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STRATIGRAPHY AND PALYNOLOGY OF UPPER MESOZOIC SECTIONS IN SOME DEEP WELLS IN THE SURAT BASIN, QUEENSLAND.

by

D. Burger

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STRATIGRAPHY AND PALYNOLOGY OF UPPER MESOZOIC SECTIONS IN SOME DEEP WELLS IN THE SURAT BASIN, QUEENSLAND

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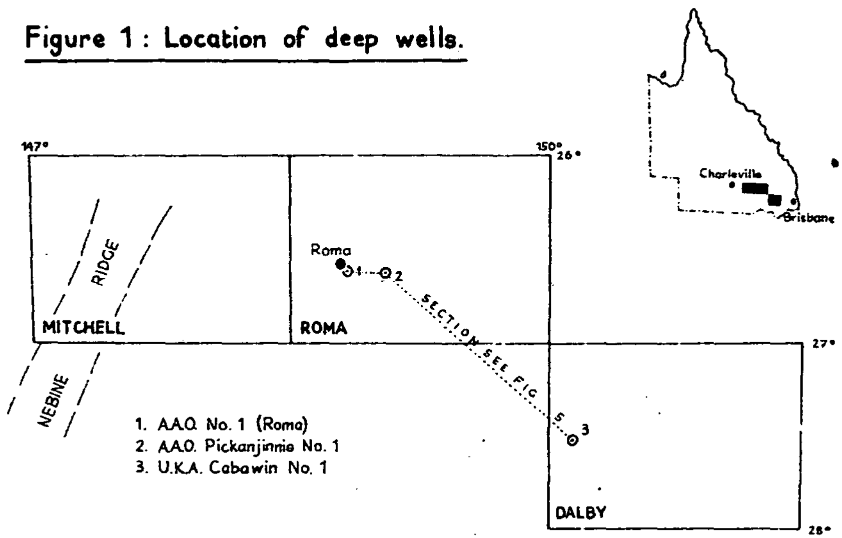
ABSTRACT

This report deals with the lithostratigraphy and palynology of Upper Mesozoic sections from three deep wells: A.A.O. No. 1 (Roma), A.A.O. Pickanjinnie No. 1 and U.K.A. Cabawin No. 1, located in the Surat Basin, Queensland; as a contribution to a more extensive study of the relationship between lithostratigraphy and microfloral zonation in the Great Artesian Basin.

The correlation of surface geology with subsurface lithology of the well sections is discussed in the light of the stratigraphic nomenclature that emerges from recent surface mapping in parts of the Surat Basin. The interval discussed comprises the Jurassic Hutton Sandstone (sensu lato); Injune Creek Group, consisting of the Birkhead and Westbourne Formations; Gubberamunda Sandstone; Orallo Formation; and the Cretaceous Blythesdale Formation. In the section of Cabawin No. 1 well the Cretaceous Wallumbilla Formation is also represented.

Detailed palynological study of samples available, from which Jurassic spore units J 4 to J 6 and Cretaceous spore units K 1a to K 1d are recognized, establishes the parallel time relation between lithostratigraphy and spore zonation across large distances in the Surat Basin. The vertical range of each spore unit is represented in Figures 4 and 5.

Figure 1: Location of deep wells.



To accompany Record 1968/24.

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INTRODUCTION

Of the many wells drilled into the Surat Basin in search of oil, few have been suitably cored for detailed palynological study of the Upper Mesozoic. Sufficient samples are available only from A.A.O. No. 1 (Roma), A.A.O. Pickanjinnie No. 1 and Union-Kern A.O.G. Cabawin No. 1. The locations of these wells are plotted in Figure 1 and their coordinates listed in Table 1.

TABLE 1: COORDINATES OF STUDIED WELLS

Well	Longitude	Latitude	Drilled	T.D.
A.A.O. No. 1 (Roma)	$148^{o}51'10''$ E	$26^{o}34'29''$ S	1952	3897'
A.A.O. Timbury Hills No. 2	148 49 38	26 33 38	1960	4400'
A.A.O. Pickanjinnie No. 1	149 07 18	26 35 42	1960	5213'
U.K.A. Cabawin No. 1	150 11 22	27 29 46	1960/61	12035'

The lithological sequence of Roma No. 1 was published by the Geological Survey of Queensland (1960). Those of Pickanjinnie No. 1 and Cabawin No. 1, together with the wireline logs, were published respectively by Mines Aministration Pty Ltd (1960) and Union Oil Development Corporation (1964). The stratigraphic nomenclature used for these wells by Mines Administration Pty Ltd and first established by Reeves (1947) and Whitehouse (1954), was subsequently modified in the course of subsurface and field mapping in the Roma-Wallumbilla area (Day 1964) and in the Mitchell and Roma 1:250.000 sheet areas (Exon et al., 1966, 1967), where Day's formations could be traced in outcrop. Further revision was later proposed by Vine et al. (1967) in order to obtain a valid and more uniform Cretaceous nomenclature in the Surat and Eromanga Basins.

The portions of the wells discussed here comprise the Middle and Upper Jurassic and Lower Cretaceous. The stratigraphic nomenclature is based on Day (1964), Exon (1966), Exon et al. (1966, 1967), Vine et al. (1967) and is given in Table 2.

