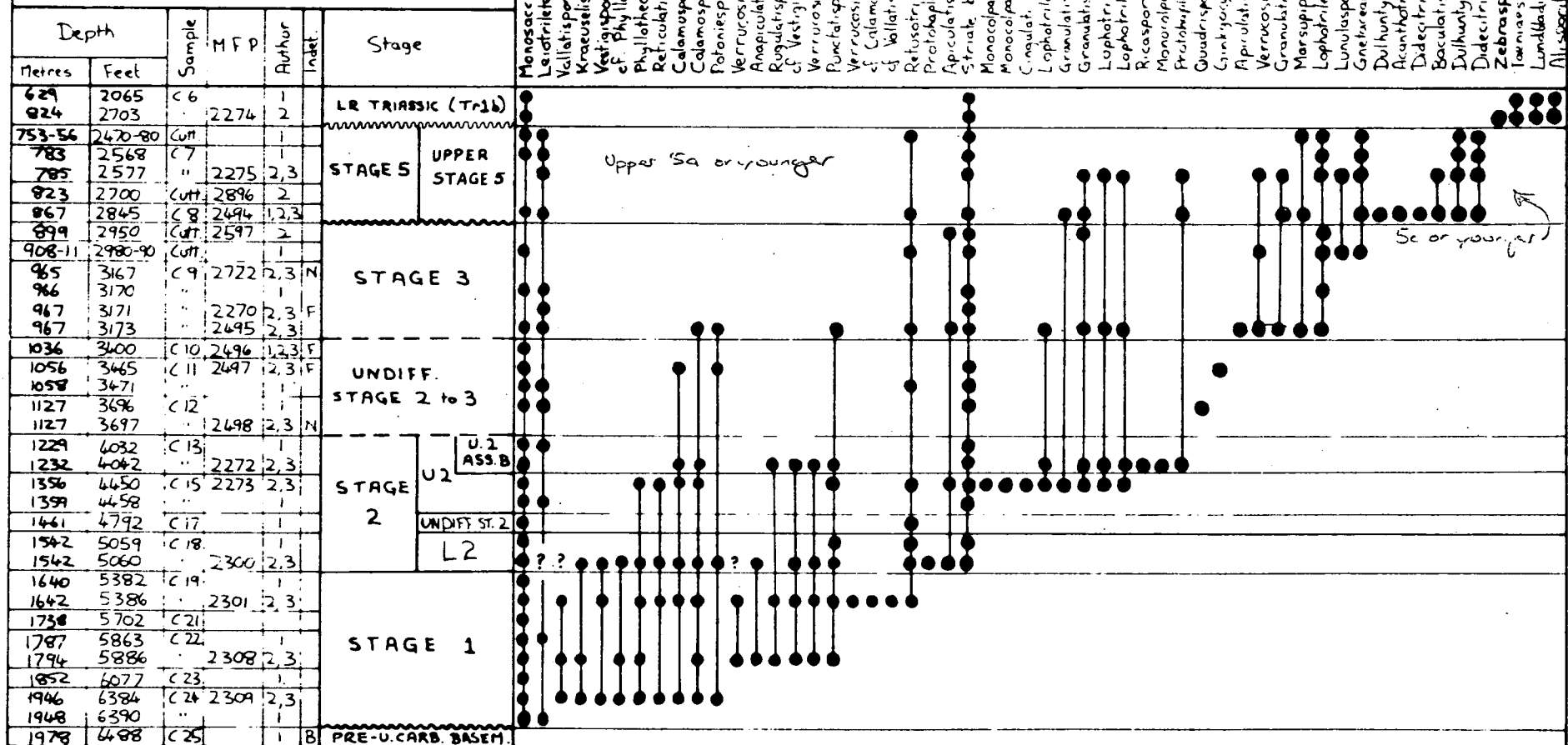
Palynology: This well has been extensively sampled for palynology and preliminary reports were by Evans and De Jersey (both in Le Blanc, 1963). Since then, several further descriptions of the microfloral succession were made by Evans (1964c, 1966a, d) and De Jersey, Hamilton & Paten (1963). Slides held by the Bureau of Mineral Resources have been re-examined for this study. The results of earlier studies on the Upper Carboniferous to Permian samples and their re-interpretation are set out below (re-examined samples are indicated by an asterisk). The distribution of the stratigraphically most important species is shown on fig. 15.

Fig 15
OIL DEVELOPMENT N.L.
MARANDA No.1

RANGE CHART FOR
SELECTED SPECIES

B Barner
N Indeterminate microspores
F Insufficient for dating

1 De Jersey et al 1963
2 Evans 1964c
3 re-examined



Monosaccate pollen
Leidtriletes directus (B.M.R. sp. 207)
Vallatisporites sp. 37
Kraeuselisporites sp. 35
Vestigisporites sp. 44
cf. Phyllotheconites sp. 10
Phyllotheconites sp. 7
Reticulatisporites sp. 43
Calamospora sp. 58
Calamospora sp. 4
Potamiosporites neglectus (B.M.R. sp. 192)
Verrucosiporites sp. 28
Anapiculatisporites sp. 17
Rugulatisporites sp. 22
cf. Vestigisporites sp. 45
Verrucosiporites sp. 8
Punctatisporites synovus (B.M.R. sp. 45)
Verrucosiporites sp. 111
cf. Calamospora sp. 4
cf. Vallatisporites sp. 36
Reticulatisporites diversiformis (B.M.R. sp. 184)
Protoboloporphyrus aff. granensis (B.M.R. sp. 184)
Apiculatisporites sp. 62
Striate bisaccate pollen
Monocolpate pollen sp. 186
Monocolpate pollen sp. 197
Cingulatisporites sp. 64
Lophotriletes sp. 64
Granulatisporites microdonatus (B.M.R. sp. 111)
Granulatisporites sp. 51
Lophotriletes sp. 183
Lophotriletes sp. 702
Ricaspora sp. 1113
Monocolpate pollen sp. 106
Protoboloporphyrus rugatus (B.M.R. sp. 192)
Quadratisporites horridus
Cinkyscadaphylus sp. 811
Apiculatisporites sp. 408
Verrucosiporites pseudoreticulatus (B.M.R. sp. 68)
Granulatisporites aff. microdonatus (B.M.R. sp. 405)
Marsupolletes triradiatus (B.M.R. sp. 152)
Lophotriletes, terebratulatus (B.M.R. sp. 113)
Lophotriletes, collensis (B.M.R. sp. 132)
Lunulaspores, sinensis (B.M.R. sp. 151)
Dulhuntyispora dulhuntyi (B.M.R. sp. 122)
Acanthotriletes dentatus (B.M.R. sp. 1160)
Dilectotriletes uncinatus (B.M.R. sp. 114)
Baculatisporites sp. 109
Dulhuntyispora purvithala (B.M.R. sp. 123)
Dilectotriletes ericanius (B.M.R. sp. 115)
Zebriasporites sp.
Tamiariporites spp
Lundbladispore spp
Alisporites spp

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Given Spore Unit</u>	<u>Author</u>	<u>Revised Stage</u>
Cutt.	753-56m	2470-80'	M.-Up. Perm.	De Jersey et al.	Up. Stage 5
Core 7	783m	2568'	M.-Up. Perm.	De Jersey et al.	Up. Stage 5
"	785m	2577'	2275* P3-4	Evans, 1964c	Up. Stage 5
Cutt.	823m	2700'	2896 P3-4	Evans, 1964c	Stage 5
Core 8	867m	2845'	2494* P3-4	Evans, 1964c	Up. Stage 5
"	"	"	M.-Up. Perm.	De Jersey, et al.	
- - - - hiatus - - - -					
Cutt.	899m	2950'	289* Plc	Evans, 1964c	Prob. Stage 3
Cutt.	908-11m	2980-90'	M.-Up. Perm.	De Jersey et al.	Prob. Stage 3
Core 9	965m	316'	2722* Plc	Evans, 1964c	? (indet)
"	966m	3170'	Lr. Permian	De Jersey et al.	?
"	967m	3171'	2270* Plc	Evans, 1964c	? (indet)
"	"	3173'	2495* Plc	Evans, 1964c	Stage 3
Core 10	1036m	3400'	2271* ? (barren)	Evans, 1964c	?
"	"	"	2496* ? (barren)	Evans, 1964c	?
"	"	"	? (v. poor)	De Jersey et al.	?
Core 11	1056m	3465'	2497* P1b	Evans, 1964c	? (indet)
"	1058m	3471'	Lr. Permian	De Jersey et al.	? Up. Stage 2-3

