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PERMIAN AND LATE CARBONIFEROUS PALYNOSTRATIGRAPHY OF THE GALILEE BASIN, QUEENSLAND

by

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ABSTRACT

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.

NOTE

This report was completed by M. Norvick in 1974, and has been only slightly updated. Since completion of the report there has been little palynological re-examination of the well sections described herein, and the raw data presented here is, therefore, more-or-less up to date. Since 1974, there has, however, been considerable revision of the palynological zonation of the late Carboniferous and Permian of Australia: these more recent schemes are not taken into account in the sections headed 'Previous work on palynological zonation' and 'Discussion of zonation'. Zonal schemes, as presently understood, are outlined in the article 'Carboniferous and Permian palynostratigraphy in Australia and Antarctica: a review', by E.M. Kemp, B.E. Balme, R.J. Helby, R.A. Kyle, G. Playford, & P.L. Price published in 1977 (BMR Journal of Australian Geology & Geophysics, 2, 177-208).

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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 km^2 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.

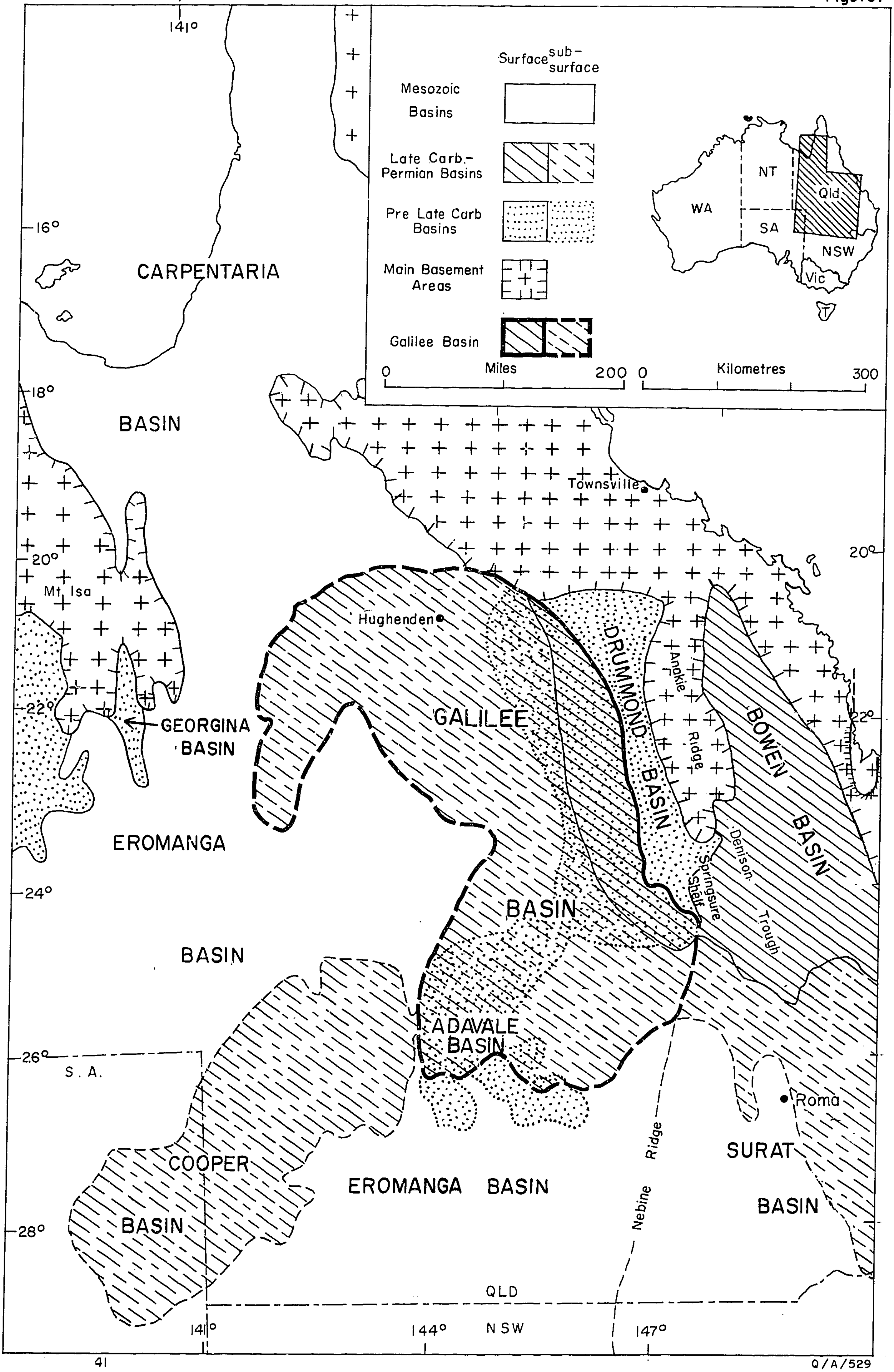

Fig. 1 Principal Sedimentary Basins of Central Queensland

More of the stratigraphic and palynological information on the Galilee Basin comes from petroleum exploration wells. Forty-two subsidized wells, drilled before 1973, were used in this report (Fig. 2, table 1)*. Palynological work done in conjunction with these operations has been compiled from unpublished oil company well completion reports and from unpublished BMR records. The results of studies on two outcrop sections from the northern margin of the basin are also included. Some of these studies were made by past and present members of the palynological staff of the Bureau of Mineral Resources (P.R. Evans, E.A. Hodgson, E.M. Kemp, D. Burger, and the author). Their assemblage slides are kept in the Bureau collections and, where possible, these have been re-examined so as to bring their results into line with current biostratigraphic zonal usage.

Previous workers (mainly in unpublished oil company reports) have correlated subsurface lithologic units in the centre of the Galilee basin with formations named either in the limited outcrop areas at the northern margin (Hughenden area) (Vine & others, 1964), or from the Springsure Shelf (Mollen et al., 1969) and Denison Trough (Power, 1967) in the east. These procedures, however have been rather unsatisfactory and the correlation of these stratigraphic sections into the centre of the Galilee Basin presents considerable problems. In the Hughenden area, successions are severely condensed and truncated, and this district is thought to have been close to the depositional edge of the basin. The Springsure Shelf sections are much more complete, but they represent a transitional zone between the Galilee Basin sensu stricto, and the Denison Trough, which is part of the Bowen Basin. Consequently, an informal nomenclature is used as an interim measure in this report. In the discussion of well sections in a later section, the earlier, though unsatisfactory, Springsure Shelf terminology is quoted from the well completion reports with the understanding that its revision will follow in the near future.

* Since this paper was compiled, the following wells have been drilled and information on them is available on open file at the Bureau of Mineral Resources, Canberra, and the Geological Survey of Queensland, Brisbane.

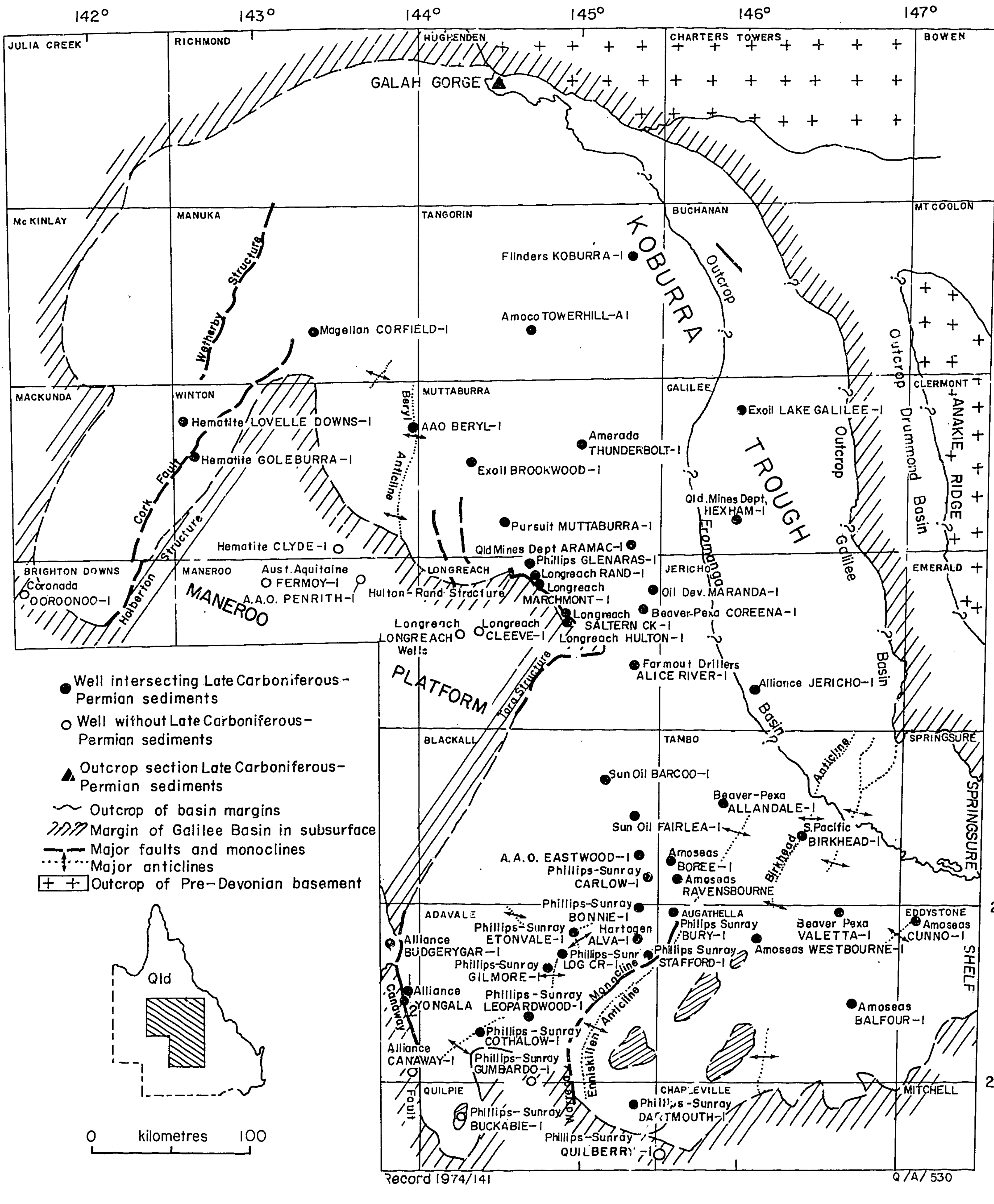

Fig 2 Well location map, Galilee Basin, Queensland

TABLE 1: SUMMARY OF WELL DATA

Well Name	Company	Reference	Latitude	Longitude	Sheet	Total Depth Metre.	Total Depth Feet	Kelly Bushing Metres	Kelly Bushing Feet	Ground Level Meters	Ground Level Feet	Palynology Reference
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	1299	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, 1968b	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	Mines 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°22'07"	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"	Muttaburra	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	Knutn, 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	Mines 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 & others, 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
Muttaburra No. 1.	Pursuit Oil	Myers & Spencer, 1970	22°48'33"	144°31'35"	Muttaburra	1449	4753	215	705	211	698	None
Rand No. 1.	Longreach Oil	Warris, 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	Netzel, 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"	Muttaburra	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, 1966a
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

Hematite Goleburra No. 1	lat. 22°25'00.6"S, long. 142°36'35.2"
Hartogen Alva No. 1	lat. 25°12'31"S, long. 145°23'14"E
Henry B. Kelsey Ban Ban No. 1	lat. 24°07'56"S, long. 143°42'14"E
Qld Mines Dept. Aramac No. 1	lat. 22°57'S, long. 145°17'E
Qld Mines Dept. Hexham No. 1	lat. 22°48'S, long. 145°57'E

A preliminary 1976 broad stratigraphic reappraisal has recently been completed by Vine 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. His four Upper Carboniferous and Permian intervals are recognized here with slight modification and are described below.

STRATIGRAPHY

Regional Geology

The Late Carboniferous to Triassic Galilee Basin is one of several Palaeozoic and Early 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 Early Carboniferous; the Bowen, Cooper, and Galilee Basins are Late Carboniferous to Triassic. The Drummond Basin, which is separated from the Bowen Basin by a crystalline basement high (the Anakie Ridge) crops out 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 & others, 1969; Vine & others, 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 sequence , 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 & others , 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 & others, 1965). The Permian and Triassic are exposed in the southern half of the Jericho Sheet area (Vine & others, 1965), and in Tambo (Exon & Kirkegaard, 1965; Exon & others 1966, 1972) and Springsure Sheet areas (Mollan, 1967; Mollan, Exon & Kirkegaard, 1964; Mollan & others, 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 & others, 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 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 (1976) (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

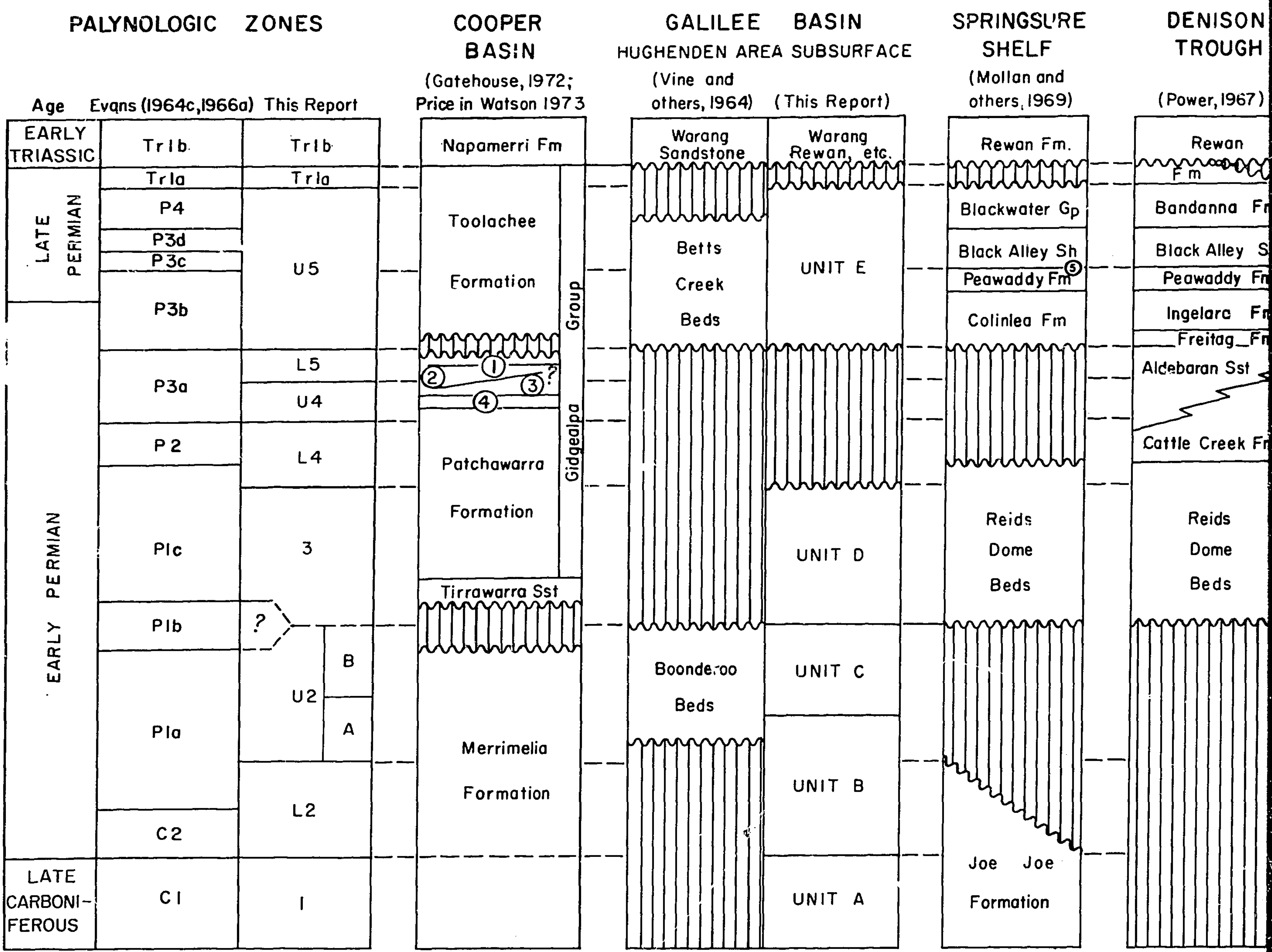

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Fig. 3 Correlations between the Permian Basins of eastern Australia between four wells in the central part of the Galilee Basin is shown in Figure 4, and this can be used to illustrate the main features of the sequence.