TABLE 2: STRATIGRAPHIC NOMENCLATURE

<table>
<tr><th colspan="2">AGE</th><th colspan="2">FORMATION</th><th>MEMBER</th></tr>
<tr><td rowspan="4">CRETACEOUS</td><td>Albian</td><td colspan="2" rowspan="2">Wallumbilla Fm.</td><td>Coreena Mbr.</td></tr>
<tr><td rowspan="2">Aptian</td><td>Doncaster Mbr.</td></tr>
<tr><td colspan="2" rowspan="2">Blythesdale Fm.</td><td>Minmi Mbr.</td></tr>
<tr><td>Neocomian</td><td>Nullawurt Sst. Mbr.
Kingull Mbr.
Mooga Sst. Mbr.</td></tr>
<tr><td rowspan="6">JURASSIC</td><td rowspan="3">Upper</td><td colspan="2">Orallo Fm.</td><td rowspan="3"></td></tr>
<tr><td colspan="2">Gubberamunda Sst.</td></tr>
<tr><td rowspan="2">Injune Creek Group</td><td>Westbourne Fm.</td></tr>
<tr><td rowspan="2">Middle</td><td>Birkhead Fm.</td><td>Springbok Sst. Mbr.</td></tr>
<tr><td colspan="2" rowspan="2">"Hutton Sst."</td><td rowspan="2"></td></tr>
<tr><td>Lower</td></tr>
</table>

The Upper Mesozoic formations were repeatedly identified in sub-surface. Exon et al. (1967) recognized these formations in the wireline logs from BMR Mitchell Scout Holes and in a number of deep wells from which the logs were previously published.

Day (1964) recognized the formations above the Injune Creek Group in the sub-surface of A.A.O. No. 1 (Roma) and some A.A.O. Hospital Hill wells. No electrical logs were taken from Roma No. 1, but its section is compared with the electrical logs of A.A.O. Timbury Hills No. 2 (Derrington 1960), located at a distance of only 2 miles (coordinates see Table 1). Although the lithology of the Timbury Hills section is not available, the identification of the formations from electrical log interpretation by Exon et al. (1967) permits stratigraphic correlation of the two sections. In general there are only small differences in thickness and depth of each formation in the section, as shown in Tables 4 and 5 and Figure 5. This illustrates the close agreement between lithological and wireline log interpretations of the local sedimentary sequence. Discrepancy in the interpretations may account for part of the difference in thickness of the Gubberamunda Sandstone and the Kingull and Nullawurt Sandstone Members in the Blythesdale Formation. In these cases the e-log interpretation is favoured.

Subsurface correlation is based on the combined stratigraphic information from Timbury Hills No. 2 and Roma No. 1, while previous work by Tissot (1961, 1962), who recognized certain intervals in the electrical logs of Timbury Hills No. 2, Pickanjinnie No. 1 and Cabawin No. 1, is also taken into account.

A comparison of various nomenclatures used by the authors mentioned above is summarized in Figure 2 for each well section.

TABLE 3: LITHOLOGY AND THICKNESS IN OUTCROP

Formation		Map code	Lithology	Approximate thickness
Wallumbilla Fm.		Klw	Mainly mudstone and siltstone, some glauconitic sandstone	
Blythesdale Fm.		Klb		
	Minmi Mbr.	Kli	Quartzose, glauconitic fine-grained sandstone and siltstone	70
	Nullawurt Sst. Mbr.	Kln	Fine-grained, angular, quartzose sandstone	50
	Kingull Mbr.	Klk	Siltstone, some labile sandst.	100
	Mooga Sst. Mbr.	Klm	Mainly fine to coarse-grained quartzose to sublabile sandstone. Pebble horizons.	200
Orallo Fm.		Juo	Labile to sublabile sandstone and mudstone. Carbonaceous shales to coal beds near the top. Fossil wood fragments common.	400
Gubberamunda Sst.		Jug	Massive sublabile, medium-grained, porous crossbedded sandst.	200
Injune Creek Group	Westbourne Fm.	Juw	Fine-medium grained, lithic sublabile sandstone and siltstone	400
	Birkhead Fm.	Jmb	Mainly mudstone and siltstone, some labile sandstone, carbonaceous mudstone or coals	400
"Hutton Sandstone"		Jlh	Mainly thickbedded, sublabile to quartzose sandstone	

STRATIGRAPHY

Lithology and age.

Various aspects of the formations discussed below in stratigraphical order were compiled from Day (1964) and Exon et al. (1966, 1967). The lithology of each formation is briefly summarized in Table 3.

Jurassic

HUTTON SANDSTONE

The interval here allocated to the Hutton Sandstone (sensu lato) was subdivided by Exon et al. (1967), who proposed the name of Eurombah Beds (unpublished) for the upper part, which is less sandy with interbedded siltstone and mudstone. The Eurombah Beds were recognized in outcrop east of Injune and in the wireline logs of a number of deep wells in the Mitchell and Roma sheet areas. In outcrop the sandstones are more lithic than those of the Hutton Sandstone proper.

The top of the whole interval is recognized by electrical log picks and the depth in Roma, Pickanjinnie and Cabawin wells is given in Table 4.

INJUNE CREEK GROUP

The name of the Group (Exon 1966) replaces the informal name "Injune Creek Beds" of Jensen (1921), applied in the Injune area. In the Surat Basin the Group consists of the Birkhead Formation and the Westbourne Formation.