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Given Spore Unit</u>	<u>Author</u>	<u>Revised Stage</u>	
Core 12	1127m	3696'		Lr.Permian	De Jersey et al.	?Up.Stage 2-3
"	"	3697'	2498*	P1b	Evans, 1964c	? (indet)
Core 13	1229m	4032'		Lr.Permian	De Jersey et al.	?
"	1232m	4042'	2272*	P1b	Evans, 1964c	Up.Stage 2(B)
Core 15	1356m	4450'	2273*	P1a	Evans, 1964c	Up. Stage 2
"	1359m	4458'		Lr.Permian	De Jersey et al.	?
Core 17	1461m	4792'		Lr.Permian	De Jersey et al.	Prob.Stage 2
Core 18	1542m	5059'		Lr.Permian	De Jersey et al.	Prob. Stage 2
"	"	5060'	2300*	C2	Evans, 1964c	Prob.Lr.Stage 2
Core 19	1640m	5382'		Lr.Permian	De Jersey et al.	?
"	1642m	5386'	2301*	C1	Evans, 1964c	Stage 1
Core 21	1738m	5702'		Lr.Permian	De Jersey et al.	?
Core 22	1787m	5863'		Lr.Permian	De Jersey et al.	?
"	1794m	5886'	2308*	C1	Evans, 1964c	Stage 1
Core 23	1852m	6077'		Lr.Permian	De Jersey et al.	?Stage 1
Core 24	1946m	6384'	2309*	Carbonif.undiv.	Evans, 1964c	?Stage 1
"	1948m	6390'		Lr.Permian	De Jersey et al.	?Stage 1
- - - - unconformity - - - -						
Core 25	1978m	6488'		Pre-Perm. (barren)	De Jersey et al.	?(basement)

De Jersey et al. (1963) were not able to find any recognisable microfossils in the basal core (c. 25, 1978m, 6488'). Lithologically it consisted of steeply dipping, recrystallized, sheared silty mudstone (Houston in Le Blanc, 1963) and is unconformably overlain by nearly horizontal, unindurated strata, which contain Upper Carboniferous microfloras. A pre-Upper Carboniferous age can thus be assumed on stratigraphic grounds.

Cores 23 (1852m, 6077') and 24 (1946m, 1948m; 6384', 6390') contained rather impoverished assemblages of somewhat carbonised and corroded palynomorphs. The microflora in core 23 was dominated by species of Phyllothecotriletes (spp. 7 and 10), with saccate pollen represented by Potonieisporites neglectus (sp. 192), Parasaccites spp. and Vestigisporites sp. 44. Several zonate spores were also present. The position of these samples below more diverse Stage 1 assemblages, coupled with the complete lack of striate pollen, suggests that they also belong in Stage 1. Cores 19 (1642m, 5386') and 22 (1794m, 5886') contained monosaccate pollen in association with typical Stage 1 to Lower Stage 2 trilete spores. Verrucosisporites sp. 910, cf. Calamospora sp. 9 and cf. Vallatisporites sp. 36 (in core 19), and Anapiculatisporites sp. 17 (in core 22) are not known from above Lower Stage 2. Striatiti are again lacking and these samples are placed in Stage 1.

The floras listed by De Jersey et al. (1963) from these same cores and also from core 21 (1738m, 5702') cannot be directly assigned to the stage system used here. Very little formal taxonomic work has yet been published on Australian latest Carboniferous and earliest Permian microfloras, with the result that comparison between assemblages described by different authors is possible only at a generic level. This problem is most acute in the case of Maranda no. 1. De Jersey et al. (1963) mention a form in cores 19 and 21, which they describe as "Marsupipollenites sp. aff. M. sinuosus". They also found it in a great many other samples throughout the Lower Permian, including horizons which have been independently dated Stage 1, Stage 2 and Stage 3. Typical Gnetaceaepollenites sinuosus (sp. 151) is not known below Upper Stage 4, and the pollen mentioned by De Jersey et al. is most probably a quite distinct species. Their records of "Granulatisporites sp. cf. G. micronodosus" in core 22 and of "G. sp. cf. G. trisinus" in core 21 pose similar problems, because neither occur in their typical form before Upper Stage 2 in other parts of the basin.

The first sample from which striate pollen has been removed is core 18. A sample of this core from 1542m (5060') contains Protophloxypinus aff. goraiensis (sp. 187). This is associated with Phyllothecotriletes spp. 7 and 10, Calamospora sp. 4, Punctatisporites gretensis (sp. 5), Anapiculatisporites sp. 17, Kraeuselisporites sp. 35 and Reticulatisporites sp. 43. Apart from the

rare occurrence of Apiculatisporis sp. 62, this is a typical Stage 1 to Lower Stage 2 trilete spore assemblage. The presence of Striatiti, which were also noted by De Jersey et al. (1963) from the same core (c.18, 1542m, 5059'), confirms a position within Lower Stage 2.

The next sample (c. 17, 1461m, 4792') has been examined by De Jersey et al. (1963) and, for the reasons given above, cannot be integrated into the stage zonation beyond saying that it probably lies within Stage 2. However, slides from the succeeding cores (c.15 and c.13) are available in the BMR and have been re-examined for the present study. The assemblages contain common monosaccate pollen, a few Striatiti (Protohaploxypinus rugatus, sp. 198) and a large suite of trilete spores. Of particular zonal use among the latter are various types of Lophotriletes (spp. 64, 183 and 70), Monocolpate pollen sp. 186 and Granulatisporites sp. 59, none of which are known from below Upper Stage 2. In addition, core 15 (1356m, 4450') yielded Cingulati sp. 699, which in Thunderbolt no. 1 disappears at the top of Stage 2 (assemblage A). Core 13 (1232m, 4042') contained Ricaspora sp. 1113, one of the forms upon which assemblage B was characterized in the Thunderbolt samples (Norvick, 1971). The presence of Calamospora sp. 4 and Phyllothe-cotriletes sp. 7 in core 15, and the dominance of Parasaccites spp. in core 13 indicate that these samples are no younger than Upper Stage 2.

Samples held in the BMR from cores 12 (1127m, 3697'), 11 (1056m, 3465') and 10 (1036m, 3400') are either barren, or contain very poorly preserved microfloras which are insufficient for zonation. De Jersey et al. (1963) recorded quite abundant assemblages from cores 12 (112m, 3696') and 11 (1058m, 3471'), although core 10 was again very poor. They mention small numbers of Marsupipollenites triradiatus in core 12. This form appears in large numbers at the base of Stage 3 but also occurs rarely in Upper Stage 2. The use of their record of Granulatisporites trisinus (also in core 12), one of Evans' (1967a, 1969) marker species of Stage 3, must also be treated with caution because they list it from several samples lower in the succession. They give percentage distribution graphs for the major palynomorph groups but these do not show any particularly major changes in the interval under discussion. In conclusion, the section between 1127m and 1036m (3697' and 3400') cannot be dated accurately but lies within Upper Stage 2 or Stage 3 on the grounds of superposition.

A much more characteristic microflora was obtained from core 9 (967m, 3173'). Among the diverse trilete spores were several well-preserved specimens of Verrucosisporites pseudoreticulatus (sp. 68). Apart from some rather problematical records of Evans (1964c, 1966a) in spore unit P1b, this

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species makes its debut at the base of P1c. Its first appearance also marks the base of Stage 3 and the sample is given this date. Other components of the microflora are common Granulatisporites sp. 59 and zonate trilete spores. Marsupipollenites triradiatus (sp. 152) also occurs here. A single specimen referable to Calamospora sp. 4 is the youngest occurrence of that species so far encountered. The possibility of reworking cannot be excluded and C. sp. 4 is otherwise only known from strata dated Upper Stage 2 or older. The cuttings from 908-11m (2980-90') and 899m (2950') can probably also be placed in Stage 3. De Jersey et al. (1963) found the first downhole occurrence of Verrucosisporites pseudoreticulatus in the cuttings from 908-11m (2980-90') and this species has not yet been recorded from the Upper Permian (Upper Stage 5). It was associated with Gnetaceaepollenites sinuosus and Lunulasporites colliensis, which could represent caving contamination. De Jersey et al. distinguished this cutting sample from underlying core 9, among other things on a percentage increase in striate bisaccate pollen and a corresponding decrease in monosaccate pollen. However, the presence of the Stage 3 marker species at 908-11m (2980-90') and the lowest appearance of unequivocal Upper Stage 5 microfloras in core 8 (867m. 2845') are sufficient evidence for placing the major regional hiatus between these two horizons.