Unit A is a succession of thick conglomerates and sandstones, with minor shales. At least some of this unit is glacigene in origin. It correlates with the lower part of the Joe Joe Formation on the Springsure Shelf, and with Vine's (1976) "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 (1976) "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 (1976) "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 glacigene 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 (1976) "Mid-Lower Permian coal measures and varved shale sequence" and correlates with part of the Reids Dome Beds on the Springsure Shelf (Mollan & others, 1969) and Denison Trough (Power, 1967).

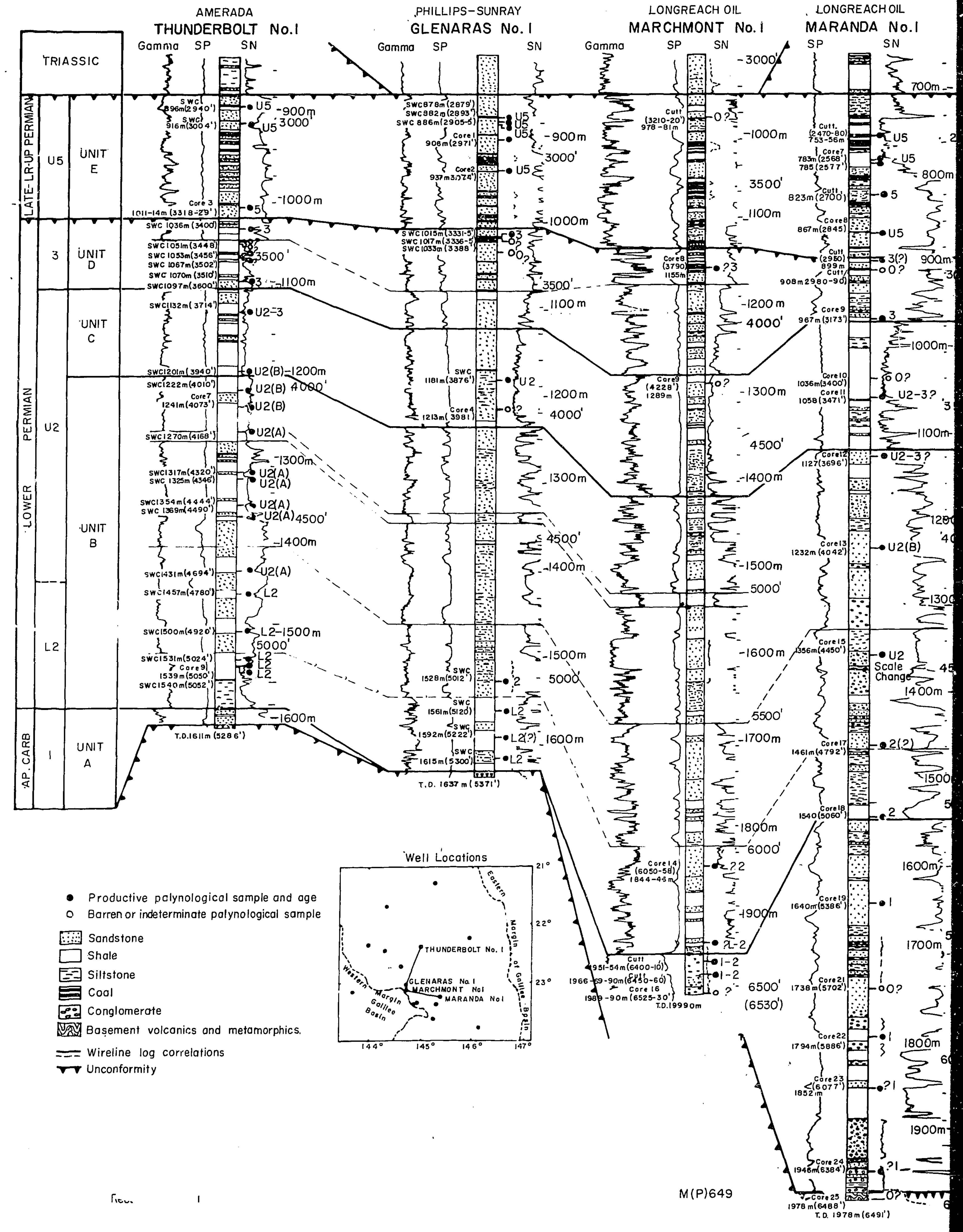

Fig. 4: Well Correlations in the Northern Galilee Basin

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 crops out 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, 1976). 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 Trla) microfloras have been identified. Unit E is everywhere unconformably overlain by Triassic or younger clastic formations.

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 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 later. Balme (in Johnson, 1968)

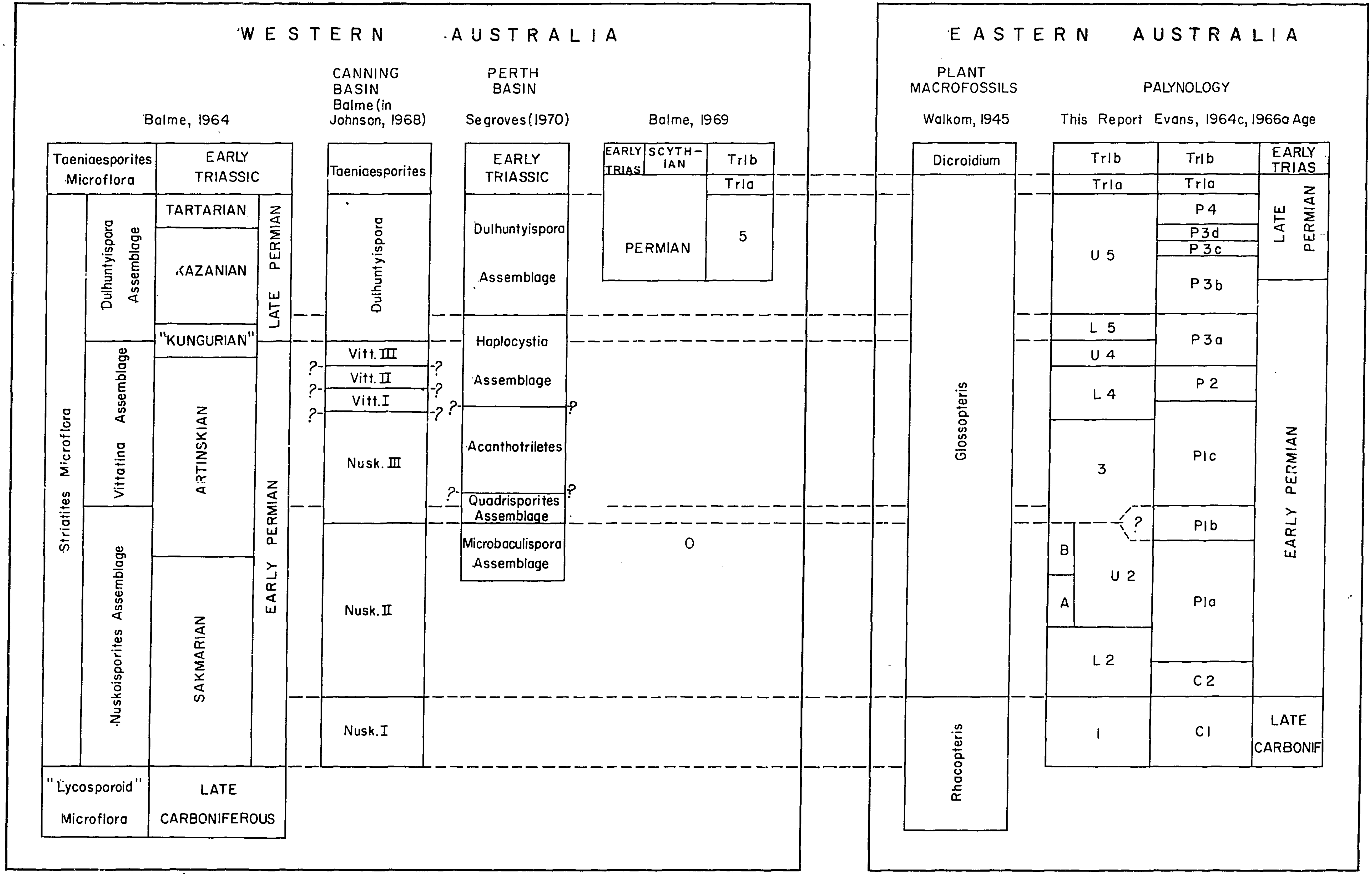

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Figure 5: Relationship between Permian palynologic zonations in eastern and western Australia

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 (g.e. 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.

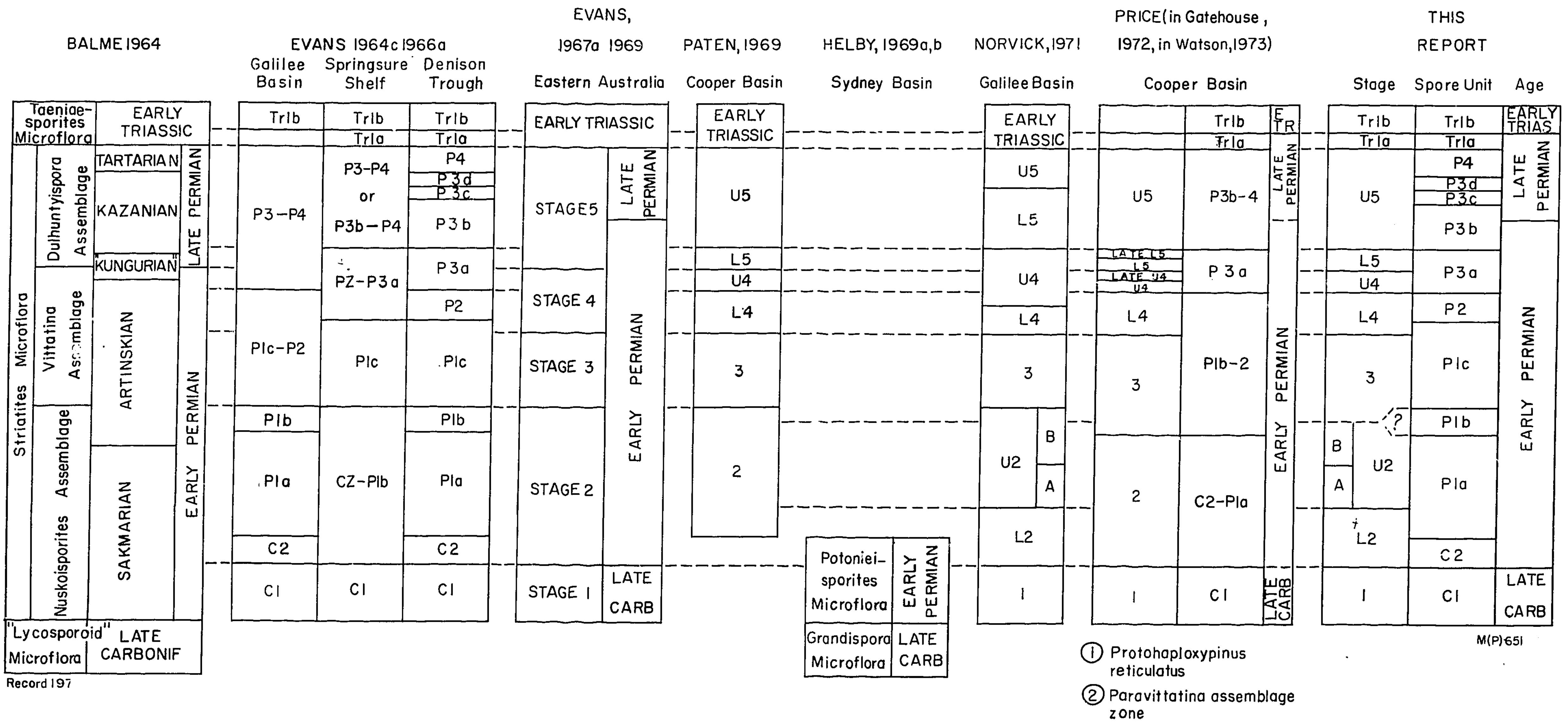

Fig 6 The relationship between Upper Carboniferous to Permian palynologic zonations in eastern Australia

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 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 summarised in Figure 7.

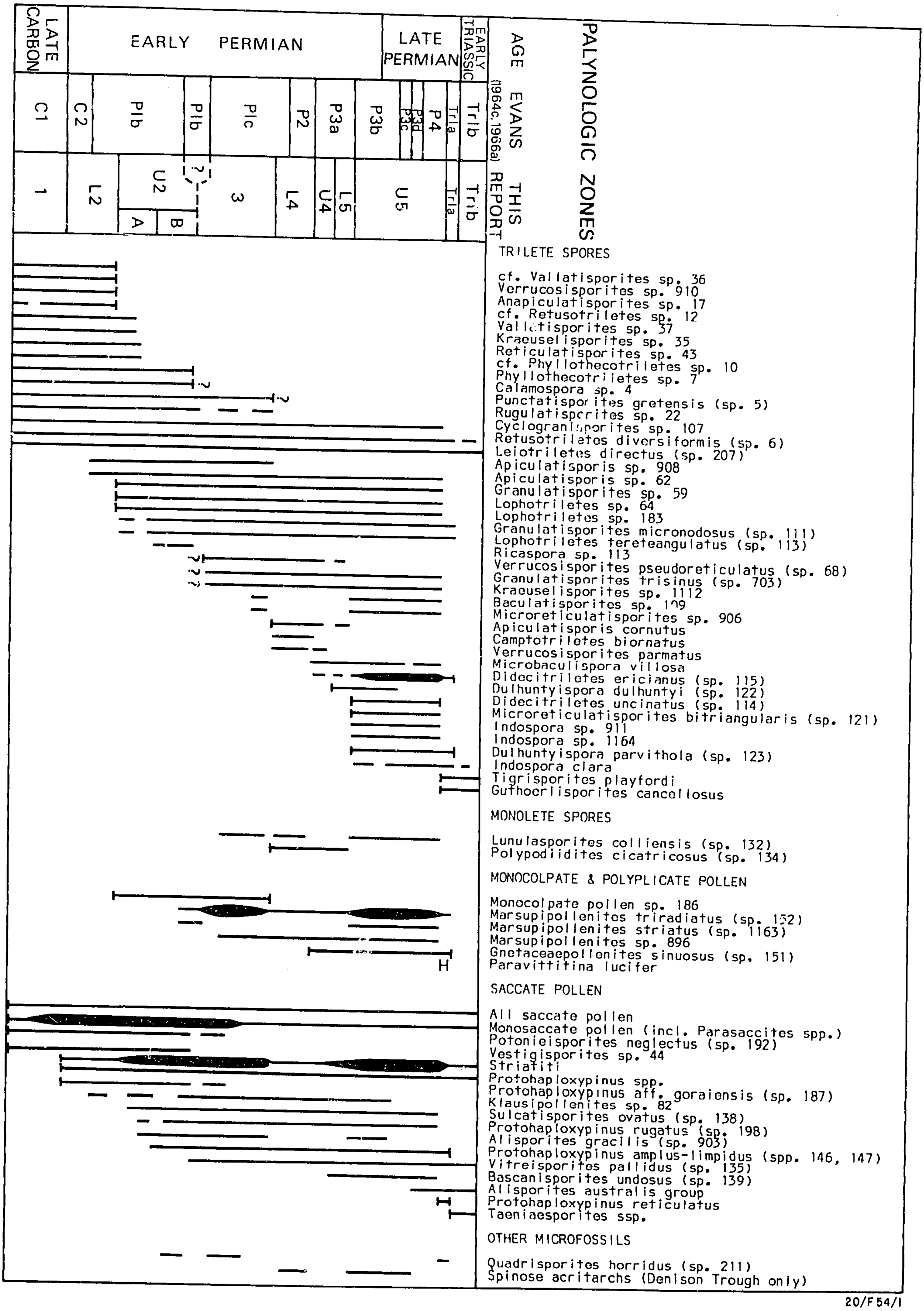

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Figure 7. Range chart for selected palynomorphs in eastern Australia.

One major problem remaining 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 the 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).

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 Late 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 glacigene strata which have yielded microfloras, dated as P1a by Evans (1964a). I have since collected a closely sampled section in the Galah Gorge, and the horizon from which White described her macroflora can now be placed in Late 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/NII 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 Phacopteris macroflora, is characterised palynologically by abundant Parasaccites and Potonieisporites. It lacks Striatiti, which make their first appearance higher in the succession.