BIRKHEAD FORMATION

The formation is named and described by Exon (1966). The upper, sandy part is called the Springbok Sandstone Member.

Distribution: Outcropping in a continuous belt, running approximately to the west in the Eddystone and northern part of the Roma and Mitchell 1:250,000 sheet areas.

Identification: Depth intervals and thickness are given in Tables 4 and 5 respectively. The base of Tissot's interval D lies at 2640 feet in Roma No. 1. According to the interpretation by the Geological Survey of Queensland (1960) however, the base of the "Walloon", otherwise coinciding with the base of interval D (Tissot 1962), is placed at 2772 feet, at the base of the first major shale body overlying the Hutton Sandstone. This report accepts the interpretation by G.S.Q.; the thickness of the Injune Creek Group in Roma No. 1 and Timbury Hills No. 2 are in this way closely comparable.

The top of the Birkhead Formation in Timbury Hills No. 2 (1780 feet) does not coincide with the top of Tissot's unit D 1-2 (1895 feet; Tissot 1962). The interval between these levels, easily recognized in the electrical logs, is identified as the Springbok Sandstone Member (Exon et al. 1967) and can also be traced in the other wells (Figure 5). The formation can therefore be correlated with unit D 1-2 and the basal part of unit D 3 (Figure 2).

In Roma No. 1 the top of the formation is here accepted to lie in the 1900-1950 feet interval, above the development of the carbonaceous shale beds.

Environment: Freshwater conditions were established from many wells in the Surat and southeastern Eromanga Basins. The Springbok Sandstone Member consists of crossbedded lithic sandstone and siltstone and is of fluviatile origin.

Fossils and age: Plant fragments are regularly found. Whitehouse (1954) suggests a Middle Jurassic age on paleontological evidence. Microfloras belonging to Evans' spore units J 4 and J 5 were found (Evans 1966-a).

WESTBOURNE FORMATION

The name of the formation, proposed by Gerrard (Amoseas Westbourne No. 1 Well Completion Report 1964) was maintained and published by Exon (1966).

Distribution: Outcropping in a wide belt in the northern Mitchell and Roma sheet areas.

Identification: Depth intervals and thickness are given in Tables 4 and 5 respectively.

The formation coincides with the major part of Tissot's interval D-3 (Figure 2). As interval D is not subdivided in the section of Roma No. 1, the base of the formation is accepted on lithological grounds between 1900 and 1950 feet.

Environment: The formation is supposed to be deposited in a mainly lacustrine environment in the Mitchell and western Roma area.

Fossils and age: Very few fossils are known. Some plant fragments are found, but were not identified. Spore assemblages indicate Evans' spore unit J 5.

GUBBERAMUNDA SANDSTONE

The name was first used by Reeves (1947). Day (1964) maintains the name and designates the type locality.

Distribution: Outcropping in a narrow easterly running belt in the eastern Mitchell and Roma sheet areas. Further eastwards the Sandstone seems to disappear.

Identification: Depth intervals and thickness are given in Tables 4 and 5 respectively (see also Figure 2).

The Sandstone forms the lower part of Tissot's unit E (Figure 2) and shows quite distinct log characteristics. The interval appears to be much narrower than the sequence previously logged as Gubberamunda in A.A.O. No. 5 (Hospital Hill) and A.A.O. Pickanjinnie No. 1 wells. Day (1964) accounts for this difference, stating that a great deal of the feldspathic, lithic and argillaceous sandstones characteristic for the Orallo Formation have been logged as Gubbermunda.

In Cabawin No. 1 the Sandstone is identified between 3340 feet and 2865 feet on electrical and lithological log characteristics.

Environment: The Sandstone shows the characteristics of a high velocity current deposit.

Fossils and age: No diagnostic fossils have been described from the Sandstone. Microfloras indicate Jurassic units J 5-6 (Evans 1966a).

ORALLO FORMATION

The name of the formation is published in Day (1964) and replaces the name "Fossil Wood Beds" of Whitehouse (1954).

Distribution: Outcropping in a wide, easterly running belt in the eastern Mitchell and Roma sheet areas.

Identification: Depth intervals and thickness are given in Tables 4 and 5 respectively. The formation occupies the central part of Tissot's interval E (Figure 2).

Environment: Low energy current to stagnant freshwater conditions. The overall picture has probably been "that of a valley-flat, with local ponding-" (Day 1964).

Fossils and age: Plant fossils mainly found in shales near the top of the formation give an insufficient knowledge of the age of the vegetation. Plant microfossils of (Jurassic) J 6 age were reported by Evans from other parts of the Basin. Fossil wood fragments are abundant in certain horizons.

Cretaceous

BLYTHESDALE FORMATION

The name of the formation replaces the name "Blythesdale Braystone" of Jack (1895). Day (1964) summarizes the different interpretations of the name in history and designates the name of the formation to the same lithological sequence. The formation is subdivided into four members, the Mooga Sandstone Member, Kingull Member, Nullawurt Sandstone Member and Minmi Member (Day 1964). The Mooga Sandstone Member occupies the upper part of Tissot's interval E, the other Members belong into interval F (Figure 2).