Core 8 (867m. 2845') is dated as Upper Stage 5 on the presence of Dulhuntyispora parvithola (sp. 123) and D. dulhuntyi (sp. 122) in BMR material. Other species present include Didecitriletes ericianus (sp. 115), D. uncinatus (sp. 114), Gnetaceaepollenites sinuosus (sp. 151) and abundant Striatiti. The form which De Jersey et al. (1963) recorded as "Dulhuntyispora egregia" is probably conspecific with D. dulhuntyi. Core 7 (785m and 783m; 2577' and 2568') and the cuttings at 753-56m (2470-80') contain similar microfloras with D. parvithola but lacking D. dulhuntyi. These also are characteristic of Upper Stage 5.

Lower Triassic assemblages have been reported by both Evans and De Jersey from core 6 (629m and 632m; 2065' and 2073'). Important elements present include Taeniaesporites spp. Lunbladispora spp. and abundant Alisporites. Evans (1964c) placed this core in spore unit Tr1b.

Longreach Oil MARCHMONT No. 1

Reference: Mott & Associates (1964c).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1007m	Surface - 3305'
	- unconformity -		
Up. Permian	Bandanna Formation	1007 - 1271m	3305 - 4170'
?M. Permian	Mantuan equivalent	1271 - 1313m	4170 - 4307'
Lr. Permian	Colinlea Formation	1313 - 1984m	4307 - 6510'
?Carbonif.	Joe Joe Formation	1984m - TD	6510' - TD
Total Depth		1990m	6530'

The stratigraphy of the Permian section needs some revision (see Evans, 1964c). Correlation with nearby wells on the northeastern side of the Hulton-Rand structure, by means of lithology and wireline logs, indicates that the Upper Permian extends down to 1103m (3620') and unconformably overlies Lower Permian sediments (Vine, pers.comm.).

Palynology: Playford (in Mott & Associates, 1964c) examined the pollen and spores from five conventional cores and three cutting samples. Subsequently, Evans (1964c, and in McDonagh, 1967) reinterpreted the stratigraphy and studied further palynological samples from this well. All their results from the Permian interval and a reappraisal in terms of the present zonal scheme are set out in the table below.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Age Given</u>	<u>Author</u>	<u>Revised Stage</u>
Cutt.	978-81m	3210-20'	3373	Indet.	Evans, 1964c	?
Core 8	1153-56m	3782-92'		Perm. (undiff.)	Playford	Perm. (undiff.)
"	1155m	3790'	3270	P1c	Evans, 1964c	?Stage 3
Core 9	1289m	4228'	3271	Barren	Evans, 1964c	?

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Age Given</u>	<u>Author</u>	<u>Revised Stage</u>
Core14	1844-46m 6050-58'		Lr. Permian	Playford	Stage 2-3
"	1845m 6054'	4168	Indet.	Evans (in McDonagh, 1967)	?
Core15	1930-33m 6332-42'		Lr. Permian	Playford	Stage 2 (?Lr. 2)
"	1931m 6336'	4169	C2	Evans (in McDonagh, 1967)	
Cutt.	1951-54m 6400-10'		Lr. Permian	Playford	Stage 1-2
Cutt.	1966-69m 6450-60'		Lr. Permian	Playford	Stage 1-2
Core16	1989-90m 6525-30'		Barren	Playford	?
Cutt.	" "		caving contam.	Playford	?

Evans (1964c) thought that the Jurassic/Permian boundary was at a higher level than that picked by Mott & Associates (1964c) (1007m, 3305'). He considered that the horizon sampled by cuttings at 978-81m (3210-20') should be included in the Upper Permian section. Unfortunately, palynological preparations from that level contained only Mesozoic pollen and spores and he was unable to prove whether or not these represented caving contamination. The position of the Jurassic/Permian boundary remains open, although on the presence of coal seams and from correlations with neighbouring wells, Upper Permian sediments are probably present in Marchmont no. 1.

Playford (in Mott & Associates, 1964c) found a very poor assemblage of trilete spores and striate pollen in core 8 (1153-56m, 3782-92'), which he was unable to date more accurately than Permian (undifferentiated). Evans (1964c) allocated a second sample from the same core to spore unit Plc, but assemblage details are not accessible. In the Cooper Basin and Denison Trough palynologic unit Plc equates with Stage 3 and the basal part of Lower Stage 4. In the Galilee Basin however, Stage 4 is absent and samples previously dated as Plc have proved to belong to Stage 3. Lithological and wireline logs suggest that the interval containing core 8 in Marchmont no. 1 correlates with a unit containing Stage 3 assemblages in nearby Glenaras no. 1. Consequently core 8 is tentatively assigned to Stage 3.

Core 14 (1844-46m, 6050-58') has been dated Lower Permian by Playford (in Mott & Associates, 1964c) but could not be accurately dated by

Evans (in McDonagh, 1967). The slides in the BMR collections contain very rare, poorly preserved saccate pollen. Playford recorded common monosaccate pollen and rare Striatiti, associated with a number of unpublished echinate and smooth, zonate and azonate trilete spore genera. His taxa cannot be compared directly with BMR numbered species and only a Stage 2-3 age can be given from his description. The same comments apply to Playford's discussion of core 15 (1930-33m, 6332-42'). Material from the same core held in the BMR has also been examined by both Evans (in McDonagh, 1967) and the present author, and contains the following species.

Reticulatisporites sp. 43

Phyllothecotriletes sp. 7

Calamospora sp. 4

Rugulatisporites sp. 22

Retusotriletes diversiformis (sp. 6)

cf. Retusotriletes sp. 1109

Potonieisporites cf. neglectus (? sp. 192)

Monosaccate pollen.

This assemblage, taken in conjunction with Playford's record of striate bisaccate pollen from the same core, is characteristic of Stage 2, possibly Lower Stage 2.

Playford examined core 16 (1989-90m, 6525-30') and also cuttings from the same interval. He found that core 16 was barren and the cuttings contained a very poor microflora of Mesozoic (probably Lower Jurassic) spores. The latter are obviously derived from cavings and no age can be given for this horizon. Similarly, cuttings from above core 16 (1951-54m and 1966-69m; 6400-10' and 6450-60') also contained Mesozoic caving contaminants. These were associated with monosaccate and rare striate pollen, which led Playford to suggest an early Permian age for both samples. Their position below Stage 2 microfloras in core 15 provides a younger limit to their age but the possibility of further caving from Permian horizons means that the presence of Stage 1 cannot be ruled out.

Pursuit Oil MUTTABURRA No. 1

Reference: Meyers & Spencer (1970).

Generalized section (as in well completion report):

AGE	FORMATION		DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 833m	Surface - 2734'
Triassic	Moolayember Formation	833 - 843m	2734 - 2767'
	Clematis Sandstone	843 - 80m	2767 - 2855'
	Rewan Formation	870 - 882m	2855 - 2893'
Up. Permian	unnamed	882 - 1079m	2893 - 3540'
Lr. Permian	unnamed	1079 - 1402m	3540 - 4600'
	- unconformity -		
Pre-Permian	volcanic basement	1402m - TD	4600' - TD
Total Depth		1449m	4753'

Palynology: No palynological control is available for this well so all stratigraphic comparisons of the Permian interval rest on lithologic and wireline log information. The regional unconformity which marks the Upper/Lower Permian boundary is thought to lie higher than indicated (1079m, 3540') by Meyers & Spencer (1970). Using wireline log correlations from Brookwood no. 1 (to the northwest), and Glenaras no. 1 (to the south), the unconformity is picked at or about 991m (3250'). This lies within a coal-bearing sequence, which elsewhere has been dated Stage 3 and Upper Stage 5. The major fine clastic sequence, (unit C), which has been traced over much of the northern Galilee Basin (Vine, in press), extends from 1079m to 1173m (3540' to 3850') and is underlain by interbedded sandstones and shales (unit B) down to the supra-basement unconformity.

Longreach Oil RAND No. 1

Reference: Warris (1969).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 942m	Surface - 3090'
Permian	Bandanna Formation	942 - 1122m	3090 - 3680'
	Reids Dome Beds	1122 - 1265m	3680 - 4150'
lr. Permian	Joe Joe Formation	1265 - 1861m	4150 - 6105'
Carboniferous	basal sand	1861m - TD	6105' - TD
Total Depth		1986m	6516'

Rand no. 1 was drilled on the northeastern flank of the Hulton-Rand structure, very close to and between Glenaras no. 1 (to the north) and Marchmont no. 1. Consequently, the succession in these three wells is very similar. A comparison of their lithologies and wireline logs indicates a somewhat different Permian stratigraphy from that described by Warris (1969) in the well completion report. Unfortunately no palynological control is available for Rand no. 1 and the ages given in the table below are correlated from other wells.