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 in the interval Stephanian C. This level, he suggested, could be correlated with one near the base of the Kiaman magnetic reversal in Australia. As this level is approximately coincident with the change from his Grandispora to Potonieisporites microfloras, Helby suggested that the Permo-Carboniferous boundary in Australia could be conveniently drawn at the base of the Potonieisporites assemblage. Striatiti do not appear until at least the upper part of the Potonieisporites microflora and 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. More recently, Helby (in ARCO, 1972) has brought forth fresh evidence that strongly suggests that Stage 1 is of Late Carboniferous age. In Pelican Island No. 2 well, in the Bonaparte Gulf Basin of Western Australia, microfloras identified as equivalent to Stage 1 overlie, and are possibly transitional to, assemblages that can be dated as early Namurian to Westphalian on the basis of faunal associations. The Stage 1 assemblages, on this evidence, seem likely to span an interval equivalent to late Westphalian and Stephanian.

Stage 1

Stage 1 microfloras are characterised 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 beginning 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 therefore 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, rocks of Stage 1 age have been identified in the Koburra Trough and with the cropping out 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, 1969 a, b). The lower part of the Grant Formation of the Canning Basin, can probably also be 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).

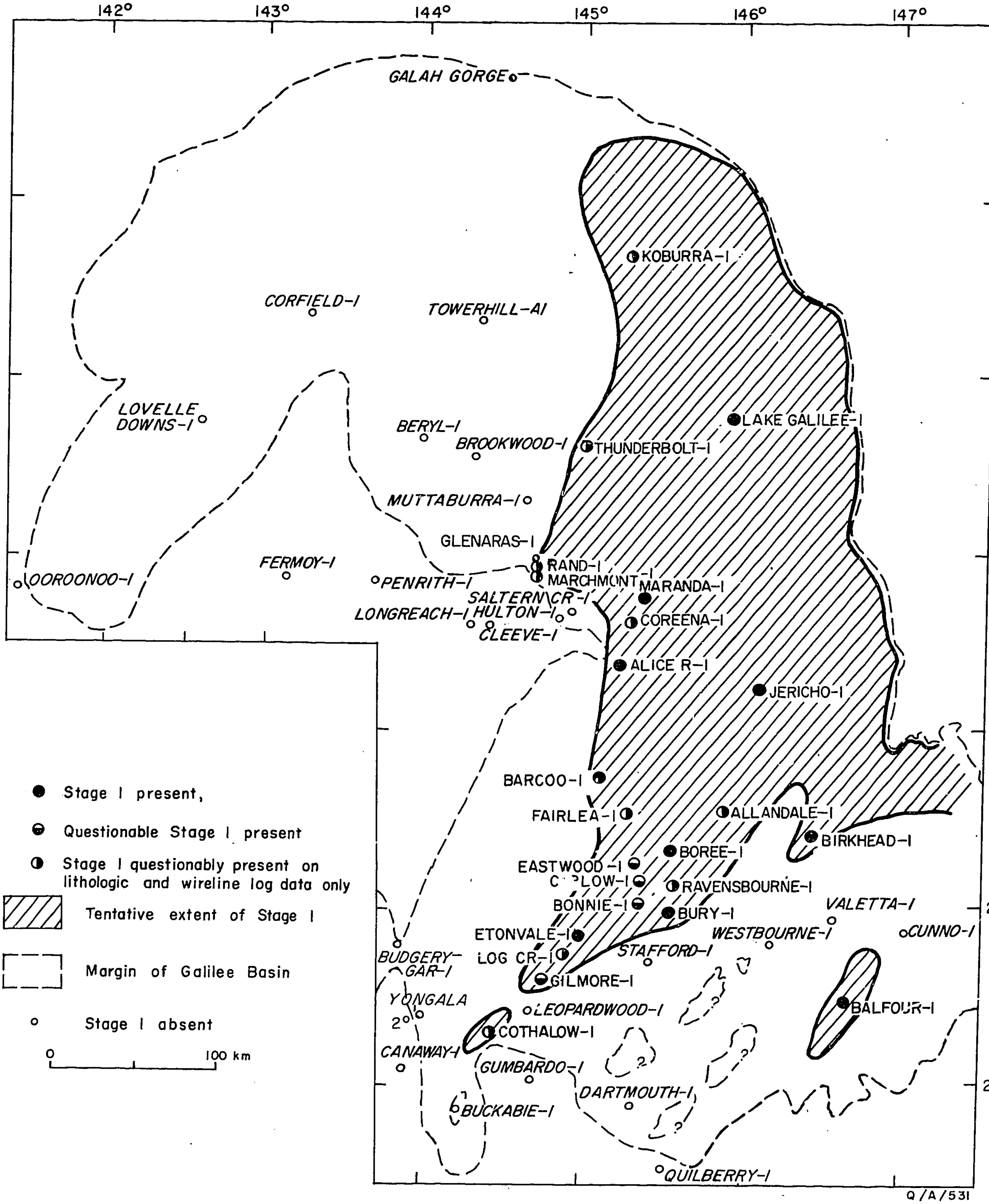


Fig 8 Distribution of stage I Microfloras in the Galilee Basin

Preservation of Stage 1 assemblages in the Galilee Basin is generally very poor. Spores are commonly heavily carbonised, some to the point of being completely unidentifiable. In the northeastern part of the Galilee Basin, partly carbonised 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, glacigene, coarse clastic rocks of unit A, which is equated with Vines (1976) "Upper Carboniferous sequence". The main features of their distribution (Fig. 8) include 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 sedimentaton at that time. Vine (1976) 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.

From Evans' (1966a) descriptions, it appears that spore units C2 and P1a form a palynologically closely related interval. He indicated 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 is at the end 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 late in Stage 3, and Protohaploxypinus af. goraiensis (sp. 187) first appears in Early 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 end of Stage 2.

On present evidence, the start 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). An early division of Stage 2 is characterised 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 start of Late 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

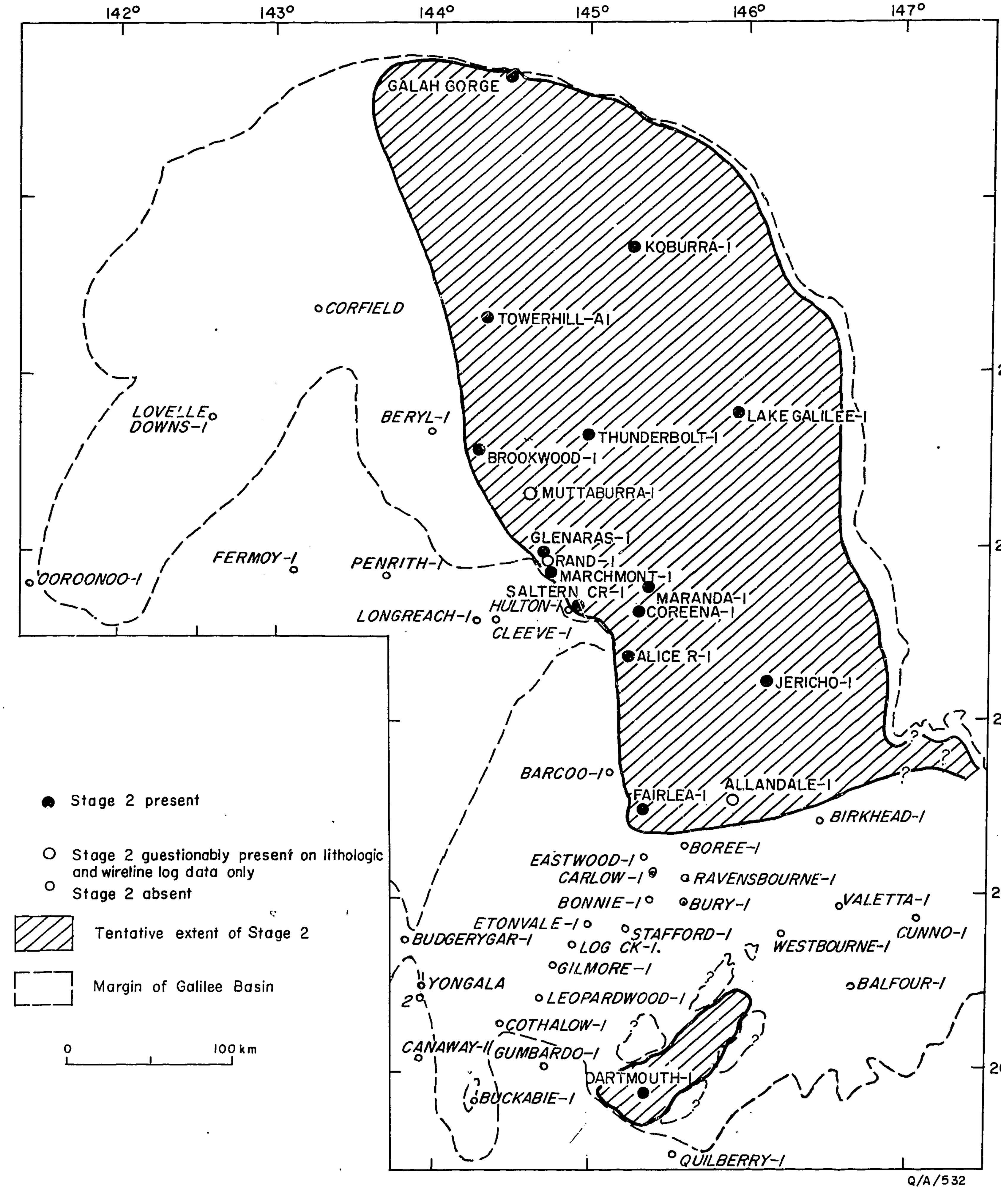


Fig 9 Distribution of stage 2 Microfloras in the Galilee Basin

(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 as Late 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 Early to Late Stage 2 microfloral assemblages. Above this, the predominantly fine clastic sediments of unit C have been dated as Late 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, 1976). All of the Boonderoo Beds cropping out 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 varved sequence (Vine & others, 1964; Vine, 1976). 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 1976) "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 (1976) and Allen (1974) showed that the Beryl Ridge and the Hulton-Rand structure formed the southwest limit of sedimentation at this time. Vine's (1976) "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 glacigene sequences in other parts of Australia: In the Officer, Perth, Carnarvon and Canning Basins of Western Australia, in the Cooper, Troubridge and Arckaringa Basins of South Australia, in the Bacchus Marsh district of Victoria, and in eastern Tasmania.

Stage 3

The start 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) noted their first occurrence in palynological unit P1b. Paten's (1969) definition of the Stage2/Stage 3 boundary closely follows that of Evans (1967a, 1969); 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 shale 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 (1976) 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 Early 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 (Late 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 Early Stage 5 indicator species, and the sudden change in the areal pattern of sedimentation all favour a regional disconformity.

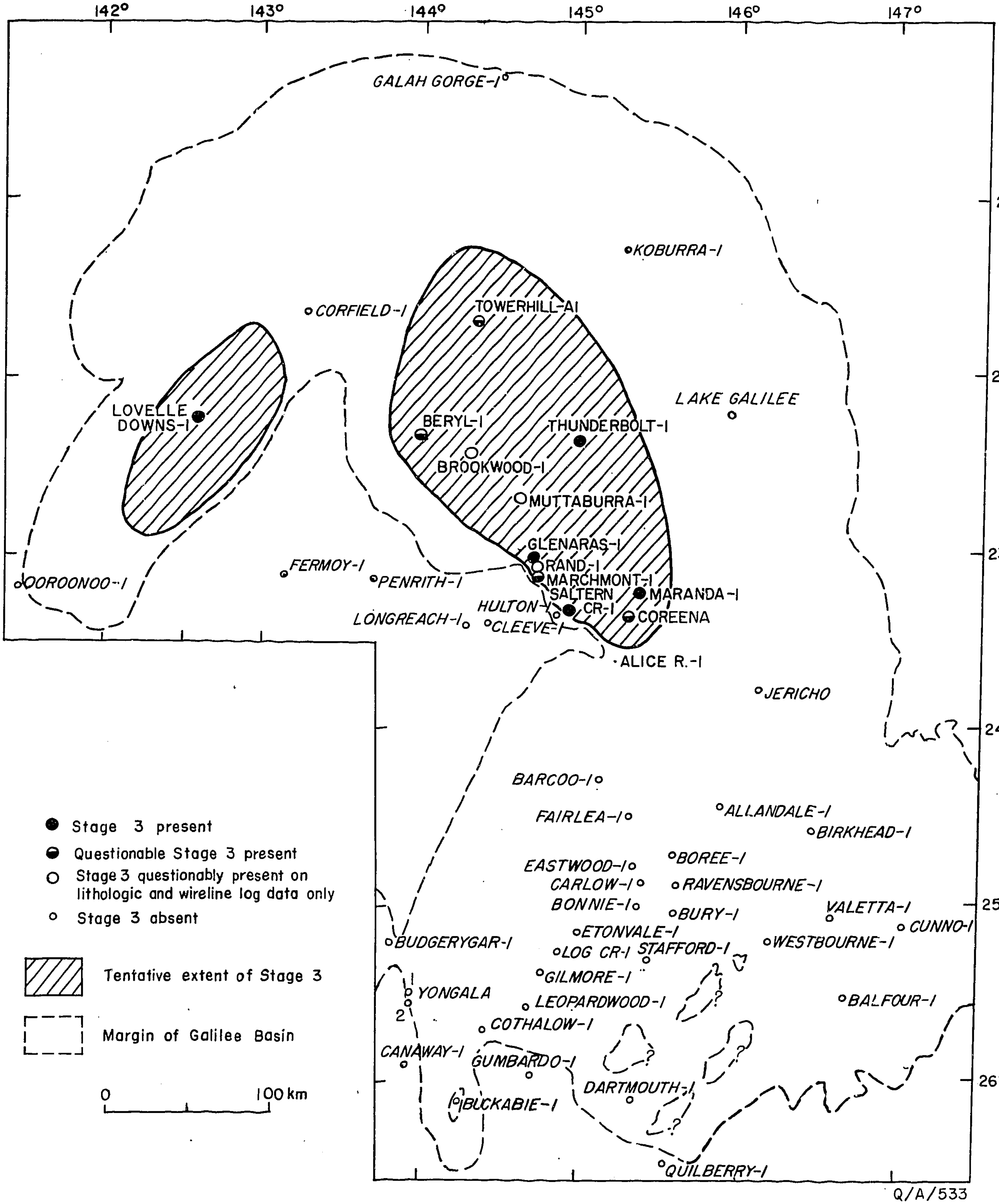


Fig 10 Distribution of stage 3 Microfloras in the Galilee Basin

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 formulated Stages 4 and 5, based entirely on spores and pollen, with the result that they have much wider application (Evans 1967a, 1969).

Stage 4 marks the first appearance of Polypodiidites 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 Dulhuntyispora and a suite of other distinctive spores. It is characterised 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 a late and an early subdivision in the Cooper Basin. He defined the start of his early 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 late 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

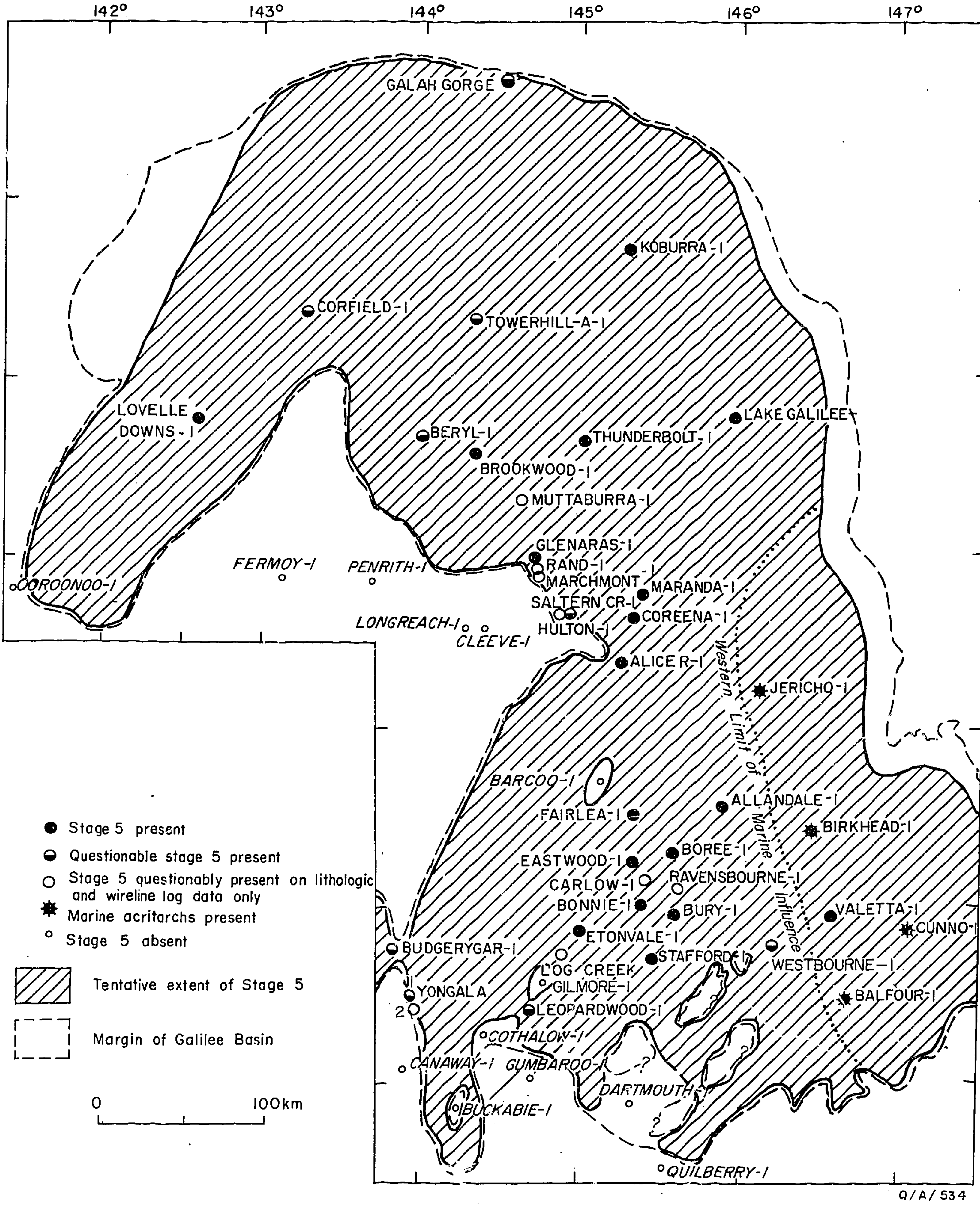


Fig II Distribution of stage 5 Microfloras in the Galilee Basin bitriangulatus (sp.121), Gnetaceaepollenites sinuosus (sp.151), and several species of Indospora. Striate bisaccate pollen and Marsupipollenites triradiatus (sp.152) reach their final acme in Late Stage 5.