As Tissot did not identify intervals E and F in the section of Cabawin No. 1, it is accepted in this report, based mainly on wireline log characteristics, that the base of the Blythesdale Formation lies at approximately 2050 feet.

Distribution: Outcropping in the Mitchell sheet area east of the Nebine Ridge, in the Roma area and also traceable further to the east.

Identification: Depth intervals and thickness are given in Tables 4 and 5 respectively. The Members are identified in the section of Timbury Hills No. 2 by Exon et al. (1967). Almost identical electrical log characteristics permit their identification also in Pickanjinnie No. 1 (Figure 5). The top of the formation in this well is tentatively placed approximately at 200 feet. In the section of Roma No. 1 both the Mooga and the Minmi intervals were recognized by Day, while a Nullawurt type lithology was described from the 280-300 feet level.

A subdivision of the Blythesdale interval in the section of Cabawin No. 1, based on lithology and electrical log characteristics is given in Table 4 and shown in Figure 5.

Environment: Conditions of deposition varied considerably during the whole Blythesdale interval. The Mooga Sandstone Member shows the characteristics of shallow rapid-current deposition, while the overlying Kingull Member indicates quiet slow-motion current environment. The Nullawurt Sandstone Member shows crossbedding comparable with sandy beach deposits and appears to have been laid down under quiet conditions. Finally the Minmi Member is considered to have been deposited in shallow water, nearcoast environments.

Fossils and age: Plant fragments, fossil wood and pelecypods occur infrequently in the frshwater sediments. Marine fossils, mainly molluscs and some belemnites occur sporadically in the Minmi Member. The resemblance with Aptian faunas from the overlying Wallumbilla Formation suggests an Aptian age for the marine part of the Blythesdale Formation. A marine fauna collected from a horizon in the Nullawurt Sandstone Member (Mitchell area) was dated as possibly Neocomian by Day (Appendix 1 to Exon et al. 1967). Spores studied by Evans from various localities in the Basin indicate (Lower Cretaceous) spore unit K 1a.

WALLUMBILLA FORMATION

The name of the formation was proposed by Vine et al. (1967) as part of an alternative nomenclature for "Roma" and "Tambo" Formations of Whitehouse (1954). In the Surat Basin the formation comprises the Doncaster Member and Coreena Member, both of which are described in outcrop in the southern part of the Mitchell and Roma sheet areas. The Wallumbilla Formation is sampled in the subsurface of Cabawin No. 1 and the presence of the Members is established by palynological evidence.

Exon et al. (1967) report the Doncaster Member as consistently 300-400 feet thick in subsurface from study of logs in oil wells, possibly increasing up to 800 feet in the Surat area. A maximum thickness of 250 feet was measured for the Coreena Member in the Mitchell sheet area, while in the Arbroath Trough (A.A.O. Arbroath No. 1 well) a thickness of 700+ feet was found.

The lithological sequence above 1500 feet in Cabawin No. 1, described by Union-Kern - A.O.G. (1964) does not provide any means of recognizing the characteristics of the Members, described in the outcrop areas. Microfloras belonging to unit K 1d from core 1 (570 feet) and cuttings (105 feet) point to the Coreena Member (Burger, App. 3 to Exon et al. 1967). In view of the probable vertical range of K 1d connected with the thickness of the Member elsewhere, a minimal thickness of about 600 feet may be estimated for the member in Cabawin No. 1. Other information is not available, so that a thickness of 800 feet is provisionally assumed for the Coreena Member, comparable with the section of Arbroath No. 1, and consequently 700 feet for the Doncaster Member.

Aptian faunas were collected from the Doncaster and lower Albian faunas from the Coreena Member (Day 1964; Appendix 1 to Exon et al. 1967).

Laterial thickness variations.

The Jurassic strata in Cabawin No. 1, located close to the axis of the Mimosa Syncline, thin towards the northwest against the Nebine Ridge, the western margin of the Basin. This is illustrated in the sections of Pickanjinnie No. 1, Roma No. 1 and Timbury Hills No. 2, located closer to the Basin periphery. Across the Ridge the Gubberamunda Sandstone, the Orallo

Formation and the Blythesdale Formation are not recognized in outcrop or subsurface. Their stratigraphical equivalent in the eastern Eromanga Basin is formed by the more or less undifferentiated Hooray Sandstone (Exon 1966; Exon et al. 1966, 1967).

The Blythesdale Formation varies little in thickness in the well sections. Low relief and quiet sedimentation seem to have characterized the landscape at least in the western part of the Basin.

During the Jurassic interval represented, tectonic movements seem to have had only minor consequences (Whitehouse 1954). Freshwater conditions predominated.

The first Cretaceous transgression that rapidly flooded both the Surat and Eromanga Basins is dated as early Aptian (Whitehouse 1954). Marine Aptian macrofossils were found in the Doncaster Member, both in the Surat and in the Eromanga Basin. Considerable thickness variations of the Member between the Mitchell sheet area and Cabawin No. 1 might indicate continuous movements of the substratum during the Aptian.

<u>Lateral lithological variations:</u>

A comparison of the lithology of the Jurassic formations in the Roma area with the remote section of Cabawin No. 1 reveal very few fundamental differences. The wireline logs appear to be strikingly similar.