Revised Permian stratigraphy based on log correlations:

AGE	LITH. UNIT	DEPTH		REMARKS
Jur.-Cret.	Eromanga Basin sequence	Surf.-942m	Surf.-3090'	
	- unconformity -			
Up. Perm.	sandstones with coals (unit E)	942-1033m	3090-3390'	Up.Stage 5 in Glenaras no. 1.
	- unconformity -			

AGE	LITH. UNIT	DEPTH	REMARKS
Lr. Perm.	sandstones with coals (unit D)	1033-1122m 3390-3680'	Stage 3 in Glenaras no. 1.
	shales, ssts with coals (unit D)	1122-1192m 3680-3910'	Stage 3 in Thunderbolt no. 1.
	major shale unit (unit C)	1192-1381m 3910-4530'	Up.Stage 2 in Glenaras no. 1 & Thunderbolt no. 1.
	interbedded ssts, shales (unit B)	1381-1861m 4530-6105'	Lr. to Up.Stage 2 in Glenaras no. 1 & Thunderbolt no. 1.
	"basal sand" of Warris (1969) (unit A)	1861m -TD L6105'-TD	Lr.Stage 2 immed. above in Glenaras no. 1 & March- mont no. 1.

Amoseas RAVENSBOURNE No. 1

Reference: Sirovs (1968).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 1093m Surface - 3585'
Triassic	Moolayember Shale	1093 - 1125m 3585 - 3692'
	Clematis Sandstone	1125 - 1250m 3692 - 4100'
Permian	unnamed	1250 - 1530m 4100 - 5020'
	- unconformity -	
Lr. Dev.	unnamed	1530m - TD 5020' - TD
Total Depth		2358m 7736'

Palynology: Paten and De Jersey (both in Sirovs, 1968) examined a number of samples from the Lower Devonian section in Ravensbourne no. 1 but none from the supposed Permian interval. To date the latter has not been studied palynologically and its identification must rest on lithological and electric log characteristics. The presence of coal in the upper part of the ?Permian suggests that the Upper Permian (Stage 5) and/or Stage 3 may be represented.

Longreach Oil SALTERN CREEK No. 1

Reference: Mott Associates (1964b).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface-762m	Surface-2499.5'
	- unconformity -		
Up. Permian	Bandanna Formation	762 - 1036m	2499.5 - 3400'
	Mantuan Formation	1036 - 1074m	3400 - 3525'
Lr. Permian	Colinlea Formation	1074 - 1454m	3525 - 4770'
	- unconformity -		
Dev.-Carb.	Drummond Group	1454m - TD	4770' - TD
Total Depth		1514m	4966'

Palynology: Hodgson, Evans and Playford (all in Mott & Associates, 1964b) have reported palynological studies on the Mesozoic and Palaeozoic of Saltern Creek no. 1. Evans (1964c) has also interpreted some of this data in terms of his spore units. The results of the part of these studies dealing with the Permian are summarized below, together with suggested allocation to Evans' (1967a, 1969) stages.

<u>Sample</u>		<u>Depth</u>	<u>M.F.P.</u>	<u>Spore Unit Given</u>	<u>Author</u>	<u>Revised Stage</u>
Cutt.	735-38m	2410-20'	3374	Indet.	Evans, 1964c	?
Core5	758m	2488'	3263	Barren	Evans, 1964c	?
"	"	2488.5'	3261	Barren	Evans, 1964c	?
Core6	763m	2502'	3264	P3-4	Evans, 1964c	?Stage 5
Cutt.	799-808m	2620-50'	3092	P3-4	Evans, 1964c	?Stage 5

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Spore Unit Given</u>	<u>Author</u>	<u>Revised Stage</u>
Cutt. 835-44m	2740-70'	3093	Plc	Evans, 1964c	? Stage 5
Core7 858m	2815'	3265	Plc	Evans, 1964c	Prob. Stage 3
Core8 950m	3117'	3266	Pl(undiff.)	Evans, 1964c	Up. Stage 2-3
Core10 1134m	321'	3267	Plb	Evans, 1964c	Up. Stage 2
Core13 1408-11m	4619-29'		Lr. Perm.	Playford	Stage 2(?Up. 2)

Evans (1964c) noted that all palynomorphs from the cuttings at 735-38m (2410-20') were Mesozoic forms but thought that this horizon and that of palynologically barren core 5 (758m, 2488') could be correlated with the Permian on lithologic evidence. Mott & Associates (1964b), on the other hand, placed the Jurassic/Bandanna Formation boundary at a lower horizon (762m, 2499.5'). In the absence of palynological evidence, this question remains open.

Evans (in Mott & Associates, 1964b) gave Upper Permian dates to cuttings from 799-808m (2620-50') and 835-44m (2740-70'). However, he later placed the cuttings from 835-44m (2740-70') in the Lower Permian spore unit Plc (Evans, 1964c). Full microfloral lists and slide preparations are not accessible, but from the available reports, both sets of cuttings are of probable late Lower or Upper Permian (?Stage 5) age. Evans (in Mott & Associates, 1964b) states

"Cuttings 799-808m (2620-50 feet) yielded abundant striate saccate pollens with rare acanthine spores, an assemblage typical of the late Permian coals of the upper Bandanna Formation. Cuttings 835-44m (2740-70 feet) yielded mainly vegetable tissue, but relatively common striate saccate pollens, with Laevigatosporites vulgaris and Acanthotriletes ericianus. This assemblage should probably also be linked with the upper Bandanna Formation".

Didecitriletes ericianus (sp. 115) is not known elsewhere from either spore unit Plc, nor from its partial correlate Stage 3. Instead, it does not appear until Upper Stage 4 in the Cooper Basin (Paten, 1969) and is not common in eastern Australia generally before Upper Stage 5. In addition, wireline log correlations on the northeastern side of the Hulton-Rand structure (Vine, pers.comm.) allow moderately confident identification of the Upper/Lower Permian boundary with 847m (2780') in Saltern Creek no. 1. For these reasons a questionable Stage 5 position is favoured for the cuttings at 799-808m (2620-50') and 835-44m (2740-70'), together with the stratigraphically higher but palynologically very impoverished core 6 (763m, 2502').

Core 7 (858m, 2815') contains an abundant and moderately well preserved microflora. It has been briefly re-examined for the present study and contains the following species.

Verrucosisporites cf. pseudoreticulatus (?sp. 68)

Diatomozonotriletes townrovii (sp. 1114)

Kraeuselisporites sp. 1112

Apiculatisporis spp. 62 and 908

Granulatisporites micronodosus (sp. 111)

Granulatisporites sp. 59

Lophotriletes tereteangulatus (sp. 113)

Lophotriletes sp. 183

Monocolpate pollen sp. 186

Marsupipollenites triradiatus (sp. 152)

Sulcatisporites ovatus (sp. 138)

Protohaploxypinus rugatus (sp. 198)

Protohaploxypinus spp. (common)

Parasaccites spp. (rare).

This assemblage is characteristic of Upper Stage 2 and Stage 3. The presence of a number of poorly preserved specimens of Verrucosisporites very close to V. pseudoreticulatus (sp. 68), and of Diatomozonotriletes townrovii (sp. 1114) and common Marsupipollenites triradiatus (sp. 152) (very rare in Stage 2 assemblages) support a probable Stage 3 position for core 7. Evans (1964c) allocated it to spore unit P1c. Core 7 can be correlated on wireline logs with a coal-bearing unit containing Stage 3 microfloras in Glenaras no. 1.

Core 8 (950m, 3117') contains very few unidentifiable spores and was placed in undifferentiated spore unit P1 by Evans (1964c). Its stratigraphic position between probable Stage 3 of core 7, and Upper Stage 2 of core 10, suggests it lies in one of these two zones. Lithologic correlation with a major shale unit (unit C), which has been well dated elsewhere indicate that it may be part of Upper Stage 2.

Evans (1964c) placed core 10 (1134m, 3721') in spore unit P1b. Information in BMR files, supplemented by further examination of the slides, resulted in the following species list.

Granulatisporites sp. 59
Calamospora sp. 58
Apiculatisporis sp. 62
Leiotriletes directus (sp. 207)
Punctatisporites gretensis (sp. 5)
Verrucosisporites sp. 58
Parasaccites spp.
Vestigisporites sp. 44
 cf. Vestigisporites sp. 45
Klausipollenites sp. 82
Protohaploxypinus aff. goraiensis (sp. 187)
Protohaploxypinus rugatus (sp. 198)

This assemblage is sufficient to date core 10 as Upper Stage 2.