No Early Stage 5 microfloras have yet been identified in the Galilee Basin, and a continuation of the Stage 4 regional hiatus is assumed. However, during Late Stage 5, sedimentation started again and spread over most of the basin (Fig. 11). As described by Vine (1976), Late Stage 5 deposition is characterised 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 & others, 1969). Along the northern basin margin, a series of sandstones with coal seams crop out as the Betts Creek Beds in the Hughenden area (Vine & others, 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 cropping out 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 Late 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., Gnetaceaepollenites sinuosus Marsupipolleniites 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. A 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 late Stage 5 in Maranda No. 1 (Evans, 1966a). Elsewhere only younger Triassic or Jurassic palynologic units overlie Late 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 Late 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 Late 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.

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 - BMR reference 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)

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

Age	Formation	Depth	
Tertiary	unnamed - unconformity -	-Surface - 18 m	Surface - 60'
Jur.-Cret.	Eromanga Basin sequence	18 - 510 m	60' - 1672'
Triassic	Moolayember Shales Clematis Sandstone - unconformity -	510 - 576 m 576 - 753 m	1672' - 1890' 1890' - *2470'
Late Permian	unnamed - *unconformity -	753 - 856 m	*2470' - *2810'
*Late Carb. Early Perm.	unnamed	856 m - TD	*2810 - TD
Total Depth		1631 m	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) amended 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.

Sample	Depth			M.F.P.	Given spore unit (Evans, 1966a)	Revised stage
Cuttings	771-4m	2530 - 40'		2726	P3-4	Late Stage 5
Cuttings	805-8m	2640 - 50'		2727	P3-4	Prob. Late Stage 5
Core 6	831-6m	2728 - 43'		2373	P3-4	Late Stage 5
		- unconformity -				
Core 7	910-6m	2984 - 3004'		2374	Barren	?
Core 8	1061m	3481'	2424	2424	C2	Early 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 Early Stage 2, and the presence of a few striate bisaccate pollen restricts the assemblage to Early 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 Late Stage 2.

Another barren sample (core 9, 1213m, 3981') separates Early 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')
Kraeuselisporites sp. 35	X	X
Phyllothecotriletes sp. 7	X	X
Verrucosisporites sp. 8	X	
Calamospora sp. 4	?	X
Rugulatisporites sp. 22	X	X
Reticulatisporites sp. 43	?	X
cf Retusotriletes sp. 12	X	
Parasaccites spp.	X	X
Vestigisporites sp. 44	X	X
Punctatisporites gretensis (sp. 5)		X
Retusotriletes diversiformis (sp. 6)		?
Didectriletes sp. 19		X
Vallatisporites sp. 37		X
cf Calamospora sp. 9		X
cf Vestigisporites 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.

Generalised 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'
& Late	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	c856' (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'	Late Permian	P3b-4	Late Stage 5
Core 3	1679m	5510'			
			Late Carb.-		
	1681m	5515'	Early Permian		(poor yield)
	1681 m	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) late 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 Early Permian Joe Joe Formation. A more refined stratigraphic interpretation is not possible on the available data.

Amoseas BALFOUR No. 1

Reference: Gerrard (1966a)

Generalised 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 equivalent	1338 - 1387m	4391 - 4550'
	Peawaddy Formation equivalent	1387 - 1401m	4550 - 4597'
?Late Carb.-Perm.	Joe Joe Formation	1401 - 1671m	4597 - 5481'
	- unconformity -		
Pre ?Late Carb.	basement intrusives	1671m - TD	481' - TD
Total Depth		1695m	5560'

Palynology: A total of 21 samples from the Late 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 reinterpretation in terms of Evans' (1967a, 1969) stage terminology are summarised below.

Sample	Depth		M.F.P.	Given age	Author	Revised stage
SWC	1356m	4450'		Up. Permian	Playford	Late Stage 5
Cuttings	1362m	440'	4134	P3d-4	Evans	Late Stage 5
Cuttings	1366m	4480'	4135*	P3d	Evans	Late Stage 5
Cuttings	1372m	4500'	4136*	P3d	Evans	Late Stage 5
Cuttings	1378m	4520'	4137	P3c	Evans	Late Stage 5
SWC	1379m	4525'		Late Permian	Playford	Late Stage 5
SWC	1381m	4531'	4129	P3c	Evans	Late Stage 5
			- unconformity -			
Core 5	1410m	4627'	4126*	C1-2	Evans	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	?
"	"	"		Early Perm.	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 Sulcatisporites spp. and Striatiti. Similar assemblages were recorded by Playford from side-wall cores at 1356m (4450') and 1379m (4525'). This association is characteristic of Late Stage 5.

Playford examined core 5 (1411m, 4628') and dated it Artinskian-Kungurian on a mixture of early and late Permian palynomorphs. Evans studies 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 fc t) 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 sidewall core at 1422m (4665') have now been briefly re-examined and yielded:

Phyllothecotriletes sp. 7
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 Early Carboniferous and from Stage 1 to Early 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 sidewall 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 Early 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 Parassaccites 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 Early 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 -		
Late Carb.-	unnamed	1187 - 1710m	3895 - 5609'
Early Perm.	- 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 and 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).

Sample	Depth		M.F.P.	Given age	Author	Revised stage
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 amended 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 State 1 date.

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 -		
Late Permian	Bandanna Formation	1000 - 1109m	3280 - 3640'
	- unconformity -		
Early Permian	unnamed	1109 - 1237m	3640 - 4060'
	- unconformity -		
?Devonian	metamorphic basement	1237m - TD	4060' - TD
Total Depth		1266m	4154'

<u>Palynology</u>: 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 has 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.

Sample	Depth		M.F.P.	Age given (Evans)	Revised stage
Cuttings	1006m	3300'	3315	?Permian	?Permian
Cuttings	1018m	3340'	3327	P3d-4	?Stage 5
Cuttings	1021m	3350'	3316	Permian (undiff.)	Permian (undiff.)
Cuttings	1033m	3390'	3321	Permian (undiff.)	Permian (undiff.)
Cuttings	1055m	3460'	3328	Permian (undiff.)	Permian (undiff.)
Cuttings	1079	3540'	3329	?P3-4	?Stage 5
Cuttings	1100m	3610'	3317	?P3-4	?Stage 5
Cuttings	1158m	3800'	3318	P1	Late Stage 2-3
Cuttings	1189	3900	3319	P1	?Stage 3
Cuttings	1219m	4000'	3320	P1	Late 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, a Late 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 Early 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. Protohaploxypinus goraiensis
Protohaploxypinus spp. (fairly common)

V. pseudoreticulatus indicates an age no younger than P2. Its association with abundant Parasaccites spp. and aff. Protohaploxypinus 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 final appearance at the start of Stage 3 and Marsupipollenites triradiatus (sp. 152) is very rare earlier than that. It should be noted that no restricted species characteristic of either Late or Early 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 palaeontological 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 & others (1972) and this is quoted below.

Generalised section (after Exon & others, 1972):

Age	Formation	Depth	
Jurassic	Eromanga Basin sequence	Surface - 372 m	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 - 2360'
Permian	Blackwater Group	872 - 893m	2860 - 2930'
	Black Alley Shale	893 - 988m	2930 - 3240'
	Colinlea Sandstone	988 - 1036m	3240 - 3400
Carb.- Early Perm.	Joe Joe Formation	1036 - 1359	3400 - 4460'
	- unconformity-		
Devonian	Etonvale Formation	1359m - TD	4460' - TD
Total Depth		1580m	5185'

<u>Palynology</u>: 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 summarised below. None of these samples has been re-examined and the revised stage stratigraphy is interpreted from existing assemblage lists.

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

Sample	Depth		M.F.P.	Age given	Report	Revised stage
Cuttings	1402m	4600'	13C9	Caving contam.	Evans 1962a	?
Cuttings	1433m	4700'	1310	V. poor	Evans 1961b	?
Cuttings	1463m	4800'	1311	Barren	Evans 1961b	?
Cuttings	1477m	4845'	1312	Barren	Evans 1961b	?
Cuttings	1494m	4900'	1313	V. poor	Evans 1961b	?
Cuttings	1524m	5000	1314	Pre-Perm.	Evans 1966a	?Devonian
Cuttings	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 991 m (2900 to 3250') and Late 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 Early Permian microflora in core 4, and could thus dismiss the Late 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 Exon et al., 1972) and will not be repeated here.

In addition to Mesozoic caving contaminants, the cutting samples from 884 to 991 m (2900 to 3250') contain a Stage 5, probably Late 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 Late 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 Early Stage 2, including

<u>Phyllothecotriletes</u> sp. 7
<u>Calamospora</u> sp. 4
cf. <u>Phyllothecotriletes</u> sp. 10
cf. <u>Retusotriletes</u> sp. 12
<u>Rugulatisporites</u> sp. 22
<u>Kraeuselisporites</u> sp. 35
<u>Vallatisporites</u> sp. 37
<u>Reticulatisporites</u> 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 147 m (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 possible 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.

<u>Phillips-Sunray BONNIE No. 1</u>
<u>Reference</u>: Kyranis (1966b)
<u>Generalised section</u> (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 -		
Late Permian	unnamed	1422 - 1506m	4665 - 4940'
	- unconformity -		
Early Permian	unnamed	1506 - 1707m	4940 - 5600'
	- unconformity -		
Dev.-Early 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).

Sample	Depth		Age given	Revised stage
SWC	1476m	4844'	Late Permian	Probably Late Stage 5
SWC	1605m	5267	Early Permian	?Stage 1

This sidewall 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. amplus (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 means that the assemblage probably belongs in Late Stage 5. D. ericianus is known from Stage 5 and possibly Late Stage 4, while D. uncinatus has so far only been found in Late Stage 5. A Late Stage 5 date is also supported by regional stratigraphic evidence.

From the side-wall core at 1605m (5257') (quoted as 5268') De Jersery 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 Early Permian, but the abundance of monsaccate pollen and the apparent absence of Striatiti would rather support a Late Carboniferous, Stage 1 date. 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)

Generalised 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'
Late Permian	unnamed	1154 - 1222m	386 - 4009'
	- unconformity -		
Early 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 sidewall core samples, held in the BMR collections, have now been examined.

Sample	Depth		M.F.P.	Age given	Revised stage
Core 7	1212-15m	3978-86'	3105	P3-4	Prob. Late Stage 5
Cuttings	1213-16m	3980-90'	3835	not reported	Late Stage 5
Cuttings	1216-19m	3990-4000'	3836	not reported	Late Stage 5
Cuttings	1219-22m	4000-4010'	3837	not reported	Late Stage 5
SWC	1214m	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 identifications 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 Late Stage 5. By superposition and from its rather sparse microflora, core 7 can then be given a probably Late 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 P1a, 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
Reference: Pemberton (1963).
Generalised 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'
Late Permian	Betts Creek Beds	1042 - 1264m	3417 - 4147'
	- unconformity -		
Early 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 (Muttaburra 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 Early to Late 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). Palynological stage nomenclature was applied in the latter paper and this has not been changed in the present study. The results are summarised below.

Sample	Depth		M.F.P.	Spore unit given	Author	Revised stage
Core 9	1078m	3537'		Late Permian	De Jersey	Late Stage 5
"	1079m	3539'	2245	P3 - 4	Evans 1964c	Late Stage 5
Core 10	1169m	3834'	2246	Barren	Evans, 1964c	?
Core 12	1352m	4437'	2247	P1a-b	Evans, 1964c	Stage 2 (undiff.)
Core 13	1446m	4744'	2248	P1a-b	Evans, 1964c	Stage 2 (?Late 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 Late 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 log. 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 Early Permian and, later, (Evans, 1964c) amended this to spore unit P1a-b. Burger & Kemp (1972) reassigned these samples to Stage 2. Specimens listed on BMR sample cards have now been re-examined and a Stage 2 date 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)
...llothecotriletses 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)
Quadrisporites 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)
Protohaploxypinus aff. goraiensis (sp. 187)
Protohaploxypinus rugatus (sp. 198)
Protohaploxypinus 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 Protohaploxypinus sp. 904 indicate a position within Late Stage 2. However, many of the common Late Stage 2 spores, notably Granulatisporites sp. 59, Lophotriletes tereteangulatus (sp. 113) and Lophotriletes sp. 183 are not present. If this core came from Late Stage 2, as is tentatively suggested, then it must represent the earliest part of the unit. In Thunderbolt No. 1, Late/Early 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 Late 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 palynological data on the Permian section is included here.

Generalised 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'
Late 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 ?Late 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 Late Stage 5. Following his correlations, the cuttings from 1615m (5300') Budgerygar No. 1 can be given a ?Late Stage 5 date.

Phillips - Sunray BURY No. 1

Reference: Patterson (1966).

Generalised section (as quoted in well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1178m	Surface - 866'
	- disconformity -		
Triassic	Clematis Sandstone	1178 - 1305m	3866 - 4280'
	- disconformity -		
Late Permian	unnamed	1305 - 1402m	4280 - 4600'
	- disconformity -		
"Early Permian	unnamed	1402 - 1604m	4600 - 5264'
	- unconformity -		
?Early 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 Late Carboniferous to Permian interval.

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

The sidewall 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) Late Stage 5. The microflora from sidewall 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 Late Stage 4. Although no unequivocal markers could be identified, the presence of Indospora sp. 911 and Lunulasporites colliensis suggest a probable Late Stage 5 date.

Evans (in Patterson, 1966) assigned the sidewall 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')
Phyllothecotriletes sp. 7	x	x
Calamospora sp. 4	x	x
Reticulatisporites sp. 43	x	x
Verrucosisporites sp. 28	x	x
Rugulatisporites sp. 22	x	
Retusotriletes diversiformis (sp. 6)	x	
Didecitriletes sp. 19		x
Vallatisporites sp. 37	?	x
Punctatisporites gretensis (sp. 5)		x
Verrucosisporites sp. 8		x
Vestigisporites sp. 44	x	x
Parasaccites 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)

Generalised 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 - 3423m	5546 - 11,230'
Early 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 date 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, Late Permian (Late 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 Late Permian sediments may also be present here.

Beaver - Pexa COREENA No. 1

Reference: Leslie (1970b)

Generalised section (from well completion report):

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

Age	Formation	Depth	
Late Carb. - Early Perm.	Reid's Dome Beds	809 - 872m	2653 - 2860'
	Joe Joe Formation	872 - 1579m	2860 - 5181'
	- unconformity -		
Siluro-Devonian	igneous basement	1579 - 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 summarised below.