Field mapping in the Western part of the Chinchilla 1:250,000 sheet area by the author during 1967 showed that the equivalents of the Westbourne Formation become more sandy towards the East, while the sandstones contain a higher fraction of lithics. The Gubberamunda Sandstone thins rapidly eastwards in outcrop in the Wandoan area, becoming less quartzose and less well-sorted, and disappears in outcrop in the western part of the Chinchilla sheet area, suggesting an eastern source area.

While the Orallo Formation shows characteristics as described by Day (1964) from the Roma area, the Blythesdale Formation is subject to important lateral changes. The Members loose their characteristics and cannot be traced in outcrop. In the Jackson-Wandoan area, east of Yuleba

TABLE 4: DEPTH INTERVALS OF FORMATIONS

Formation / Well		A.A.O. No. 1 (Roma)	A.A.O. No. 2 Timbury Hills	A.A.O. No. 1 Pickanjinnie	U.K.A. No. 1 Cabawin
Wallumbilla Fm.		200 -	170 -	?200 -	1500 -
Blythesdale Fm.	Minmi	280 - 200	300 - 170	260 - ?200	1640 - 1500
	Nullawurt	? - 280	445 - 300	380 - ?60	1770 - 1640
	Kingull	580 - ?	515 - 445	475 - 380	1870 - 1770
	Mooga	770 - 580	720 - 515	750 - 475	2050 - 1870
Orallo Fm.		1250 - 770	1190 - 720	1240 - 750	2865 - 2050
Gubberamunda Sst.		1485 - 1250	1380 - 1190	1428 - 1240	3340 - 2865
Westbourne Fm.		1940 - 1485	1780 - 1380	1950 - 1428	4070 - 3340
Birkhead Fm.		2772 - 1940	2702 - 1780	2898 - 1950	5444 - 4070
Hutton Sst.		- 2772	- 2702	- 2898	- 5444

TABLE 5: THICKNESS OF FORMATIONS

Wallumbilla Fm.		?	?	?	?
Blythesdale Fm.	Minmi	80	130	60	140
	Nullawurt	(60 - 80?)	145	120	130
	Kingull	?	70	95	100
	Mooga	190	205	275	180
Orallo Fm.		480	470	490	805
Gubberamunda Sst.		235	190	188	475
Westbourne Fm.		455	400	562	730
Birkhead Fm.		932	922	908	1374
Hutton Sst.		?	?	?	?

Creek the sequence is mainly represented by a "Mooga" lithology and a less distinct "Minmi" type lithology (Exon et al. 1967).

The wireline log characteristics of the Members in the subsurface of Cabawin No. 1 are very vague. Two predominantly sandy intervals at 2050 - 1870 and 1770 - 1640 feet are considered in this report to represent respectively the Mooga Sandstone and Nullawurt Sandstone Members. Palynological evidence confirms this interpretation.

The Blythesdale interval as a whole is less sandy, compared with the sections of Roma No. 1 and Pickanjinnie No. 1. This agrees with depositional environment at a greater distance from the periphery of the Basin.

PALYNOLOGY

Introduction

Samples from cores, sidewall cores and cuttings from Roma No. 1, Pickanjinnie No. 1 and Cabawin No. 1, the stratigraphical positions of which are shown in the well sections (Fig. 5), were systematically investigated on spores and microplankton.

A selection from these samples is represented in the spore distribution chart of Figure 4, together with the microfloras extracted. The arrangement of the samples according to their relative age permits to interpret the succession of microfloras as a schematic representation of the spore history in (part of) the Surat Basin. This representation proves to be a valuable means for detailed stratigraphical correlation of lithological sequences across wide areas in the Surat and Eromanga Basins.

Previous studies.

In the course of continuous drilling for oil and natural gas in the Surat Basin, together with stratigraphic shallow drilling by the Bureau of Mineral Resources, detailed palynological information of the Mesozoic became available. From this information, to which data were added from deep wells in other areas, Evans subdivided the microfloral history of the Mesozoic into spore units of limited vertical extent and characterized by one or more index spores. In addition, microplankton criteria resulted in an independent subdivision of the marine Lower Cretaceous in the Surat and Eromanga Basins into Dinoflagellate Zones (Evans 1966a, b).

In Southeastern Australia the palynology of the Lower Cretaceous was treated by Dettmann (1963) from deep wells, some of which are located in the South Australian portion of the Great Artesian Basin. Dettmann designed a succession of microfloral assemblages, defined by the co-occurrence of selected sporomorphs.

In the Western Australian area Jurassic and Lower Cretaceous pollen grains and spores were studied by Balme (1957), who recognized microfloral assemblages, each of them characterized by the first or last appearance of selected sporomorphs.

The microfloral history treated in this report is analysed according to Evans' concept. The spore units are plainly recognizable and their vertical extension is illustrated in Figure 5. The palynology of Cabawin No. 1 was previously treated by DeJersey & Dearne and Evans (Appendix 1 to U.K.A. Cabawin No. 1 Well Completion Report 1964). The results were expressed in terms of lithostratigraphy and are shown in Figure 2.

Dettmann's assemblages are poorly represented, due to insufficient sampling of the critical intervals and scarcity of the index fossils. The Western Australian microfloras are readily recognized as they coincide with groups of spore units.

The time relation of various microfloral subdivisions mentioned is discussed below and illustrated in Figure 3.