Playford (in Mott & Associates, 1964b) has examined core 13 (1408-11m, 4619-29') and has dated it Lower Permian. Unfortunately his assemblage list cannot be compared directly with the unpublished species used here. It is possible however, to fairly confidently identify Playford's microflora as belonging in Stage 2. Monosaccate pollen is common, striate bisaccate forms are rare and he did not mention any of the characteristic and well documented index species of Stages 3 to 5. The presence of Lophotriletes tereteangulatus, Granulatisporites micronodosus (or a closely related species to BMR sp. 111) and "Marsupipollenites cf. sinuosus" (this is unlikely to be related to Gnetaceaepollenites sinuosus sensu stricto - it may or may not be related to Monocolpate pollen sp. 186) suggest it may be from the upper, rather than the lower division of Stage 2.

Phillips - Sunray STAFFORD No. 1

Reference: Netzel (1967).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH	
Tert/Rec.	unnamed	Surface - 4m	Surface - 14'
Jur.-Cret.	Eromanga Basin sequence	4 - 1411m	14 - 4630'
	- disconformity -		

AGE	FORMATION	DEPTH	well pro- posed study
Triassic	Clematis Sandstone	1411 - 1557m	4630 - 5107'
	- disconformity -		
Up. Permian	unnamed	1557 - 1626m	5107 - 5336'
	- unconformity -		
M.Dev. ?Carb.	Adavale Basin sequence	1626m - TD	5336' - TD
Total Depth		3141m	10,306'

Palynology: De Jersey (in Netzel, 1967) studied a number of Jurassic, Triassic and Devonian samples from this well. In addition, Evans (in Netzel, 1967) examined a single Permian sample (core 4, 1612-14m. 5290-96') and assigned it to spore unit P3b-4. A brief re-examination of the same sample (M.F.P. 4167) yielded abundant Sulcatissporites ovatus (sp. 138) and striate bisaccate pollen (chiefly Protohaploxylinus spp. of the P. amplus-limpidus group), together with

Dulhuntyispora parvithola (sp. 123)

Didecitriletes ericianus (sp. 115)

Gnetaceaepollenites sinuosus (sp. 151)

Baculatisporites sp. 109

Marsupipollenites triradiatus (sp. 152)

Ricaspora sp. 1113

Leiotriletes directus (sp. 207)

Retusotriletes diversiformis (sp. 6)

Lophotriletes sp. 64

Granulatisporites micronodosus (sp. 111).

This assemblage can now be dated Upper Stage 5.

Evans (1968) has identified the following taxa in the following order:

Amerada THUNDERBOLT No. 1

Reference: Amerada (1967).

A full discussion of the stratigraphy of this well may be found in Norvick (1971) and Burger & Kemp (1972).

Generalized section:

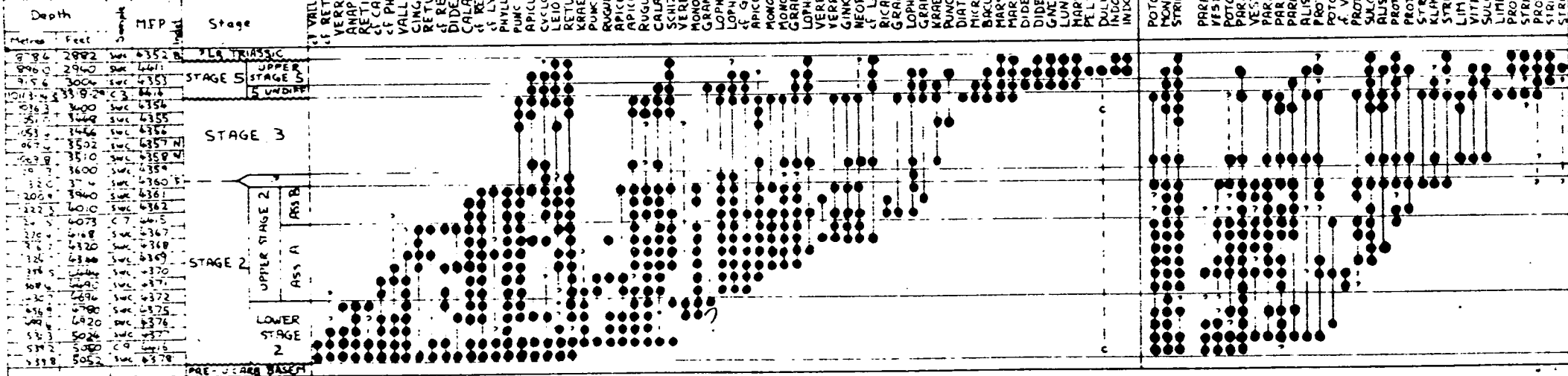
AGE	FORMATION	DEPTH	
Quaternary	unnamed	Surface - 12m	Surface - 38'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	12 - 389m	38 - 1277'
	- unconformity -		
Triassic	Moolayember Formation	389 - 577m	1277 - 1892'
	Clematis Sandstone	577 - 707m	1892 - 2320'
	Rewan Formation	707 - 881m	2320 - 2892'
	- unconformity -		
up.Lr. - Up. Perm.	unnamed	881 - 1050m	2892 - 3444'
	- unconformity -		
Up.Carb. - Lr.Permian	unnamed	1050 - 1608m	3444 - 5274'
	- unconformity -		
Pre-Up. Carb.	volcanic basement	1608m - TD	5274' - TD
Total Depth		1611m	5286'

Palynology: The Permian succession in Thunderbolt no. 1, although not complete, was relatively fully sampled. Fifty three side wall cores, conventional cores and ditch cuttings were made available for palynological study by the company. Of these, 34 yielded recognisable microfossils, including 22 from the Permian interval. For these reasons the Upper Carboniferous to Permian microfloral succession was examined in some detail and formed the basis of a special report (Norvick, 1971). This report is quoted here in full with very few changes and the results are summarized in the table below.

<u>Sample</u>	<u>Depth</u>		<u>M.F.P.</u>	<u>Spore Unit</u> (Evans in Amerada 1967)	<u>Stage</u> (Norvick, 1971)
SWC	896m	2940'	4411	P4	Up. Stage 5
SWC	916m	3004'	4353	P4	Up. Stage 5
Core 3	1011-14m	3318-29'	4414	P3b-4	Stage 5 (undiff.)
- - - - hiatus - - - -					
SWC	1036m	3400'	4354	P1c	Stage 3
SWC	1051m	3448'	4355	?(indet)	? (poor yield)
SWC	1053m	3456'	4356	?(indet)	? (poor yield)
SWC	1067m	3502'	4357	?(indet)	? (indet.)
SWC	1070m	3510'	4358	?(indet)	? (indet.)
SWC	1097m	3600'	4359	P1c	Stage 3
SWC	1132m	3714'	4360	?(indet)	Up. Stage 2 - Stage 3
SWC	1201m	3940'	4361	P1b	Up. Stage 2 (B)
SWC	1222m	4010'	4362	P1b	Up. Stage 2 (B)
Core 7	1241m	4073'	4415	P1b	Up. Stage 2 (B)
SWC	1270m	4168'	4367	P1b	Up. Stage 2 (A)
SWC	1317m	4320'	4368	P1a	Up. Stage 2 (A)
SWC	1325m	4346'	4369	P1a/C2	Up. Stage 2 (A)
SWC	1354m	4444'	4370	P1a/C2	Up. Stage 2 (A)
SWC	1369m	4490'	4371	P1a/C2	Up. Stage 2 (A)
SWC	1431m	4694'	4372	P1a/C2	Up. Stage 2 (A)
SWC	1457m	4780'	4375	P1a/C2	Lr. Stage 2
SWC	1500m	4920'	4376	P1a/C2	Lr. Stage 2
SWC	1531m	5024'	4377	P1a/C2	Lr. Stage 2
Core 9	1539m	5050'	4416	C2	Lr. Stage 2
SWC	1540m	5052'	4378	C2?	Lr. Stage 2

Fig. 16
AMERADA
THUNDERBOLT No. 1
RANGE CHART FOR SELECTED
SPECIES

720 Barren
Indeterminate specimens
insufficient for dating
c Drilling mud contaminants



NON-SACCATES

SACCATES

Previous work on this section includes Evans' (in Amerada, 1967) short report on the Triassic, Permian and Upper Carboniferous microfloras. He dated the assemblages using his (1964c, 1966a) lettered spore units and Norvick (1971) reinterpreted these using the later stage nomenclature. Burger (1970) compared the Thunderbolt sequence with the neighbouring section in Towerhill no. A-1, and Burger & Kemp (1972) examined the Jurassic and Cretaceous samples.