Sample	Depth		Stage given	Revised stage
Cuttings	671m	2200'	Stage 5	Late Stage 5
Cuttings	814m	2670'	caving contam.	?
Cuttings	899m	2950'	Stage 2 - 3	Stage 2 - 3
Core 3	1388m	4555'	Stage 2	Stage 2 (undiff.)
Cuttings	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 Late 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 up to Stage 3. The two horizons in Maranda No. 1 have been re-examined and are now dated as Late 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).

Generalised section (after Evans, 1962b):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1085m	Surface - 3560'
	- disconformity -		
?Triassic	unnamed	1085 - 1250m	3560 - 4100'
Late 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 Late 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 - 51 m (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

Reference: Lewis (1961); 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 redbeds 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.

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

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1543m	Surface - 5061'
	- unconformity -		
Early 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 Early 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).

Generalised 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/non-marine affinities, but he did not discuss the age of the sediments. Evans (unpublished BMR data) studied 13 conventional and sidewall 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. Late Stage 5
SWC	750m	2460'	4234	P3d/P4	Late Stage 5
SWC	759m	2490'	4235	P3d	Late Stage 5
SWC	765m	2510'	4236	P3b/P3d	Prob. Late Stage 5
Core 4	792m	2597'	4204	P3b/P3d	Late Stage 5
SWC	800m	2624'	4237	Barren	?

Sample	Depth		M.F.P.	Given spore unit	Revised stage
SWC	824m	2702'	(Unsuitable for processing)		
SWC	826m	2710'	4197	P3b/P3d	Prob. Late Stage 5
SWC	829m	2720'	4198	P3b	Late Stage 5
SWC	833m	2734'	4199	Barren	?
SWC	839m	2754'	4200	Barren	?
SWC	841m	2760'	4201	Barren	?
SWC	846m	2774'	4202	Barren	?

The lower four samples (sidewall 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 Late 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 Late Stage 5. Elsewhere in the basin it does not occur above the early part of Stage 3. A questionable identification of Phyllothecotriletes sp. 7 as 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)

Generalised section (from well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1387m	Surface - 4552'
	- disconformity -		
Early 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.

Sample	Depth		M.F.P.	Age given	Author	Revised stage
SWC	1395m	4578'	4142	P1a	Evans	Late Stage 2
SWC	1423m	4670'	4143	P1a	Evans	Late Stage 2
Core 2	1550m	5085'		Early Permian	De Jersey	Stage 2

In the sidewall 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
Protohaploxypinus aff. goraiensis (sp. 187)
Parasaccites sp.

(*names changed to present usage)

The sidewall 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
Protohaploxypinus aff. goraiensis (sp. 187)
Parasaccites sp.

The association of Calamospora sp. 4, Didecitriletes sp. 19, Vestigisporites sp. 44 and Protohaploxypinus 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 Late Stage 2.

De Jersey examined a sample from core 2 (1550m, 5085') and 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 it does from below Evans' Late Stage 2 samples, is inconsistent in containing "Marsupipollenites aff. sinuosus."Typical Gnetaceaepollenites sinuosus (sp. 151) does not appear until the start of Late Stage 4. If this contradictory occurrence is set aside, the presence of Striatiti and its superposition by definite Late 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 Late Stage 5 or Stage 1 or both are 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)

Generalised 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 -		
Late 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 was studied by Paten (in Mines Administration, 1970). Of these, 6 were from the Late Carboniferous to Permian interval (see below). Nothing can be added to Paten's discussion and his report is quoted below.

Sample	Depth		Age	Palyn. stage	Remarks
Cuttings	1655m	5430'	?Late Permian	?Late Stage 5	Low yield, mainly cavings
Cuttings	1667m	5470'	Late Permian	Late Stage 5	
Cuttings	1707m	5600'	Late Permian	Late Stage 5	
	- unconformity -				
Cuttings	1786m	5860'	?	?	cavings
Cuttings	1844m	6050'	?	?	cavings
Cuttings	2021m	6630'	Late Carb/ Early Permian	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)

Generalised section:

Etonvale No. 1 was one of the first wells to intersect a full section of Silurian to Early 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 - 5543'
	- unconformity -		
Late 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 -		
Late 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 summarised below.

Sample	Depth		M.F.P.	Given age	Author	Revised stage
Core 6	1715m	5627'	1663	Late Permian	Evans	Late Stage 5
"	1716m	5629'	1664	Late Permian	Evans	Prob. Late Stage 5
"	1717m	5632'		Late Permian	De Jersey	Late Stage 5
			- unconformity -			
Core 7	1729m	5674'		Early Permian	De Jersey	Prob. Stage 1
"	1730m	5676'	1762	Early Permian	Evans	Stage 1
SWC	1745m	5725'	1825	Early Permian	Evans	Stage 1
Core 9	1847m	6059'		Early Permian	De Jersey	?
"	1848m	6063'	1763	Early Permian	Evans	Stage 1
SWC	1901m	6238'	1826	Early 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 Late Silurian to Devonian						

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

<u>Dulhuntyispora</u> <u>parvithola</u> (sp. 123)
<u>Didecitriletes</u> <u>ericianus</u> (sp. 115)
<u>Didecitriletes</u> <u>uncinatus</u> (sp. 114)
<u>Gnetaceaepollenites</u> <u>sinuosus</u> (sp. 151)
<u>Marsupipollenites</u> <u>triradiatus</u> (sp. 152)
<u>Leiotriletes</u> <u>directus</u> (sp. 207)
<u>Cirratriradites</u> <u>splendens</u>
<u>Lophotriletes</u> <u>tereteangulatus</u> (sp. 113)
<u>Apiculatisporites</u> spp.
<u>Retusotriletes</u> <u>diversiformis</u> (sp. 6
<u>Granulatisporites</u> spp.
<u>Sulcatisporites</u> <u>ovatus</u> (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, Didecitriletes ericianus and Gnetaceaepollenites sinuosus, can be confidently dated as Late Stage 5.

The sidewall cores from 1745m and 1901m (5725' and 6238') together with cores 7 and 9, were dated by both Evans and De Jersey as Early 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 is characteristic of Stage 1, and is provisionally assigned to that stage.

Core 10 and sidewall 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).

Generalised section (as quoted in well completion report):

Jur.-Cret.	Eromanga Basin sequence	Surface - 1224m	Surface - 4015'
	- unconformity -		
Triassic	Moolayember Shale	1224 - 1238m	4015 - 4062'
	Clematis Sandstone	1238 - 1366m	4062 - 4480'
	- disconformity -		
Late Permian	unnamed	1366 - 1455m	4480 - 4773'
	- disconformity -		
Early Permian	unnamed	1455 - 2021m	4773 - 6630'
	- unconformity -		
Devonian	Adavale Basin sequence	2021 - 3036m	6630 - 9959'
Early 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'	Late Permian: Stage 5	Late Stage 5
Core 6	1489m	4886'	Early 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 Late 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 crop out 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 & others (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 ?Late Precambrian Cape River Metamorphics. Coarse and, in places, pebbly sandstones are associated with thin beds of polymict conglomerate, which have been interpreted as tllites. A contorted carbonaceous shale from one of these possible tillite horizons has yielded fragmentary glossopterid plant macrofossils (White, 1964); the stratigraphically 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 is visible at this locality.

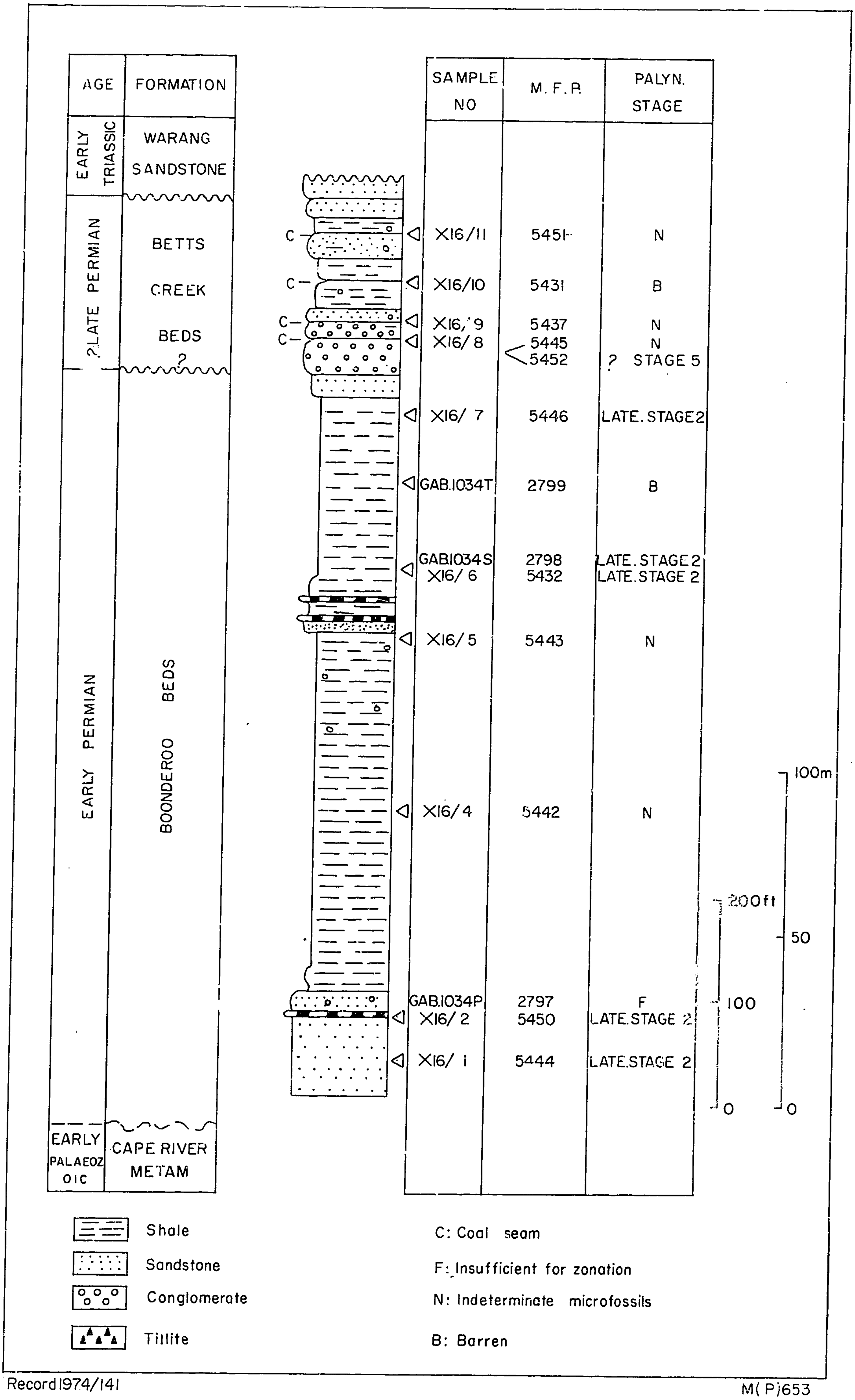
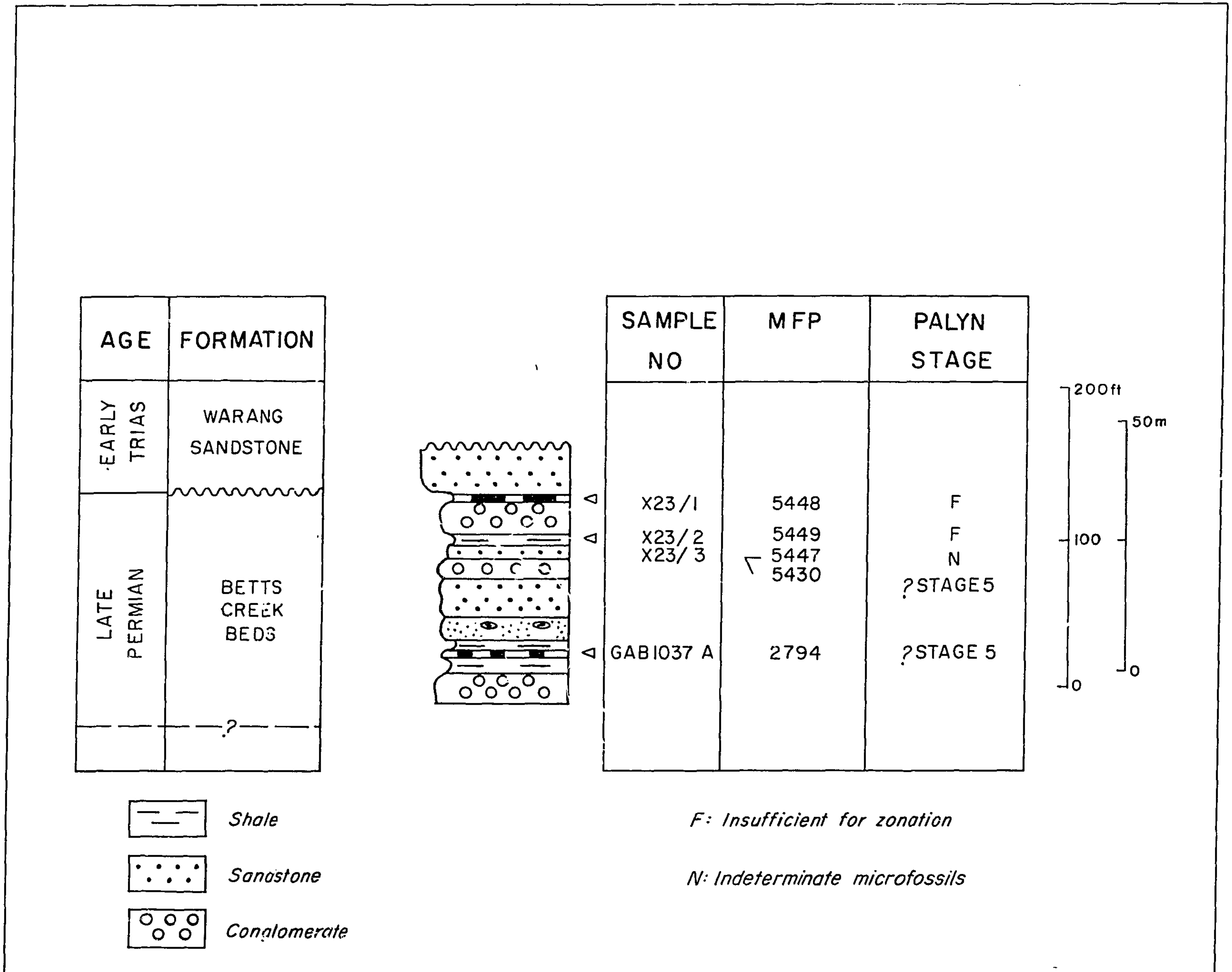


Fig 12 Sample Locations Outcrop Section X16 Hughenden Sheet



Record 1974/141 M(P) 654

Fig 13 Sample locations Outcrop Section X23 Hughenden sheet

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 Early 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 re-measured, and samples were placed stratigraphically, using the columnar sections of Vine & others (1964). Evans' slides were also studied, and the results obtained from all the samples examined are summarized on Figures 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

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 P1c (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

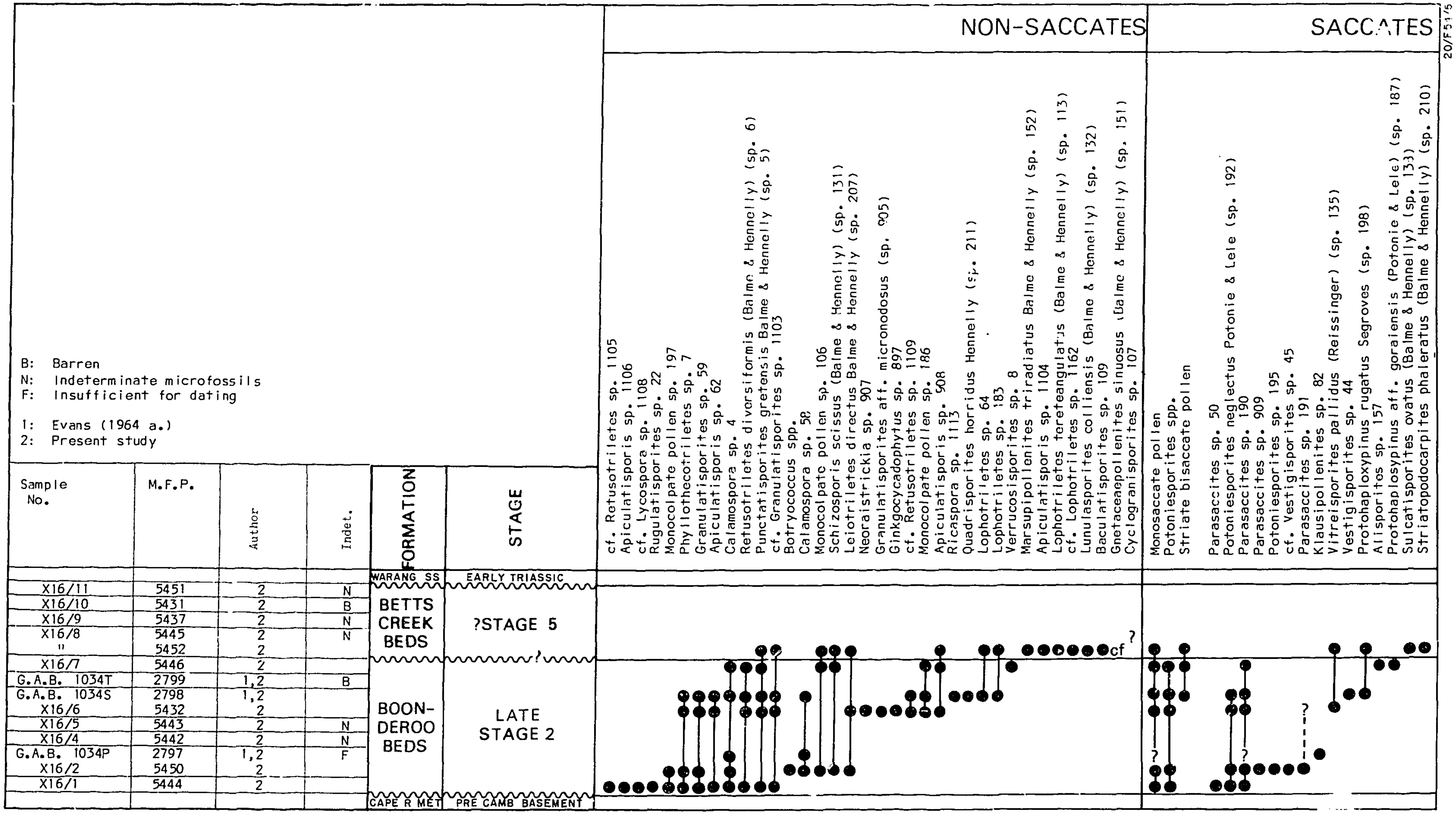


Figure 14. Outcrop section, Galah Gorge X16: range chart for selected species.