Spore units

Unit J 4

Evans characterized J 3-4 by a significant reduction of the Classopollis percentage and the predominance of Applanopsis, Cyathidites, Lycopodiumsporites, Osmundacidites, Baculatisporites. The units were recognized in the Hutton Sandstone of Pickanjinnie No. 1 (cores 9 and 8), Cabawin No. 1 (core 12), and in the lower part of the Birkhead Formation of Roma No. 1 (cores 10 and 9) and Cabawin No. 1 (core 11).

Evans' assumption that Lycopodiumsporites was valuable in separating unit J 3 from unit J 4 could not be substantiated. Recent studies on microfloras from the Hutton Sandstone in other localities seem to restrict the first appearance of Leptolepidites verrucatus, Neoraistrickia truncata and Cingulatisporites saevus to the interval of the Sandstone. Unit J 4 is here tentatively separated by the first appearance of L. verrucatus and is recognized in the upper part of the Hutton Sandstone and lower part of the Birkhead Formation in Roma No. 1 (cores 12 to 9).

Unit J 5

Evans commenced J 5 with the appearance of Contignisporites spp. (C. cooksonii) and recognized the unit in the Surat Basin from the Adori Sandstone equivalent upwards. Unit J 5 is recognized in the upper Birkhead Formation and Westbourne Formation of Roma No. 1 (cores 8 an 7), Pickanjinnie No. 1 (cores 5 and 4) and Cabawin No. 1 (cores 9 and 8).

Another trilete spore occurs persistently in the Injune Creek Group. It closely resembles Perotrilites pseudoreticulatus Couper 1953, described in New Zealand only from the Ohika Beds, regarded as Upper Jurassic. Attention should also be paid to a trilete spore provisionally assigned to the genus Todisporites Couper 1958 (BMR serial number 630). This type, although rare, seems to be restricted to the Gubberamunda-Blythesdale interval, at least in the Roma and Mitchell areas.

Unit J 6

Evans suggested the first appearance of Dictyotosporites complex as the base of Unit J 6 and tentatively placed this boundary within the Gubberamunda Sandstone (Evans 1966a). The range of D. complex however seems to extend further downwards into J 5. In this report a separation of J 6 is suggested on the first appearance of Aequitriradites spp.; A. verrucosus is recorded from the Gubberamunda Sandstone in Roma No. 1 (core 5) and from the Orallo Formation in Cabawin No. 1 (cores 5 and 4).

Earlier occurrence of Aequitriradites in Australia has not been reported until now. Microfloras recently studied from the Injune Creek Group in the Eromanga Basin (Burger, in prep.) did not contain this spore type. Further study should appraise the value of J 6 as an acceptable biostratigraphical unit in wider areas.

Unit K 1a

This unit is characterized by the co-occurrence of Cicatricosisporites spp. and Murospora florida and is firmly established in Lower Cretaceous microfloras from the Australian region. The earliest occurrence of Cicatricosisporites australiensis in the uppermost Orallo Formation of Roma No. 1 (core 3; R.J. Paten, Mines Administration Pty Ltd, pers. comm. October 1966) and of C. hughesi in Cabawin No. 1 (core 4) establishes a downward extension of the previously accepted range of the unit. Murospora florida occurs as high as the Minmi Member of Cabawin No. 1 (core 3).

Palynology of shallow holes drilled in the Mitchell sheet area confirms that the contact of units K 1a and K 1b-c must be placed within the Minmi Member (Evans and Burger, Appendix 2 and 3 respectively; in Exon et al. 1967).

Unit K 1a appears to cover almost exactly the interval of the Blythesdale Formation. From BMR Mitchell Scout Hole No. 11, penetrating the Formation east of Mitchell township (Burger, ibid.) an identical extension of K1a was established.

Unit K 1b-c

These units are characterized by Dictyotosporites speciosus, Crybelosporites punctatus, Pilosisporites notensis and a number of rare spores. Recent shallow drilling in the Eromanga Basin disclosed that Cyclosporites hughesi extends higher upwards than previously assumed by Evans, who separated unit K 1b from K 1c by C. hughesi (Evans 1966-a). At the present time these units are being studied in greater detail (Burger, in prep.). Spores with limited vertical extent described by Dettmann (1963) in this interval seem to be too rare in the Surat Basin area to be of value in otherwise separating K 1b and K 1c. C. punctatus is known to occur in the Doncaster Member but is fairly rare in the Surat Basin.

On these more or less negative characteristics the units are recognized in the upper Minmi Member of Roma No. 1 (core 1), Pickanjinnie No. 1 (core 1) and in the Doncaster Member of Cabawin No. 1 (core 2).

Unit K 1d

Evans distinguished K 1d by the first appearance of Crybelosporites striatus and reported the unit from post "Roma" formations in the Surat Basin. The unit is identified in the Coreena Member of Cabawin No. 1 (core 1). From studies in the Eromanga Basin the unit is known to be restricted to this Member only (Burger, in prep.). This confirms approximately the vertical range of K 1d indicated by Evans (1966a, b).

Microfloral assemblages.

Dettmann (1963) defined in stratigraphical succession the Stylosus, Speciosus and Paradoxa Assemblages. The Stylosus Assemblage is recognized in the Minmi Member of Roma No. 1 (core 1) and Pickanjinnie No. 1 (core 1). Evans extends the Assemblage downwards as far as the basal part of the Blythesdale Formation (Figure 3). The Speciosus Assemblage was identified only in the Doncaster Member of Cabawin No. 1 (core 2); it is known to include also unit K 1d.