The lowest sample in Thunderbolt no. 1 contains striate bisaccate pollen and can be placed in Lower Stage 2. Below this are 68m (222 feet) of unsampled sandstone, shale and siltstone, which rest unconformably on volcanic basement. These strata can be tentatively correlated, on lithologic and wire-line log criteria, with a section below 1542m (5060 feet) in Maranda no. 1. In Maranda no. 1, they have yielded Stage 1 assemblages, and the presence of this stage is suspected in Thunderbolt.

Figure 16 shows the distribution of selected pollen and spores in the Permian samples. Five species listed below occur more or less frequently throughout the succession and appear to be of little stratigraphic use.

Leiotriletes directus (sp. 207)

Retusotriletes diversiformis (sp. 6)

Schizosporis scissus (sp. 131)

Apiculatisporis sp. 1104

Cyclogranisporites sp. 107.

Lower Stage 2 (1457 to 1540m; 4780 to 5052 feet)

The lowest assemblage present in Thunderbolt no. 1 is characterised by abundant

monosaccate pollen (Parasaccites spp. 51, 190, 191, 50)

Punctatisporites spp.

Phyllothecotriletes spp. 7 and 10

Calamospora spp.

Apiculatisporis sp. 908

Rugulatisporites sp. 22.

A distinctive suite of zonate spores are present, including

cf. Vallatisporites sp. 36

Vallatisporites sp. 37

Kraeuselisporites sp. 35.

Four other species do not occur above this unit, namely

Anapiculatisporites sp. 17

cf. Retusotriletes sp. 12

Reticulatisporites sp. 43

Verrucosisporites sp. 910.

Striate pollen occurs very rarely and Protohaploxypinus aff. goraiensis (sp. 187) makes its first appearance here. Other saccate species present (although not restricted to this assemblage) include cf. Vestigisporites sp. 44 and Potonieisporites neglectus (sp. 192). The upper limit of the unit lies between 1431 and 1457m (4694 and 4780 feet), in a series of alternating feldspathic sandstones and shales. There is no evidence from the palaeontology, the lithology or the wireline logs for a major sedimentary break at this horizon.

Upper Stage 2 (1201 to 1431m; 3940 to 4694 feet)

Samples within this unit show a progressive and gradual change from bottom to top. Thus the lowest samples have abundant

Phyllothecotriletes spp. 7 and 10*

Calamospora spp. 4* and 58

Punctatisporites gretensis (sp. 5)

Apiculatisporis spp. 908 and 62

Rugulatisporites sp. 22

Monocolpate pollen sp. 106

Lophotriletes spp. 64 and 183

monosaccate pollen

Potonieisporites spp.

with rare

cf. Calamospora sp. 9*

Vallatisporites sp. 37*

cf. Retusotriletes sp. 1105*

Kraeuselisporites sp. 35*

Rugulatisporites sp. 104*

Striatiti spp.

In the uppermost samples, a number of these forms have disappeared (those marked with an asterisk above). The Striatiti have become much more abundant and a new group of species have appeared, in particular Monocolpate pollen spp. 197 and 186, Granulatisporites sp. 59 and Lophotriletes sp. 702.

A boundary between the lower (assemblage A) and upper (assemblage B) microfloras is very hard to define. It is provisionally taken between 1241 and 1270m (4073 and 4168 feet), at the upper limit of

Cingulati sp. 699

Retusotriletes sp. 1111

cf. Retusotriletes sp. 1105

Didecitriletes sp. 19.

The lowest occurrences at this level of Granulatisporites micronodosus (sp. 111) and Lophotriletes sp. 702 may represent contamination, but a third species, Ricaspora sp. 1113, appears to be restricted to assemblage B. The change in lithology at about 1370m (4,500 feet), from alternating sandstones and shales to a predominantly shale sequence (also shown by the wireline logs), does not reflect a palynological break.

The upper boundary of Upper Stage 2 as a whole is marked by the top occurrences of

Phyllothecotriletes sp. 7

Apiculatisporis sp. 1106

cf. Retusotriletes sp. 1109

cf. Lycospora sp. 1108

Monocolpate pollen sp. 106.

Calamospora sp. 4 has its top just below this level. Rugulatisporites sp. 22, a form whose specific identity is not yet fully understood, becomes much less abundant above this boundary. The base of Upper Stage 2 is placed at first occurrences of Lophotriletes spp. 64, L. sp. 183 and cf. Granulatisporites sp. 1103. Apiculatisporis sp. 62 appears just above this horizon.

Stage 3 (1036 to 1097m; 3400 to 3600 feet)

The boundary between Stages 2 and 3 cannot be located with accuracy in Thunderbolt no. 1, but lies between 1201 and 1097m (3940 and 3600 feet). The side wall core at 1201m (3940 feet) (M.F.P. 4361) contains an abundant Upper Stage 2 microflora and marks the top of a number of species listed above. The next sample (at 1132m; 3714 feet) is heavily contaminated and contains a poor assemblage, all of whose members range above and below. The sample from 1097m (3600 feet) (M.F.P. 4359) again contains a rich microflora characterised by abundant Apiculatisporis spp. 62 and 1104, Sulcatisporites spp. and Striatiti, with significant numbers of

Lophotriletes tereteangulatus (sp. 113)

Apiculatisporis sp. 908

Granulatisporites sp. 59

Kraeuselisporites sp. 1112

Lophotriletes sp. 702.

It marks the first appearance of Kraeuselisporites sp. 1112, Limitisporites sp. 899, Vitreisporites pallidus (sp. 135) and Sulcatisporites splendens (sp. 137).

The succeeding four samples are either completely barren (1070 and 1067m; 3510 and 3502 feet), or contain very sparse microfloras (1053 and 1051m; 3456 and 3448 feet). The uppermost assemblage in Stage 3 (at 1036m; 3400 feet) is, in contrast, excellently preserved and very rich. It contains most of the species which occur at 1097m (3600 feet) with a number of new arrivals, including

Microreticulatisporites sp. 906

Baculatisporites sp. 109

Marsupipollenites triradiatus (sp. 152)

Marsupipollenites sp. 896.

This sample contains the highest occurrence of, among others, Punctatisporites gretensis (sp. 5), Apiculatisporis spp. 62, A. sp. 908 and Monocolpate pollen spp. 197 and 186.

Stage 5 (896 to 1014m) (2940 to 3329 feet)

Core 3 (1011-14m; 3318-29 feet) contains a somewhat poorly preserved and restricted microflora, which nevertheless shows a marked contrast to lower samples. It lacks the species mentioned above and contains the first appearance of several others, including

Gnetaceaepollenites sinuosus (sp. 151) (common)

Didecitriletes ericianus (sp. 115) (common)

Didecitriletes uncinatus (sp. 114)

Lunulasporites colliensis (sp. 132).

The microflora of the succeeding side wall core (916m; 3004 feet) is much better preserved. It is dominated by species of Sulcatisporites and Striatiti and contains all the species mentioned above, together with considerable numbers of

Baculatisporites sp. 109

Marsupipollenites triradiatus (sp. 152)

Lophotriletes spp. (tereteangulatus and sp. 183)

Granulatisporites sp. 59.

Occurring for the first time are

Dulhuntyispora parvithola (sp. 123)

Indospora spp. 911 and 1164

Peltacystia sp. (an undescribed form).

The palynological study indicates the presence of a major hiatus between Stages 3 and 5, with at least the whole of Stage 4 missing. There is an important lithological change in this part of the section, from a less to a more carbonaceous type of sedimentation. At 1050m (3444 feet) the lithologic log shows a change from a pale siltstone/coal sequence to a carbonaceous siltstone/sandstone/coal sequence. This is accompanied by features on the SP, resistivity and gamma ray logs. Amerada (1967) showed the Upper/Lower Permian boundary at this level.

The presence of an undoubted Stage 3 microflora 14m (44 feet) above the horizon of this apparent lithological break (1036m. 3400 feet, M.F.P. 4354) is very puzzling. Three possible explanations may cover this discrepancy.

- a. The contents of side wall core from 1036m (3400 feet) may represent and impoverished stage 5 flora, masked by over-riding numbers of reworked species from stage 3. The high standard of preservation in this sample does not agree with large scale recycling.
- b. The disconformity at 1050m (3444 feet) is within stage 3, while another one above that level removes stage 4. Palynological evidence for an hiatus within stage 3 is lacking.
- c. The interpretation of the lithologic log is incorrect and the change to more carbonaceous sedimentation occurs at a slightly higher level. Electric and gamma ray log characteristics provide little data for this.

None of these hypotheses fully explains all the evidence and the problem remains unsolved.

Sample M.F.P. 4411 (896m; 2940 feet) contains the highest, although poorly preserved, Permian microflora. Just above this horizon the lithology changes from a coaly to a red bed sequence and samples from the succeeding 180m are barren. Amerada (1967) correlated the section between 707 and 881m (2320 and 2892 feet) with the Lower Triassic Rewan Formation. The presumed Permian/Triassic boundary is associated with wireline log features.