Phyllothecotriletes sp. 7, Calamospora sp. 4, Apiculatisporis sp. 62 and Granulatisporites sp. 59 is typical of Late 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 Late Stage 2. Monosaccate pollen, Potoniisporites neglectus (sp. 192) and several species of Striatiti (including Protohaploxypinus aff. goraiiensis (sp. 187) make up the second part of the flora. Ricaspora sp. 1113 is limited to assemblage B of Late 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 Quadrisporites 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 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 a Late Permian age. Elsewhere it is known to have a range from Late Stage 4 to Late 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 <u>Gnetaceaepollenites sinuosus</u> 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 Late Stage 2. Lithological comparisons suggest that the varved siltstones and mudstones, which constitute the main part of the formation, are correlates of the major Late 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 as Early Stage 2 at its base to Late Stage 2 at its top. The Betts Creek Beds are probably of Late 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. Late Stage 5 microfloras are well documented from this unit. Thus the Permian cropping out in 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, Early Stage 2, and possibly the early portion of Late 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 Late Stage 2 shales of unit C.

<u>Phillips - Sunray GILMORE No. 1</u>

<u>Reference</u>: Lewis & Kyranis (1965).

<u>Generalised section</u> (as quoted in well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1768m	Surface - 5800'
	- unconformity -		
Permian	unnamed	1768 - 1964m	5800 - 6445'

Age	Formation	Depth	
Early 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 Early Permian, but they have not been re-examined and an accurate stage identification cannot be made from the species lists available. His results are summarised below.

Sample	Depth		Age given	Suggested Stage
Core 2	1771m	5810'	Early Permian	Stage 1 to 2
SWC	1833m	6015'	Early 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)

Generalised section (as quoted in well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 877m	Surface - 2876'
	- unconformity -		
Late Perm.	Bandanna Formation equivalents	877 - 991m	2876 - 3250'
	- unconformity -		
Early Perm.	"Reids Dome Beds" equivalents	991 - 1088m	3250 - 3570'
Late Carb. - Early 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 sidewall 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.

Sample	Depth		M.F.P.	Spore unit given (Evans)	Revised stage
SWC 21	878m	2879'	4159	P3b-4	Late Stage 5
SWC 19	882m	2893'	4153	P3b-4	Late Stage 5
SWC 17	886m	2905.5'	4160	P3b-4	Prob. Late Stage 5
Core 1	906m	2971'	4161	P3b-4	Prob. Late Stage 5
Core 2	937m	3074'	4162	P3b-4	Late Stage 5
SWC 16	1015m	3331.5'	4163	Plc	Stage 3
SWC 15	1017m	3336.5'	4154	Plc	?
SWC 13	1033m	3388'	4155	Plc	?
SWC 9	1181m	3876'	4156	Plb	Late Stage 2
Core 4	1213m	3981'	4165	Barren	?
SWC 4	1528m	5012'	4166	Pl?	Stage 2 (undiff.)
SWC 3	1561m	5120'	4157	Pla	Prob. Early Stage 2
SWC 2	1592m	5222'	4164	Pla	Stage 2 (Early 2)
SWC 1	1615m	5300'	4158	C2/P1a	Early Stage 2

Assemblages from sidewall 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 Late 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 Stage 5 age.

Sidewall 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 Early Permian Stage 3 (his P1c) at 1015m (3331.5') and Late Permian Stage 5 (his P3b-4) at 937m (3074') is confirmed. Evans also dated the sidewall cores at 1017m and 1033m (3336.5' and 3388') as P1c. Both samples contain very sparse, poorly preserved and fragmentary palynomorphs of long-ranging types. Consequently, no stage identifications are given for these horizons.

Sidewall core 9 (1181m, 3876') contained a rich microflora and yielded the following species:

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

The association of Monocolpate pollen sp. 186, <u>Phyllothecotriletes</u> sp. 7 and <u>Granulatisporites</u> sp. 59 indicates a Late 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 sidewall 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 Early and Late Stage 2 microfloras.

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

<u>Phyllothecotriletes</u> sp. 7
<u>Calamospora</u> spp. 4 and 58
cf. <u>Retusotriletes</u> sp. 1105
<u>Verrucosisporites</u> sp. 8
<u>Vallatisporites</u> sp. 37

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 Late Stage 2 markers were found and a probable position within the early division of the stage is favoured. The next sample below (SWC 1592m, 5222') contains an even more impoverised assemblage and is questionably assigned to Early 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 date. A specimen of Apiculatisporis sp. 62 in this sample is puzzling, because elsewhere it does not range earlier than Late Stage 2.

Evans (in McDonagh, 1967) dated the lowest sample from Glenaras No. 1 (SWC 1615m, 5300') as Late Carboniferous or Early 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 sidewall core contained a small flora including:

Phyllothecotriletes sp. 7
Calamospora sp. 4
cf. Calamospora sp. 9
Punctatisporites gretensis (sp. 5)
Anapiculatisporites sp. 17
Rugulatisporites sp. 22
Reticulatisporites sp. 43
Parasaccites spp.
Vestigisporites sp. 44
Protohaploxypinus aff. goraiensis (sp. 187)

The presence of Anapiculatisporites sp. 17 and Reticulatisporites sp. 43 supports an Early Stage 2 date.

Longreach Oil HULTON No. 1

Reference: Mott & Associates (1964a).

Generalised section (taken from well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 558m	Surface - 1830'
	- unconformity -		
Permian	Mantuan & Up. Colinlea equivalent	558 - 627 m	1830 - 2058'
	- unconformity -		
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):

Cuttings	576-79m	1890 - 1900'	M.F.P. 3388
Cuttings	582-85m	1910 - 20'	M.F.P. 3389
Cuttings	594-97m	1950 - 60'	M.F.P. 3371
Cuttings	607-10m	1990 - 2000'	M.F.P. 3390
Cuttings	616-19m	2020 - 30'	M.F.P. 3372
Cuttings	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 haa 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).

Generalised section (from well completion report):

Age	Formation	Depth	
Triassic	Moolayember Formation	Surface - 174m	Surface - 572'
	Clematis Sandstone	174 - 348m	572 - 1142'
	Rewan Formation	348 - 396m	1142 - 1300'
	- unconformity -		
Permian	Bandanna Formation	396 - 484m	1300 - 1588'
	Peawaddy Formation		
	Colinlea Sandstone	518 - 575m	1698 - 1886'
	- unconformity -		
Late Carb.- Early Perm.	Joe Joe Formation	575 - 1679m	1886 - 5507'
	- unconformity -		
Early 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	396m1	1212'	3582'	Tr2a	Triassic
			- unconformity-		
Cuttings	405-08m	1330-40'	3991		Prob. Late Stage 5
Cuttings	439-42m	1440-50'	3992		Prob. Late Stage 5
Cuttings	463-66m	1520-30'	3993		Prob. Late Stage 5
Cuttings	479-82m	1570-80'	3997		Prob. Late Stage 5
Cuttings	482-85m	1580-90'	3998		Prob. Late Stage 5
Cuttings	485-88m	1590-1600'	3999		Prob. Late Stage 5
Cuttings	488-91m	1600-10'	4000		Prob. Late Stage 5
Cuttings	503-06m	1650-60'	3994		Prob. Late Stage 5
Cuttings	515-18m	1690-1700'	3995		Prob. Late Stage 5
Cuttings	518-21m	1700-10'	3996		Prob. Late Stage 5
Core 2	522m	1714'	3583	P3-4	?Stage 5
			- unconformity -		
Cuttings	600-04m	1970-80'	3838	P1b	Prob. Late Stage 2
Cuttings	604-07m	1980-90'	3839	P1b	Prob. Late Stage 2
Cuttings	607-10m	1990-2000'	3840	Caving contam.	?
Core 6	1092m	3583'	3584	C2/P1a	Stage 1/Early Stage 2
Core 7	1219m	4000'	3585	C1	Stage 1
Core 9	1397m	4582'	3586	C1	Stage 1
Core 10	1548-50m	5080-85'	3587	C1	Stage 1
			- unconformity -		
Core 11	1681-82m	5516-19'	not proc.	?Dev/Early 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', 1440-30', 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, monocolpate 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 sp.. 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 Late Stage 5. The possibility of caving contamination having affected this section cannot be completely ruled out, especially as Early Stage 5 microfloras are almost identical to those from Late Stage 5. However, the complete absence of Triassic or Early 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 amplus (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 Early to Late Stage 5 under the new zonal scheme. This assemblage as listed, is known possibly from Late Stage 2 and certainly from Stage 3 to Late Stage 5 in other parts of eastern Australia. Indeed, Evans (in Benedek, 1965) noted that the Late 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 Late 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 amended 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, includding 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 P1a):

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 P1a. 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 P1a or perhaps it is not younger than Unit C2.

Units C1 - 2 and P1a 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 Early Stage 2. It should be noted that cf. Retusotriletes sp. 12 has been reported from up to the end of Early 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 end of Early Stage 2 to the end of Late Stage 2 in the Thunderbolt well. This information could be taken to indicate an Early Stage 2 date for core 6. However, in the absence of striate bisaccate pollen, the less exact determination is preferred.

	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
Marsupipollenites triradiatus	X	X	X										
"Marsupipollenites" sinuosus	X	X	X										
Didecitriletes ericianus	X		X										
Neoraistrickia ramosa	X			cf	X			?					
Acanthotriletes tereteangulatus	X	cf											
Cyclogranisporites sp.	X												X
Verrucosisporites spp.	X	X						X					X
Acanthotriletes filiformis	X												
Striatiti spp.	X	X	X	X	X	X	X	X	X	X	X	X	X
Parasaccites spp.	X	X	X	X	X	X	X	X	X	X	X	X	X
Kraeuselisporites spp.	X			X	X								
Microreticulatisporites sp.		X											
Granulatisporites sp.		X		X				X					X
Leiotriletes directus			X	X				X	cf		cf		cf
Quadrisporites sp.				X									
Granulatisporites micronodosus				X				X					
Punctatisporites gretensis				X				X					
Rugulatisporites sp. 124*				X									X
Cycadopites cymbatus				cf				X					
Limitisporites sp.				X									
Quadrisporites horridus				X				X	X				
Protohaploxypinus goraiensis				cf				X					X
Apiculati spp.				X		X		X	X		X	X	X
Apiculatisporis levis								X					
Sulcatisporites ovatus								X					
Retusotriletes diversiformis									X				
Apiculatisporis cornutus													?
Raistrickia radiosa													X
Verrucosisporites sp. cf. gobbetti													X
Verrucosisporites asperatilis													X
Grandispora sp.													X
Cirratriradites sp.													?

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Table 2. Flinders Kobura No.1:

Permian microfloral distribution.

Flinders KOBURRA No. 1

Reference: Pemberton & Brereton (1970).

Generalised section (from well completion report):

Age	Formation	Depth	
Jur.-Early Cret.	Eromanga Basin sequence	Surface - 149m	Surface - 490'
Triassic	Moolayember Formation	149 - 818m	490 - 2685'
	Clematis Sandstone	818 - 1104m	2685 - 3266'
	Rewan Formation	1104 - 1330m	3622 - 4365'
	- unconformity -		
Late Permian	unnamed	1330 - 1445m	4365 - 4740'
	- unconformity -		
Early Perm.- Late Carb.	unnamed	1445 - 2967m	4740 - 9735'
	- unconformity -		
Pre.-Late Carb.	unnamed Drummond Basin sequence	2967m - TD	9735' - TD
Total Depth		3259m	10 693'

Palynology: 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.

Sample	Depth		Age	Stage given
SWC	1322m	4336'	Early Triassic	Tr1b-Tr2b
		- hiatus-		
Cutt.	1333m	4374'	Late Permian	Late Stage 5
Core 1	1342m	4401'4"	?	? (barren)
SWC	1436m	4712'	?Late Permian	?Late Stage 5
SWC	1441n	4728'	Late Permian	Late Stage 5
SWC	1446m	4744'	?	?(indet. micro-fossils)
		- hiatus -		
SWC	1463m	4800'	Early Permian	Stage 2
SWC	1479m	4852'	Early Permian	Stage 2
SWC	1482m	4862'	Early Permian	Stage 2
SWC	1489m	4884'	Early Permian	Stage 2
SWC	1491m	4892'	Early Permian	Stage 2
SWC	1524m	5000'	Early Permian	Stage 2
SWC	1585m	5200'	Early Permian	Stage 2
SWC	1660m	5445'	Early Permian	Stage 2
SWC	1690m	5546'	Early Permian	Stage 2
SWC	1711m	5615'	Early 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.

"<u>Stage 2 (Lower Permian)</u>

The samples taken from 1463m to 1711m (4800 feet to 5615 feet) yielded assemblages characterized by an abundance of <u>Parasaccites</u> spp. together with pteridophytic elements including <u>Rugulatisporites</u> sp. 124*. Striate bisaccate pollens, including <u>Protohaploxypinus goraiensis</u> 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 <u>Parasaccites</u> not observed elsewhere in the section.

"<u>Upper Stage 5 (Upper Permian)</u>

The assemblages from cuttings 1333m (4373 feet) and SWC 1441m (4728 feet) included an abundance of striate bisaccate pollen, "<u>Marsupipollenites</u>" <u>sinuosus</u> and diverse pteridophytic elements including <u>Didecitriletes</u> <u>ericianus</u>. These assemblages characterise 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 4723 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".

Exoil-Transoil LAKE GALILEE No. 1

Reference: Pemberton (1965).

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

Age	Formation	Depth	
Cainozoic	unnamed	Surface - 53 m	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'
Late Permian	unnamed	862 - 1059m	2828 - 3476'
	- unconformity -		
Early 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.)
"	"	3164'	3289	?(barren)	Evans	?
Core 13	1056m	3464'	3290	P3-4	Evans	Stage 5 (undiff.)
Core 14	1061m	3480'	3291	?(barren)	Evans	?
"	1063m	3486'	3345	P1b	Evans	Late Stage 2
Core 15	1167m	3829'	3292	P1b	Evans	Late Stage 2
Core 20	1610m	5281	3308	?(barren)	Evans	?
Core 23	1879m	6165'		Early Permian	Playford	Early Stage 2
"	1880m	6167'	3309	C1-2	Evans	?Early Stage 2
Core 24	1986m	6515'		?(barren)	Playford	?
"	"	"	3310	?(barren)	Evans	?
Core 25	2077m	6814'		Early Permian	Playford	Prob. Stage 1
"	2078m	6817'	3311	C1	Evans	Stage 1
Core 26	2152m	7060'	3312	C1	Evans	Stage 1
"	2154m	7068'		Early 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'		Early Permian	Playford	Stage 1
Core 30	2493m	8180'		?Early Permian	Playford	?Stage 1
Core 31	2608m	8558'		?(indet.)	Playford	?
"	"	3607		?(barren)	Evans (1966a)	?
SWC	2619m	8594'		?(indet.)	Playford	?
SWC	2636m	8647'		?Early Permian	Playford	?Stage 1
Core 32	2668m	8752'		?(barren)	Playford	?
Core 33	2687m	8816'		?(barren)	Playford	?
Core 36	2842m	9325'		Late Dev./ Early Carb.	Playford	Late Dev./Early Carb.