The Western Australian microfloras (Balme 1957) are readily comparable with Evans' spore units. Microflora I extends as far upwards as unit J 4. Microflora IIA is recognized as the equivalent of units J 5 and J 6 and contains spores as Contignisporites (al Cicatricosisporites) cooksonii and Cingulatisporites saevus. Microflora IIB contains Murospora florida and Cicatricosisporites australiensis and corresponds therefore with unit K 1a.

Age of spore units.

Jurassic

As summarized above, paleontological evidence for the age of the Jurassic formations is scarce. Microfloral assemblages connected with dated horizons were studied by Balme, who reported the earliest occurrence of Contignisporites cooksonii from Callovian strata in the Carnarvon Basin. Tentative correlation with the Surat and Eromanga Basins results in a Middle Jurassic age for part of unit J 5 and consequently for most of the Injune Creek Group (Figure 3). According to this reasoning the older Middle Jurassic stages (Bathonian and Bajocian) would correlate with a certain portion of the J 3-4 interval, i.e. the lower Birkhead Formation and very probably also part of the Hutton Sandstone. In this report units J 1-3 are regarded as Lower Jurassic, units J 4 and part of J 5 as Middle Jurassic and unit J 6 as Upper Jurassic.

Cretaceous

In the Surat Basin the earliest macrofossil age determinations are known from the Nullawart Sandstone Member ("possibly Neocomian") and Minmi Member ("probably early Aptian") by Day (1964; 1967 - Appendix 1 to Exon et al. 1967). There is no evidence concerning the position of the Jurassic-Cretaceous boundary.

Balme identified microflora IIB only from post-Jurassic strata and dated the microflora as Neocomian-Aptian. Dettmann dated the Stylosus Assemblage as Neocomian on combined micro/macropaleontological indications in the Australasian area. Cicatricosisporites australiensis is a persistent spore in both microfloras and has not been reported from definite Jurassic in Australia. In view of its stratigraphical position a Neocomian age for unit K 1a can therefore be deduced.

Units K 1b-c can be dated as Aptian and unit K 1d as Albian. Foraminifera studied by Crespin (Appendix 1 to U.K.A. Cabawin No. 1 Well Completion Report 1964) suggest an Albian age for the 60-190 feet interval in Cabawin No. 1. This agrees with the macrofaunal datings.

Dinoflagellate Zones.

Microplanktonic forms were recovered from the Minmi Member and the overlying marine Cretaceous in PickanjinnieNo. 1 and Cabawin No. 1.

The Dingodinium cerviculum Zone is recognized in the Minmi Member of Pickanjinnie No. 1 (core 1) and in the Wallumbilla Formation of Cabawin No. 1 (cores 1 and 2). The Muderongia tetracantha/Odontochitina operculata Zone is recognized in the Coreena Member of Cabawin No. 1 (cut. 105 ft). Evans correlates these Zones with spore units K 1b-c and K 1d respectively (Evans 1966b) in the Eromanga Basin. This is confirmed by the correlations in the Surat Basin, which are given in Figure 3.

SUMMARY AND CONCLUSIONS

Palynological evidence shows that each spore unit discussed occupies an equal portion of the lithological sequence in different locations, so that a parallel time relation appears to exist between lithostratigraphy and spore zonations across large distances in the Surat Basin.

Apart from minor alterations the spore units and dinoflagellate zones represented show identical vertical extensions to those indicated in Evans (1966a, b). Redesigned spore units J 4 and J 6 are tentatively separated on the first appearance of respectively Leptolepidites verrucatus and Aequitriradites spp. Further investigation will establish the downwards extension of unit J 4 in the Hutton Sandstone and the connection with the two-fold lithological division of the Sandstone proposed in Exon et al. (1967) and briefly mentioned in the section STRATIGRAPHY.

Recent paleontological evidence from the Mitchell and Roma sheet areas permits a more exact dating of the Cretaceous spore units. The Jurassic units are dated on evidence derived from other areas in Australia.

Spore unit	K 1d	- (lower) Albian
	K 1b-c	- Aptian
	K 1a	- Neocomian - basal Aptian
	J 6	- Upper Jurassic
	J 5	- Middle to Upper Jurassic
	J 4	- Middle Jurassic
	J 1-3	- Lower Jurassic

Unit K 2a was not identified in the Cretaceous microfloras of Cabawin No. 1. Swarms of Leiosphaerids, discovered in the microfloras of Cabawin at 105 feet seem to correspond with similar swarms reported by Evans (1962, 1966b) from K 1d microfloras in pre-Toolebuc horizons of the Eromanga Basin, and point to an upper Coreena age. The presence of the Toolebuc Limestone equivalent and eventually younger formations in the section of Cabawin seems therefore unlikely.

The southeastern Australian Stylosus Assemblage appears to be Neocomian - lowermost Aptian, the Speciosus Assemblage Aptian - lower Albian in age.

Time correlation of the Upper Mesozoic formations against the international geological scale, resulting partly from dating of spore units and partly from direct macrofaunal evidence, is represented in Figure 3.