Amoco TOWERHILL No. A-1

Reference: Haworth (1968).

Generalized section (from well completion report):

AGE	FORMATION	DEPTH
Quaternary	unnamed	Surface - 41m
	- unconformity -	Surface - 136'
Jur.-Cret.	Eromanga Basin sequence	41 - 563m
Triassic	Moolayember Formation	136 - 1848'
	Clematis Formation	563 - 733m
	Rewan Formation	733 - 867m
		2405 - 2846'
		867 - 1049m
		2846 - 3443'

AGE	FORMATION		DEPTH
Up. Permian	unnamed	1049 - 1194m	3443 - 3918'
	- unconformity -		
Lr. Permian - Up. Carb.	unnamed	1194 - 1481m	3918 - 4858'
	- unconformity -		
Pre.-Up. Carb.	volcanic basement	1481m - TD	4858' - TD
Total Depth		1489m	4886'

Palynology: Burger (1970) made a preliminary examination of 16 conventional cores and side wall cores for palynomorphs, seven of them from the Permian interval. His results from the Permian samples are set out below. Several of his slides have been re-examined and his dates revised.

<u>Sample</u>	<u>Depth</u>	<u>M.F.P.</u>	<u>Spore Unit</u> (Burger 1970)	<u>Revised Stage</u>
SWC 9	1052m 3456'	4648	P3b-4	?Stage 5
SWC 5	1161m 3808'	4649	P?	Perm. (undiff.)
Core 3 SWC	1193m 3915'	4661	P3b-4	Up. Stage 2 - 3 ✓
SWC 4	1277m 4190'	4650	?	?
SWC 3	1311m 4300'	4653	Plc?	Up. Stage 2 ✓ o.k.
Core 5	1354m 4441'	4662	Plb-c	Up. Stage 2
SWC 2	1417m 4650'	4654	Plb-c	Prob. Up. Stage 2 ✓

The sidewall core from 1052m (3456') contained common but rather fragmentary palynomorphs. Burger recorded the following species:

Acanthotriletes sp.

Nuskoisporites gondwanensis

Leiotriletes directus

Taeniaesporites sp.

Protosacculina multistriata

Lunatisporites cf. amplus

cf. Apiculatisporites sp.

Pityosporites sp.

Striatites phaleratus

Apiculatisporites sp.

Burger's discussion on this assemblage is quoted in full.

"This assemblage is attributable to the Permian. Balme (1964) reports relative abundance of Striatites and spinose azonate trilete spores in his Upper Permian Dulhuntyispora Assemblage, which Evans correlates with Stage 5, including spore units P3b-P4 (Evans 1967a). Microfloras of this type are widely known from the Queensland area, and in the upper part are very often associated with coal measures. The logs from Towerhill show that this sample is taken just above the major development of coals at 1055m (3460 feet). The only spore indication of an uppermost Permian age is the presence of a type here attributed to Taeniaesporites, that is reported from basal Triassic strata in Western Australia (Balme, 1964) and in the eastern part of Australia (Evans 1966a), and may indicate the proximity of Balme's Taeniaesporites Microflora equivalent."

The absence of marker species precludes the positive identification of an Upper Permian age for this sample. However, Burger's comments regarding Taeniaesporites and regional stratigraphic evidence favour a Stage 5 position.

The sample from 1161m (3808') yielded very few spores. Burger identified Leiotriletes sp. and cf. Pityosporites sp. and was not prepared to place the sample beyond saying it was Permian, a view supported here. Similarly no date is suggested for side wall core 1277m (4190'), from which only Deltoidospora sp. has been reported (Burger, 1970).

Burger gave the following species list for core 3 (1193m, 3915').

Lunatisporites (Protohaploxypinus) amplus

Nuskoisporites gondwanensis

cf. Vesicaspora sp.

Laevigatosporites vulgaris colliensis

Apiculatisporites sp.

He placed the sample in spore unit P3b-4 (stage 5), based on the occurrences of Laevigatosporites vulgaris colliensis, the abundance of Apiculatisporites, and its stratigraphic position immediately below the coal-bearing sequence.

The assemblage slides have been re-examined and a somewhat older date is favoured. The specimens which Burger identified as Laevigatosporites vulgaris colliensis belong in fact to Monocolpate pollen sp. 186. This form ranges from Upper Stage 2 to Stage 3. Other species present include

Apiculatisporis sp. 6

Protohaploxylinus sp. (of the P. amplus - limpidus group)

Protohaploxylinus aff. goraiensis (sp. 187)

Protohaploxylinus rugatus (sp. 198)

Sulcatisporites ovatus (sp. 138)

Alisporites gracilis (sp. 903)

Parasaccites spp.

Quadratisporites horridus (sp. 211)

Of these, Apiculatisporis sp. 62 is known from Upper Stage 2 to Stage 3 and Protohaploxylinus aff. goraiensis (sp. 187) is typically a Stage 2 to 3 species. On these grounds the sample is dated as Upper Stage 2 or Stage 3.

Side wall core 1311m (4300') was dated by Burger as within the interval P1b - P2, or between uppermost Stage 2 and lowermost Stage 4. He preferred a P1c position and recorded the following species.

Nuskoisporites gondwanensis

Apiculatisporites filiformis

Granulatisporites sp.

Striatites phaleratus (fragment)

Punctatisporites gretensis

Protosacculina cf. multistriata

Lunatisporites amplus

Verrucosisporites pseudoreticulatus

Burger's specimens of Verrucosisporites pseudoreticulatus have been relocated and are now thought to be Rugulatisporites sp. 22. The first appearance of V. pseudoreticulatus is a marker for the base of Stage 3 (Paten, 1969), although Evans (1964c, 1966a) mentions some rather problematical occurrences from spore unit P1b. On the other hand Rugulatisporites sp. 22 is known from Stage 1, probably to the top of Stage 3. Further species identified in this

sample are listed below.

Phyllothecotriletes sp. 7

Calamospora sp. 4?

Calamospora sp. 58

Punctatisporites gretensis (sp. 5)

Retusotriletes diversiformis (sp. 6)

Leiotriletes directus (sp. 207)

Granulatisporites sp. 59

Apiculatisporis sp. 62.

Lophotriletes tereteangulatus (sp. 113) (specimens identified as Apiculatisporites filiformis by Burger).

Lophotriletes sp. 64

Monocolpate pollen sp. 186

Parasaccites spp.

Protohaploxylinus rugatus (sp. 198)

Striatiti spp.

The youngest age possible on this revised assemblage is Upper Stage 2, based on the presence of Phyllothecotriletes sp. 7. All of the trilete spores are known from Stage 2 and certain of them (Lophotriletes spp. Apiculatisporis sp. 62, Granulatisporites sp. 59) do not occur below Upper Stage 2. Similarly Monocolpate pollen sp. 186 first appears in Upper Stage 2. With the reallocation of Burger's Verrucosisporites pseudoreticulatus to Rugulatisporites sp. 22, all the microfloral evidence points to an Upper Stage 2 age.

The lowest two samples from Towerhill no. A-1 yielded rather sparse microfloras. Burger (1970) found the following species in core 5 (1354m, 4441').

Calamospora diversiformis (=BMR sp. 6)

Calamospora sp. (spp. 4 and 58 have since been identified)

Nuskoisporites gondwanensis (fragments)

Granulatisporites trisinus (specimens reallocated to Granulatisporites sp. 59)

Neoraistrickia cf. ramosa

Several other forms can be added to this emended list, including Lophotriletes

tereteangulatus (sp. 113), L. sp. 64, Rugulatisporites sp. 22, Apiculatisporis sp. 908 and Monocolpate pollen sp. 186. Protohaploxypinus rugatus (sp. 198) and Botryococcus are represented by very rare specimens. The side wall core from 1417m (4650') contained (after Burger (1970), with additions)

Phyllothecotriletes sp. 7

Calamospora sp. 58

Granulatisporites sp. 59

Apiculatisporis sp. 62

Monocolpate pollen sp. 186 (single poorly preserved specimen)

Parasaccites spp. (= cf. Nuskoisporites fragment of Burger).

Burger dated these samples Lower Permian (palynologic unit P1b-c). The association in core 5 (1354m, 4441') of Phyllothecotriletes sp. 7 and Calamospora sp. 4 (range: Stage 1 to 2), together with Monocolpate pollen sp. 186, Granulatisporites sp. 59, and Lophotriletes spp. (range: Upper Stage 2 to 3), allows refinement of this date to Upper Stage 2. The sample from 1417m, (4650') is probably of the same age.