The lowest sample to yield saccate pollen was the sidewall 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 sidewall core is underlain by a microflora which lacks saccate pollen and from which Playford identified several Late Devonian to Early Carboniferous trilete spores (core 36, 2842m, 9325'). It is succeeded by definite Late Carboniferous samples with monosaccate pollen (e.g. core 29, 2430, 7973'). For these reasons sidewall 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 Early Stage 2. As Striatiti do not appear until the start of Stage 2 according to Evans' (1967a, 1969) definition, core 23 is tentatively dated as Early 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 Late 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 as Late 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 Late 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 early and the late parts of the stage. Core 12 yielded Gnetaceaepollenites sinuosus (sp. 151), which ranges from Late Stage 4 to the end 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)

Generalised 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 & others, 1966) examined a sidewall core sample from 1680m (5512') and noted "a relative abundance of striate bisaccate pollens including the genus Striatopodocarpites". He suggeste. a Permian age for this sample. Lack of species lists precludes a more refined dating, but regional stratigraphic evidence supports a Late Permian (probably Late Stage 5) age.

Phillips - Sunray LOG CREEK No. 1

Reference: Kyranis & McDonagh (1966)

Generalised section (taken from well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1816m	Surface - 5957'
	- unconformity -		
Late Perm.	unnamed	1816 - 1851m	5957 - 6073'
	- unconformity -		
Early Permian	unnamed	1851 - 2056m	6073 - 6746'
Early Dev.-?Carb.	Adavale Basin sequence	2056m - TD	6746' - TD
Total Depth		4440m	14,566'

Palynology: There is no palynological 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.

	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)
Alisporites spp.	X	X	X		X	X
Protohaploxypinus spp.	X	X	X			X
Striatopodocarpites spp.	X	X	X	X		X
Hamiapollenites sp.	X					
"*Marsupipollenites*" *sinuosus*	X	X	X			
Marsupipollenites striatus	X	X				X
Dulhuntyispora parvithola	X	X				
Granulatisporites trisinus	X				X	X
Retusotriletes diversiformis	X	X				
Apiculatisporis sp.	X					
Marsupipollenites triradiatus		X	X		X	
Microbaculispora villosa		X				
Dulhuntyispora sp. (301*)		X				
Granulatisporites sp. (206*)		X				
Kraeuselisporites spp.		X	X		X	X
Granulatisporites micronodosus		X			X	X
Tuberculatosporites modicus		X				
Sulcatisporites spp.		X	X		X	
Parasaccites spp.		X	X			X
Laevigatosporites colliensis		X			X	
Leiotriletes directus		X	X	X		
Punctatisporites gretensis		X	X	X	X	X
Verrucosisporites pseudoreticulatus		X			X	
Microbaculispora sp. cf. *M. villosa*		X				
Acanthotriletes tereteangulatus		X	X	X	X	
Converrucosisporites sp.		X				
Neoraistrickia ramosa		X			X	X
Verrucosisporites sp. (191*)		X			X	X
Apiculatisporis cornutus			X			X
A. levis			X			
A. filiformis				X		X
Microbaculispora sp. (276*)					X	X
Striatoabietites multistriatus					X	X
Verrucosisporites sp. (94*)					X	
Apiculatisporis sp.					X	
Potonieisporites spp.						X
Vittatina sp.						X
Vestigisporites spp.						X

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Table 3. Hematite Lovelle Downs No.1:

Permian microfloral distribution.

Hematite LOVELLE DOWNS No. 1

Reference: Watson (1973).

Generalised 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'
Late Permian	unnamed	1486 - 1601m	4876 - 5251'
	- unconformity -		
Early 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.

Sample	Depth		Age	Stage given
SWC 11	1498m	4915'	Late Early to Late Permian	Late Stage 5
SWC 2b	1509m	4950'	?	?(barren)
Cuttings	1536-39m	5040-50'	?Late Early to Late Permian	?Late Stage 5
Cuttings	1618-22m	5310-20'	Early Permian	Stage 3
Core 1	1647m	5403'	Early Permian	Stage 3
SWC 10	1657m	5435'	?	?(barren)
SWC 9	1666m	5465'	Early Permian	Stage 3

Sample	Depth		Age	Stage given
SWC 8	1681m	5515'	?	?(barren)
SWC 7	1734m	5690'	Early Permian	Undiff. (indet.)
SWC 6	1770m	5808'	?	?(barren)
SWC 5	1832m	6012'	Early Permian	Stage 3
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 with 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 8/1661m (5515 ft) and SWC 10/1657m (5435 ft)) failed to yield any indentifiable 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 5136-39m (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."

Oil Development MARANDA No. 1

Reference: Le Blanc (1963)

Generalised section (as quoted in well completion report):

Age	Formation	Depth	
Quaternary	unnamed	Surface - 12 m	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 -		
Early Permian-Late Carb.	Joe Joe Creek Formation	1772 - 1971m	5815 - 6465'
	- unconformity -		
Early Palaeozoic or Precambrian	basement	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 Figure 15.

B: Barren
N: Indeterminate microfossils
F: Insufficient for dating

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

Depth Metres	Depth Feet	Sample	M.F.P.	Author	Indet	STAGE
629	2065	C.6		1		EARLY TRIASSIC (Tr1b)
824	2703	"	2274	2		
753-56	2470-80	Cutt.		1		STAGE 5 / LATE STAGE 5
783	2568	C.7		1		
785	2577	"	2275	2,3		
823	2700	Cutt.	2896	2		
867	2845	C.8	2494	1,2,3		
899	2950	Cutt.	2597	2		STAGE 3
908-11	2980-90	Cutt.		1		
965	3167	C.9	2722	2,3	N	
966	3170	"		1		
967	3171	"	2270	2,3	F	
967	3173	"	2495	2,3		
1036	3400	C.10	2496	1,2,3	F	UNDIFF STAGE 2 to 3
1056	3465	C.11	2497	2,3	F	
1058	3471	"		1		
1127	3696	C.12		1		
1127	3697	"	2498	2,3	N	
1229	4032	C.13		1		STAGE 2 / U2 ASS B
1232	4042	"	2272	2,3		
1356	4450	C.15	2273	2,3		STAGE 2 / U2
1359	4458	"		1		
1461	4792	C.17		1		STAGE 2 / UNDIFF ST2
1542	5059	C.18		1		STAGE 2 / L2
1542	5060	"	2300	2,3		
1640	5382	C.19		1		STAGE 1
1642	5386	"	2301	2,3		
1738	5702	C.21				
1787	5863	C.22		1		
1794	5886	"	2308	2,3		
1852	6077	C.23		1		
1946	6384	C.24	2309	2,3		
1948	6390	"		1		
1978	6488	C.25		1	B	PRE-LATE CARB BASEM

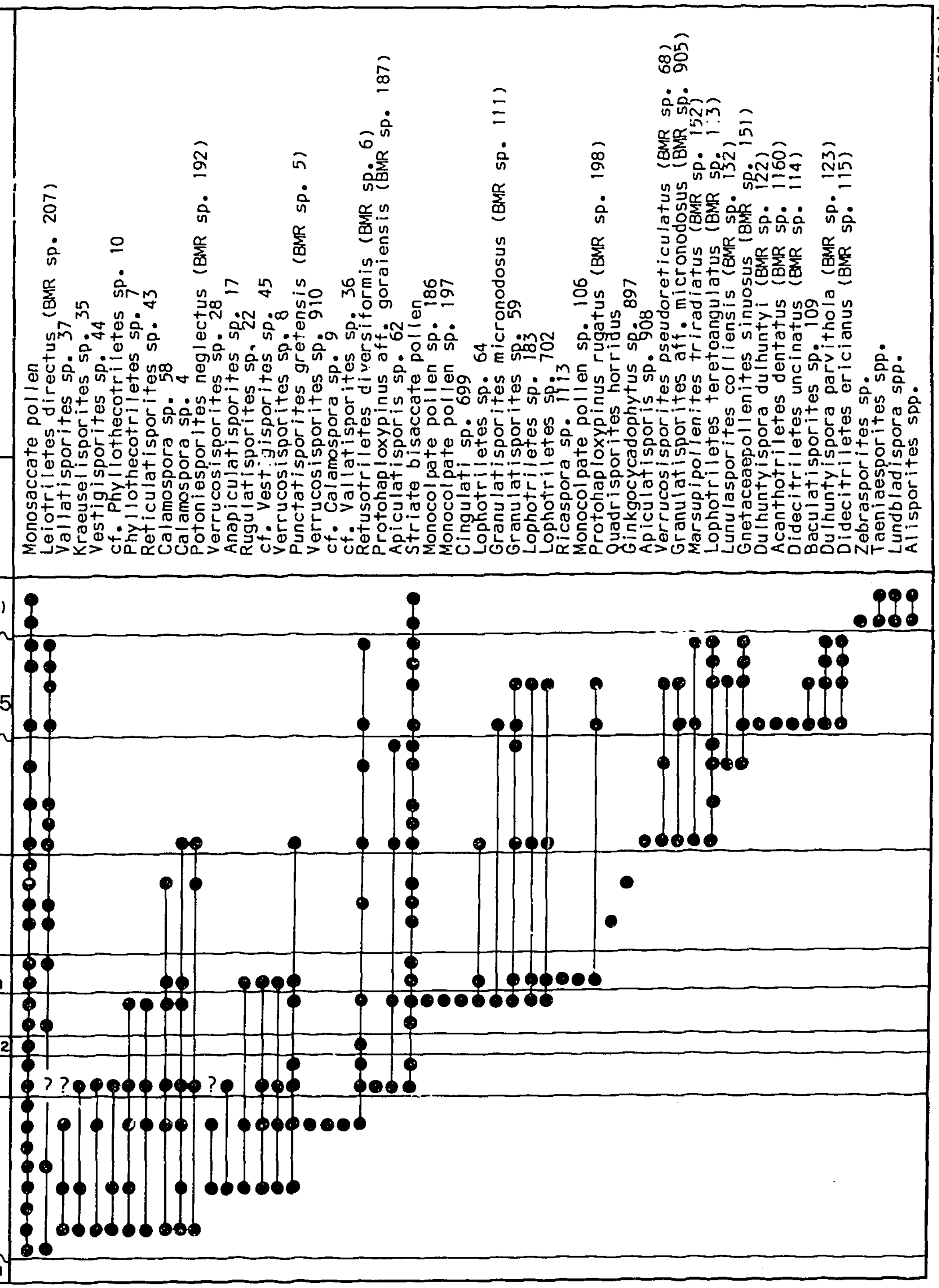


Figure 15. Oil Development N.L. Maranda No.1: range chart for selected species.

Sample	Depth		M.F.P.	Given spore unit	Author	Revised Stage
Cuttings	753-56m	2470-80'		M.-Late Perm.	De Jersey, & others	Late Stage 5
Core 7	783m	2568'		M.-Late Perm.	De Jersey, & others	Late Stage 5
"	785m	2577'	2275*	P3-4	Evans,1964c	Late Stage 5
Cuttings	823m	2700'	2896	P3-4	Evans,1964c	Stage 5
Core 8	867m	2845'	2494*	P3-4	Evans,1964c	Late Stage 5
"	"	"		M.-Late Perm.	De Jersey, & others	
		---- hiatus ----				
Cuttings	899m	2950'	289*	P1c	Evans,1964c	Prob. Stage 3
Cuttings	908-11m	2980-90'		M.-Late Perm.	De Jersey, & others	Prob. Stage 3
Core 9	965m	316'	2722*	P1c	Evans,1964c	?(indet)
"	966m	3170'		Early Permian	De Jersey, & others	?
"	967m	3171'	2270*	P1c	Evans,1964c	?(indet)
"	"	3173'	2495*	P1c	Evans,1964c	Stage 3
Core 10	1036m	3400'	2271*	?(barren)	Evans,1964c	?
"	"	"	2496*	?(barren)	Evans,1964c	?
"	"	"		?(v.poor)	De Jersey, & others	?
Core 11	1056m	3465'	2497*	P1b	Evans,1964c	?(indet)
"	1058m	3471'		Early Permian	De Jersey, & others	?Late Stage 2-3
Core 12	1127m	3696'		Early Permian	De Jersey, & others	Late Stage 2-3
"	"	3697'	2498*	P1b	Evans,1964c	?(indet)
Core 13	1229m	4032		Early Permian	De Jersey, & others	?

Sample	Depth		M.F.P.	Given spore unit	Author	Revised Stage
Core 13	1232m	4042'	2272*	P1b	Evans, 1964c	Late Stage 2(B)
Core 15	1356m	4450'	2273*	P1a	Evans, 1964c	Late Stage 2
"	1359m	4458'		Early Permian	De Jersey, & others	?
Core 17	1461m	4792'		Early Permian	De Jersey, & others	Prob. Stage 2
Core 18	1542m	5059'		Early Permian	De Jersey, & others	Prob. Stage 2
"	"	5060'	2300*	C2	Evans, 1964c	Prob. Early Stage 2
Core 19	1640m	5382'		Early Permian	De Jersey, & others	?
"	1642m	5386'	2301*	C1	Evans, 1964c	Stage 1
Core 21	1738m	5702'		Early Permian	De Jersey, & others	?
Core 22	1787m	5863'		Early Permian	De Jersey, & others	?
"	1794m	5886'	2308*	C1	Evans, 1964c	Stage 1
Core 23	1852m	6077'		Early Permian	De Jersey, & others	?Stage 1
Core 24	1946m	6384'	2309*	Carbonif. undiv.	Evans, 1964c	?Stage 1
"	1948m	6390'		Early Permian	De Jersey, & others	?Stage 1
				_ _ _ _ unconformity _ _ _ _		
Core 25	1978m	6488'		Pre-Perm. (barren)	De Jersey, & others	?(basement)

De Jersey & others (1963) were not able to find any recognisable microfossils in the basal core (c. 25, 1978m, 6488'). Lithologically, it consists of steeply dipping, recrystallized, sheared silty mudstone (Houston in Le Blanc, 1963) and is unconformably overlain by nearly horizontal, unindurated strata, which contain Late Carboniferous microfloras. A pre-Late 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 microfloras 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 Early 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 later than Early Stage 2. Striatiti are again lacking and these samples are placed in Stage 1.

The floras listed by De Jersey & others (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 & others (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 earlier than Late Stage 4, and the pollen mentioned by De Jersey & others 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 Late 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 Protohaploxypinus 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 Early Stage 2 trilete spore assemblage. The presence of Striatiti, which were also noted by De Jersey & others (1963) from the same core (c. 18, 1542m, 5059'), confirms a position within Early Stage 2.

The next sample (c. 17, 1461m, 4792') has been examined by De Jersey & others (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 earlier than Late Stage 2. In addition, core 15 (1356m, 4450') yielded Cingulati sp. 699, which in Thunderbolt No. 1 disappears at the end of Stage 2 (assemblage A). Core 13 (1232m, 4042') contained Ricaspora sp. 1113, one of the forms upon which assemblage B was characterised in the Thunderbolt samples (Norvick, 1971). The presence of Calamospora sp. 4 and Phyllothecotriletes sp. 7 in core 15, and the dominance of Parasaccites spp. in core 13 indicate that these samples are no younger than Late 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 & others (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 start of Stage 3, but also occurs rarely in Late 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 Late 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 species makes its debut at the base of P1c. Its first appearance also marks the start 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 referrable 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 Late Stage 2 or older. The cuttings from 908-11m (2980-90') and 899m (2950') can probably also be placed in Stage 3. De Jersey & others (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 Late Permian (Late Stage 5). It was associated with Gnetaceaepollenites sinuosus and Lunulasporites colliensis, which could represent caving contamination. De Jersey & others 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 Late 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 Late 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 & others (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 Late Stage 5.

Early 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).

Generalised section (from well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1007m	Surface - 3305'
	- unconformity -		
Late Permian	Bandanna Formation	1007 - 1271m	3305 - 4170'
?M. Permian	Mantuan equivalent	1271 - 1313m	4170 - 4307'
Early 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.

Sample	Depth		M.F.P.	Age given	Author	Revised Stage
Cuttings	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	?
Core 14	1844-46m	6050-58'		Early Permian	Playford	Stage 2-3
"	1845m	6054'	4168	Indet.	Evans (in McDonagh, 1967)	?
Core 15	1930-33m	6332-42'		Early Permian	Playford	Stage 2
"	1931m	6336'	4169	C2	Evans (in McDonagh, 1967)	
Cuttings	1951-54m	6400-10'		Early Permian	Playford	Stage 1-2
Cuttings	1966-69m	6450-60'		Early Permian	Playford	Stage 1-2
Core 16	1989-90m	6525-30'		Barren	Playford	?
Cuttings	"	"		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 coals 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 P1c, but assemblage details are not accessible. In the Cooper Basin and Denison Trough palynologic unit P1c equates with Stage 3 and the earliest part of Early Stage 4. In the Galilee Basin however, Stage 4 is absent and samples previously dated as P1c 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 as Early 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 Early Stage 2.

Playford examined core 16 (1989090m, 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 Early 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).

Generalised 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'
Late Permian	unnamed	882 - 1079m	2893 - 3540'
Early 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 991 m (3250'). this lies within a coal-bearing sequence, which elsewhere has been dated Stage 3 and Late 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)

Generalised 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'
Early Permian	Joe Joe Formation	1265 - 1861m	4150 - 6105'
Carboniferous	basal sand	1861 - 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	Surface-942m	Surface-3090'	
	- unconformity -			
Late.Perm.	sandstones with coals (unit E)	942-1033m	3090-3390'	Late Stage 5 in Glenaras No. 1.
	- unconformity -			
Early 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'	Late Stage 2 in Glenaras No. 1 & Thunderbolt No. 1.
	interbedded ssts, shales (unit B)	1381-1861m	4530-6105'	Early to Late Stage 2 in Glenaras No. 1 & Thunderbolt No. 1.
	"basal sand" of Warris (1969) (unit A)	1861m - TD	L6105'- TD	Early Stage 2 immed. above in Glenaras No. 1 & Marchmont No. 1.

Amoseas RAVENSBOURNE No. 1

Reference: Sirovs (1968).

Generalised 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 -		
Early 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 Late Permian (Stage 5) and/or Stage 3 may be represented.

Longreach Oil SALTERN CREEK No. 1

Reference: Mott & Associates (1964b).

Generalised section (as quoted in well completion report):

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface -762m	Surface-2499.5'
	- unconformity -		
Late Permian	Bandanna Formation	762 - 1036m	2499.5 - 3400'
	Mantuan Formation	1036 - 1074m	3400 - 3525'
Early Permian	Colinlea Formation	1074 - 1454m	3525 - 4770'
	- unconformity -		

Age	Formation	Depth	
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 allocaticn to Evans' (1967a, 1969) stages.

Sample	Depth		M.F.P.	Spore unit given	Author	Revised Stage
Cuttings	735-38m	2410-20'	3374	Indet.	Evans,1964c	?
Core 5	758m	2488'	3263	Barren	Evans,1964c	?
"	"	2488.5'	3261	Barren	Evans,1964c	?
Core 6	763m	2502'	3264	P3-4	Evans,1964c	?Stage 5
Cuttings	799-808m	2620-50'	3092	P3-4	Evans,1964c	?Stage 5
Cuttings	835-44m	2740-70'	3093	P1c	Evans,1964c	?Stage 5
Core 7	858m	2815'	3265	P1c	Evans,1964c	Prob.Stage 3
Core 8	950m	3117'	3266	P1(undiff.)	Evans,1964c	Late Stage 2-3
Core 10	1134m	321'	3267	P1b	Evans,1964c	Late Stage 2
Core 13	1408-11m	4619-29'		Early Perm.	Playford	Stage 2(?Late 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 Late 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 Early Permian spore unit P1c (Evans, 1964c). Full microfloral lists and slide preparations are not accessible, but from the available reports, both sets of cuttings are of probable late Early or Late 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 P1c, nor from its partial correlate Stage 3. Instead, it does not appear until Late Stage 4 in the Cooper Basin (Paten, 1969), and is not common in eastern Australia generally before Late 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 impoverised 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 Late 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 undifferentriated spore unit P1 by Evans (1964c). Its stratigraphic position between probable Stage 3 of core 7, and Late 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 Late 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 Late Stage 2.

Playford (in Mott & Associates, 1964b) has examined core 13 (1408-11m, 4619-29') and has dated it as Early 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 to 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 late, rather than the early division of Stage 2.

Phillips - Sunray STAFFORD No. 1
Reference: Netzel (1967).
Generalised 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	
Triassic	Clematis Sandstone	1411 - 1557m	4630 - 5107'
	- disconformity -		
Late Permian	unnamed	1557 - 1626m	5197 - 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 Sulcatisporites ovatus (sp. 138) and striate bisaccate pollen (chiefly Protohaploxypinus 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 as Late Stage 5.

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).

Generalised section:

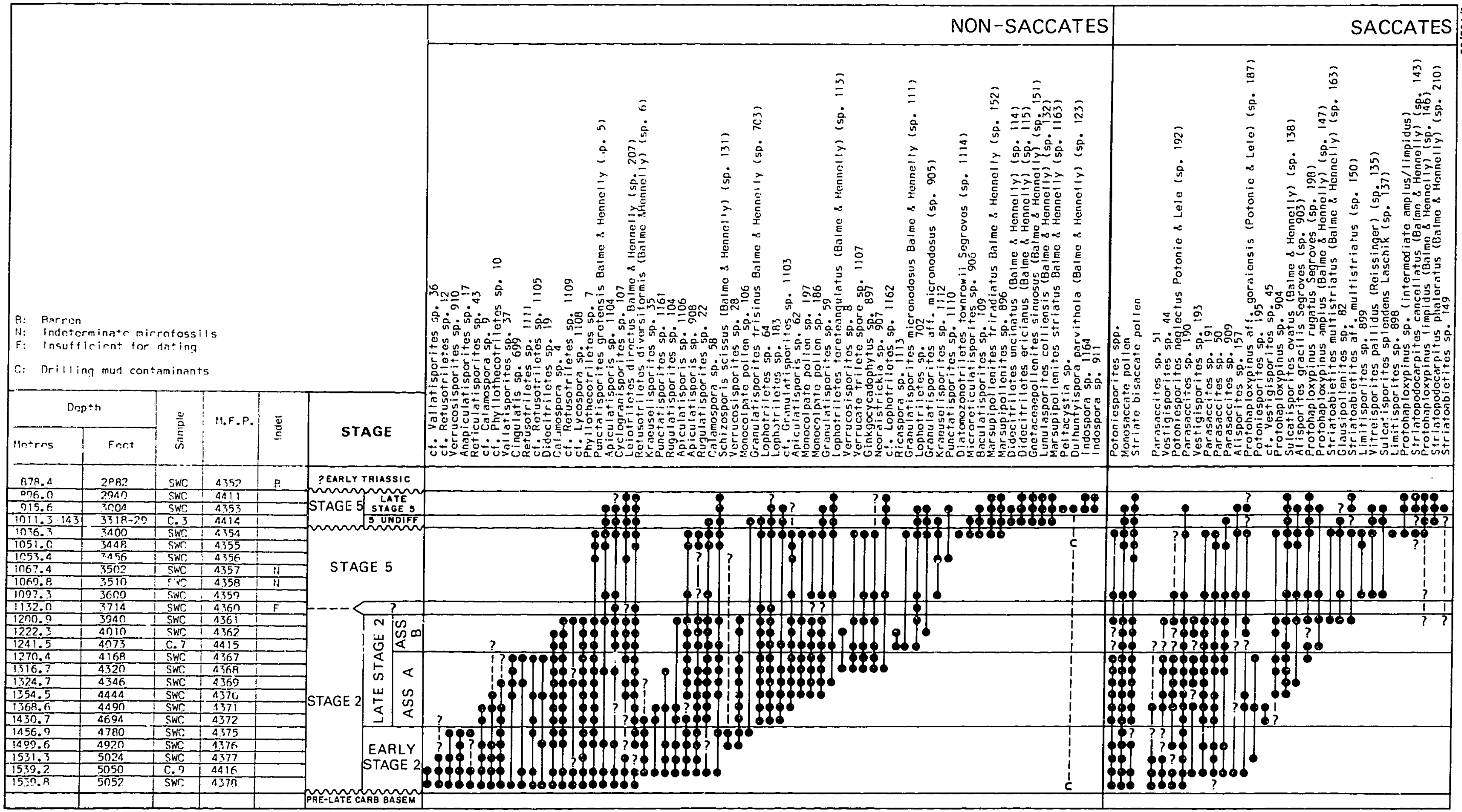
Age	Formation	Depth	
Quaternary	unnamed	Surface - 12m	Surface - 38'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	12 - 389 m	38 - 1277'
	- unconformity -		
Triassic	Moolayember Formation	389 - 577m	1277 - 1892'
	Clematis Sandstone	577 - 707m	1892 - 2320'
	Rewan Formation	707 - 881m	2320 - 2892'
	- unconformity -		
late Early-Late Perm.	unnamed	881 - 1050m	2892 - 3444'
	- unconformity -		
Late Carb. - Early Permian	unnamed	1050 - 1608m	3444 - 5274'
	- unconformity -		
Pre-Late 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 sidewall 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 summarised in the table below.

Sample	Depth		M.F.P.	Spore unit (Evans in Amerada 1967)	Stage (Norvick, 1971)
SWC	896m	2940'	4411	P4	Late Stage 5
SWC	916m	3004'	4353	P4	Late 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)	Late Stage 2 - Stage 3
SWC	1201m	3940'	4361	P1b	Late Stage 2 (B)
SWC	1222m	4010'	4362	P1b	Late Stage 2 (B)
Core 7	1241m	4073'	4415	P1b	Late Stage 2 (B)
SWC	1270m	4168'	4367	P1b	Late Stage 2 (A)
SWC	1317m	4320'	4368	P1a	Late Stage 2 (A)
SWC	1325m	4346'	4369	P1a/C2	Late Stage 2 (A)
SWC	1354m	4444'	4370	P1a/C2	Late Stage 2 (A)
SWC	1369m	4490'	4371	P1a/C2	Late Stage 2 (A)
SWC	1431m	4694'	4372	P1a/C2	Late Stage 2 (A)
SWC	1457m	4780'	4375	P1a/C2	Early Stage 2
SWC	1500m	4920'	4376	P1a/C2	Early Stage 2
SWC	1531m	5024'	4377	P1a/C2	Early Stage 2
Core 9	1539m	5050'	4416	C2	Early Stage 2
SWC	1540m	5052'	4378	C2?	Early Stage 2

Figure 16. Amerada Thunderbolt No.1:

range chart for selected species.



Previous work on this section includes Evans' (in Amerada, 1967) short report on the Triassic, Permian and Late 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 Early 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 wireline 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

Early 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.

Late 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. 45*
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 Late 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 start of Late 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 sidewall core at 1210m (3940 feet) (M.F.P. 4361) contains an abundant Late State 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 occurrece 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)
Didectriletes uncinatus (sp. 114)
Lunulasporites colliensis (sp. 132)

The microflora of the succeeding sidewall 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 3444 feet) the lithologic log shows a change from a pale siltstone/coal se 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 14 m (44 feet) above the horizon of this apparent litholigical break (1036m, 3400 feet, M.F.P. 4354) is very puzzling. Three possible explanations may cover this discrepancy:

a. The contents of sidewall core from 1036m (3400 feet) may represent an 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).

Generalised section (from well completion report):

Age	Formation	Depth	
Quaternary	unnamed	Surface - 41 m	Surface - 136'
	- unconformity -		
Jur.-Cret.	Eromanga Basin sequence	41 - 563m	136 - 1848'
Triassic	Moolayember Formation	563 - 733m	1848 - 2405'
	Clematis Formation	733 - 867m	2405 - 2846'
	Rewan Formation	867 - 1049m	2846 - 3443'
Late Permian	unnamed	1049 - 1194m	3443 - 3918'
	- unconformity -		
Early Permian-Late Carb.	unnamed	1194 1481m	3918 - 4858'
	- unconformity -		
Pre.-Late Carb.	volcanic basement	1481m - TD	4858' - TD
Total Depth		1489m	4886'

Palynology: Burger (1970) made a preliminary examination of 16 conventional cores and sidewall 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.

Sample	Depth		M.F.P.	Spore unit (Burger 1970)	Revised stage
SWC	1052m	3456'	4648	P3b-4	?Stage 5
SWC	1161m	3808'	4649	P?	Perm. (undiff.)
SWC	1193m	3915'	4661	P3b-4	Late Stage 2-3
SWC	1277m	4190	4650	?	?
SWC	1311m	4300'	4653	P1c?	Late Stage 2
Core 5	1354m	4441'	4662	P1b-c	Late Stage 2
SWC	1417m	4650'	4654	P1b-c	Prob. Late 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.
Striatities 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 Striatiti 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 sidewall 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 Late Stage 2 to Stage 3. Other species present include:

Apiculatisporis sp. 6
Protohaploxypinus sp. (of the P. amplus - limpidus group)
Protohaploxypinus aff. goraiensis (sp. 187)
Protohaploxypinus rugatus (sp. 198)
Sulcatisporites ovatus (sp. 138)

Alisporites gracilis (sp. 903)
Parasaccites spp.
Quadrisporites horridus (sp. 211)

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

Sidewall core 1311m (4300') was dated by Burger as within the interval P1b-P2, or between latest Stage 2 and earliest 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 though to be *Rugulatisporites* sp. 22. The first appearance of *V. pseudoreticulatus* is a marker for the start of Stage 3 (Paten, 1969), although Evans (1964c, 1966a) mentions some rather problematic occurrences from spore unit P1b. On the other hand *Rugulatisporites* sp. 22 is known from Stage 1, probably to the end 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.
Protohaploxypinus rugatus (sp. 198)
Striatiti spp.

The youngest age possible on this revised assemblage is Late 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 before Late Stage 2. Similarly Monocolpate pollen sp. 186 first appears in Late Stage 2. With the reallocation of Burger's Verrucosisporites pseudoreticulatus to Rugulatisporites sp. 22, all the microfloral evidence points to a Late 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 amended 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 sidewall 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 Early 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: Late Stage 2 to 3), allows refinement of this date to Late Stage 2. The sample from 1417m, (4650') is probably of the same age.

Beaver - Pexa VALETTA No. 1

Reference: Leslie (1970a)

Generalised section (formations from well completion report):

Age	Formation	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 Late 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 Early Jurassic and Early to Middle Triassic respectively. The cuttings from 1301m (4270') yielded the following species (*generic placing amended 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, Didicitriletes ericianus and Gnetaceaepollenites sinuosus also allows us to place this assemblage within Late Stage 5 of Evans (1967a, 1969), assuming that the sample has not been heavily contaminated by caving.

Amoseas WESTBOURNE No. 1
Reference: Gerrard (1964a)
Generalised 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 (sidewall core 1387m, 4550'). This contains abundant Striatiti Protohaploxypinus 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 Late 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 Late Permian.

It is of interest to note that Evans extracted a well preserved Late 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 Late 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.

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

Yongala No. 1:

Age	Formation	Depth	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1977m	Surface - 6485'
Triassic	unnamed	1977 - 2071m	6485 - 6795'
Late Permian	unnamed	2071 - 2095m	6795 - 6872'
	- unconformity -		
Dev.-Early 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	
Jur.-Cret.	Eromanga Basin sequence	Surface - 1825m	Surface - 5987'
Triassic	unnamed	1825 - 1925m	5987 - 6317'
Late Permian	unnamed	1925 - 1950m	6317 - 6398'
	- unconformity -		
Early 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 named changed to present usage):

<u>Parasaccites</u> sp. 50
<u>Baculatisporites</u> sp. 109
<u>Conbaculatisporites</u> cf. sp. 112
<u>Lophotriletes</u> <u>tereteangulatus</u> (sp. 113)
<u>Anapiculatisporites</u> sp. 117
*<u>Sulcatisporites</u> <u>splendens</u> (sp. 137)
*<u>Sulcatisporites</u> <u>ovatus</u> (sp. 138)
<u>Bascanisporites</u> <u>undosus</u> (sp. 139)
<u>Protohaploxypinus</u> cf. sp. 148
<u>Striatoabietites</u> cf. <u>multistriatus</u> (sp. 150)
<u>Ginkgocycadophytus</u> <u>vetus</u> (sp. 154)
<u>Leiotriletes</u> <u>directus</u> (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 Permo - 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 72 km to the SW of the Yongala wells. This penetrated nearly 60 m of Permian, and Evans (1966d) identified spore units P3b - 4 (probably Late Stage 5), P1c (Stage 3 or 4) and P1b (probably Late Stage 2) from this interval.

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