Beaver - Pexa VALETTA No. 1

Reference: Leslie (1970a).

Generalized section (formations from well completion report):

AGE	FORMATION	DEPTH	DEPTH
Jurassic	Eromanga Basin sequence	Surface - 741m	Surface - 2432'
	- unconformity -		
Triassic	Moolayember Formation	741 - 1054m	2432 - 3458'
	Clematis Sandstone	1054 - 1216m	3458 - 3990'
	- unconformity -		
Permian	Blackwater Group	1216 - 1281m	3990 - 4202'
	Black Alley Shale	1281 - 1307m	4202 - 4288'
	Mantuan Productus Beds	1307 - 1336m	4288 - 4382'
	- unconformity -		
Pre-Permian	basement granodiorite	1336m - TD	4382' - TD
Total Depth		1340m	4396'

Palaeontology: Dear (in Leslie, 1970a) reported the Upper Permian brachiopod Strophalosia ovalis Maxwell in core 1 at 1319m (4328'). On the basis of this determination, he correlated the sample with the Mantuan Productus Beds of the Denison Trough.

Paten (in Leslie, 1970a) examined the spores and pollen of three cutting samples. He dated the upper two assemblages (from 747m, 2450'; and 1207m, 3960') as Lower Jurassic and Lower to Middle Triassic respectively. The cuttings from 1301m (4270') yielded the following species (*generic placing emended to present usage).

Didecitriletes ericianus

Dulhuntyispora parvithola

Leiotriletes directus

Neoraistrickia sp. cf. N. ramosa

*Lophotriletes tereteangulatus

Kraeuselisporites spp.

Verrucosisporites trisecatus

Marsupipollenites triradiatus

*Gnetaceaepollenites sinuosus

Sulcatisporites ovatus

Parasaccites sp.

Striatiti spp.

Paten stated "...this association is characteristic of palynological units P3b-P4 of Evans (in Mines Administration, 1962). In the absence of acritarchs it is not possible to place the section sampled precisely within this gross stratigraphic interval on palynologic evidence alone. From independent evidence however, it appears to correlate with the upper part, i.e. P3d - P4". The association of Dulhuntyispora parvithola, Didecitriletes ericianus and Gnetaceaepollenites sinuosus also allows us to place this assemblage within Upper Stage 5 of Evans (1967a, 1969), assuming that the sample has not been heavily contaminated by caving.

Amoseas WESTBOURNE No. 1

Reference: Gerrard (1964a).

Generalized section (as quoted in well completion report):

AGE	FORMATION	DEPTH	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1006m	Surface - 3302'
	- disconformity -		
Triassic	Moolayember Shale equivalent	1006 - 1184m	3302 - 3884'
	Clematis Sandstone	1184 - 1367m	3884 - 4484'
	- disconformity -		
Permian	unnamed	1367 - 1403m	4484 - 4602'
	- unconformity -		
Pre-Permian	basement sediments	1403m - TD	4602' - TD
Total Depth		1483m	4867'

Palynology: Evans (in Gerrard, 1964a) examined a sample from core 10 (1386-89m 4548-58') and recorded

Leiotriletes directus (sp. 207)

Retusotriletes diversiformis (sp. 6)

Punctatisporites gretensis (sp. 5)

Baculatisporites sp.

Striatiti spp. (fairly common)

The specimen of Baculatisporites sp. has been relocated and can be assigned to BMR sp. 109, a Stage 3 to 5 form. Evans stated that "...these (species) are insufficient to firmly demonstrate more than just the Permian age of the sample. Baculatisporites sp. and the abundance of Striatiti spp. indicate the sample is probably to be correlated with the Colinlea Sandstone or younger Permian beds." Later (Evans 1966a) he correlated this interval with spore unit P3-4. A second sample in the BMR collection from the same interval

has been examined (side wall core 1387m, 4550'). This contains abundant Striatiti (Protohaploxylinus of the P. limpidus - amplus group, Vittitina, Striatopodocarpites spp.), together with

Lophotriletes tereteangulatus (sp. 113)

Lophotriletes spp. 183 and 702

Cyclogranisporites sp. 107

Granulatisporites micronodosus (sp. 111)

Granulatisporites cf. micronodosus (sp. 905)

Marsupipollenites sp. 1163

Retusotriletes diversiformis (sp. 6)

Baculatisporites sp. 109

Punctatisporites gretensis (sp. 5)

Didecitriletes cf. ericianus (?sp. 115)

As with core 10, an accurate age cannot be determined from this assemblage. Didecitriletes ericianus (sp. 115) is restricted to Stages 4 and 5 but the specimen seen was poorly preserved. Marsupipollenites sp. 1163 occurs in upper Stage 5 in Thunderbolt no. 1 but more information is needed before it can be used for confident dating. In conclusion the two samples from Westbourne no. 1 can only be given a Stage 3 to 5 age, although regional stratigraphic considerations suggest that they are probably Upper Permian.

It is of interest to note that Evans extracted a well preserved Upper Stage 5 microflora from core 2 (315-20m. 1035-49'). This is underlain by several Jurassic and Triassic assemblages and must represent reworking. However, it does suggest the presence of Upper Permian source sediments somewhere in the area.

Alliance YONGALA Nos. 1 and 2

References: No. 1 well - Laing (1966). No. 2 well - Laing (1967).

Alliance Oil Development Australia NL drilled Yongala nos 1 and 2 wells only 5 km apart, on the eastern side of the subsurface Canaway Ridge. Their close proximity resulted in a very similar stratigraphic section and they will consequently be dealt with together.

Generalized sections (from Laing, 1966, with emendations by Laing, 1967):

Yongala no. 1:

AGE	FORMATION	DEPTH	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 1977m	Surface - 6485'
Triassic	unnamed	1977 - 2071m	6485 - 6795'
Up. Permian	unnamed	2071 - 2095m	6795 - 6872'
	- unconformity -	12m	
Dev.-Lr.Carb.	Adavale Basin sequence	2095 - 3071m	6872 - 10,075'
	- unconformity -		
?Ordovician	basement metamorphics	3071m - TD	10,075' - TD
Total Depth		3105m	10,187'

Yongala no. 2

AGE	FORMATION	DEPTH	DEPTH
Jur.-Cret.	Eromanga Basin sequence	Surface - 1825m	Surface - 5987'
Triassic	unnamed	1825 - 1925m	5987 - 6317'
Up. Permian	unnamed	1925 - 1950m	6317 - 6398'
	- unconformity -		
Lr. Carb.	Adavale Basin sequence	1950m - TD	6398' - TD
Total Depth		2027m	6650'

Palynology: No palynological work has been done on the no. 2 well. Evans (in Laing, 1966) examined eight conventional core samples from Yongala no. 1 and processed six of them. Only one of these samples (core 9, 2084m, 6837') yielded Permian palynomorphs. Evans species list includes the following taxa (*generic names changed to present usage).

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Parasaccites sp. 50

Baculatisporites sp. 109

Conbaculatisporites cf. sp. 112

Lophotriletes tereteangulatus (sp. 113)

Anapiculatisporites sp. 117

*Sulcatisporites splendens (sp. 137)

*Sulcatisporites ovatus (sp. 138)

Bascanisporites undosus (sp. 139)

Protohaploxylinus cf. sp. 148

Striatoabietites cf. multistriatus (sp. 150)

Ginkgocycadophytus vetus (sp. 154)

Leiotriletes directus (sp. 207).

Evans stated that "...the presence of Baculatisporites sp. 109, Anapiculatisporites sp. 117 and Bascanisporites undosus (sp. 139) indicates that the core is of (spore) unit P3 - 4 age. The assemblage is not typical of that unit as the content of striate saccate pollens is not high and the key species Dulhuntyispora parvithola and "Marsupipollenites" sinuosus could not be found. However, the assemblage has nothing in common with the older Permian - Carboniferous units C1 - P1c present to the north of Yongala (Evans, 1964c)." Later, Evans (1966d, plate 1) referred the same sample to P3b - 4. In view of these observations, it is questionably assigned to Stage 5.

The Yongala wells intersected a very thin, coal-bearing Upper Permian interval (23m, (77') in no. 1, 25m (81') in no. 2). These strata represent the westernmost margin of the Galilee Basin. Permian sediments reappear west of the Canaway Ridge, in the subsurface Cooper Basin. Alliance Chandos no. 1, drilled in a northern arm of the Cooper Basin, lies 72km to the SW of the Yongala wells. This penetrated nearly 60m of Permian and Evans (1966d) identified spore units P3b - 4 (probably Upper Stage 5), P1c (Stage 3 or 4) and P1b (probably Upper Stage 2) from this interval.

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