SYSTEMATICAL NOTES ON MICROFLORAS

SPORES

The spore types represented in Figure 4 are treated systematically below. Spore classification and morphological terminology follow the definitions given in Dettmann 1963.

The scope of this record does not permit adequate illustration of the types in question. Reference however is given to representative specimens, stored in the B.M.R. palynological collection, for Leitz Dialux Binocular microscope used in the Palynological Laboratory.

Anteturma	SPORITES Potonié 1893
Turma	TRILETES Reinsch 1883 emend. Dettmann 1963
Suprasubturma	ACAVATITRILETES Dettmann 1963
Subturma	AZONOTRILETES Luber 1935 emend. Dettmann 1963

Genus Annulispora De Jersey 1960

Annulispora folliculosa (Rogalska 1954) De Jersey 1960

1954 Sporites folliculosus Rogalska pp. 26, 44, Pl. 12 fig. 8.
1960 Annulispora folliculosa (Rogalska) De Jersey p. 7, Pl. 2 fig. 2.

Reference: Slide 939-2; coordinates 325-927 (Wlt. 329). Hutton Sandstone.
Description: See De Jersey 1960.
Vertical distribution: Jurassic to Albian.
Remarks: Identical spores have been reported from the Triassic in Austria as Distalanulisporites by Klaus (1960). On some of the Australian specimens a slight flange-like equatorial thickening was observed.

Genus Cicatricosisporites Potonié & Gelletich 1933

Cicatricosisporites australiensis (Cookson 1953) Potonié 1956

1953 Mohrioisporites australiensis Cookson p. 470, Pl. 2 fig. 29-34.

1956 Cicatricosisporites australiensis (Cookson) Potonié p. 48.

Reference: Slide 901-3; coordinates 370-1089 (Wlt. 331). Blythesdale Formation.

Description: See Dettmann 1963 p. 53, Pl. 9 fig. 10-16.

Vertical distribution: Widely spread in the Australian Lower Cretaceous, also in the Upper Cretaceous (and Tertiary?).

Cicatricosisporites hughesi Dettmann 1963

Reference: Slide 902-3; coordinates 391-974 (Wlt. 331). Orallo Formation.

Description: See Dettmann 1963 p. 55, Pl. 10 fig. 6-16.

Vertical distribution: Lower Cretaceous, lowermost Upper Cretaceous (Queensland, N.T.; Burger, in prep.).

Genus Cyclosporites Cookson & Dettmann 1959

Cyclosporites hughesi (Cookson & Dettmann 1958)
Cookson & Dettmann 1959

1958 Radiatisporites hughesi Cookson & Dettmann p. 103, Pl. 15 fig. 4-6.

1959 Cyclosporites hughesi (C. & D.) Cookson & Dettmann p. 260.

Reference: Slide 773-2; coordinates 422-1134 (Wlt. 275). Blythesdale Formation.

Description: See Dettmann 1963 pp. 41-42, Pl. 6 fig. 4-7.

Vertical distribution: Neocomian to lower Albian.

Genus Dictyophyllidites Couper 1958 emend. Dettmann 1963

Dictyophyllidites crenatus Dettmann 1963

Reference: Slide 901-3; coordinates 331-1078 (Wlt. 331). Blythesdale Formation.

Description: See Dettmann p. 28, Pl. 3 fig. 1-5.

Vertical distribution: Middle Jurassic to Lower Cretaceous.

Dictyophyllidites pectinataeformis (Bolkhovitina 1953) Dettmann 1963

1953 *Matonia pectinataeformis* Bolkhovitina p. 56, Pl. 8 fig. 23.

1963 *Dictyophyllidites pectinataeformis* (Bolkh.) Dettmann p. 27, Pl. 2 fig. 9-12.

Reference: Slide 773-1; coordinates 402-1028 (Wlt. 275). Blythesdale Formation.

Description: See Dettmann 1963.

Vertical distribution: Recovered from 2 samples in the Aptian and lower Albian.

Genus *Dictyotosporites* Cookson & Dettmann 1958

Dictyotosporites complex Cookson & Dettmann 1958

Reference: Slide 905-2; coordinates 358-943 (Wlt. 322). Wallumbilla Formation.

Description: See Dettmann 1963 p. 49, Pl. 9 fig. 1-7.

Vertical distribution: Middle (?) Jurassic to Aptian.

Dictyotosporites speciosus Cookson & Dettmann 1958

Reference: Slide 906-1; coordinates 395-933 (Wlt. 323). Wallumbilla Formation.

Description: See Dettmann 1963 p. 49, Pl. 8 fig. 8-14.

Vertical distribution: Lower Cretaceous, possibly basal Upper Cretaceous (Burger, in prep.).

Genus *Foveotriletes* van der Hammen 1956 ex Potonié 1956

Foveotriletes parviretis (Balme 1957) Dettmann 1963

1957 *Microreticulatisporites parviretis* Balme pp. 24-25, Pl. 4 fig. 50-51.

1963 *Foveotriletes parviretus* (Balme)Dettmann p. 42, Pl. 8 fig. 8-13.

Reference: Slide 880-1; coordinates 461-1018 (Wlt. 314). Orallo Formation.

Description: See Balme 1957, Dettmann 1963.

Vertical distribution: Neocomian to Albian.

Genus Leptolepidites Couper 1953

Leptolepidites verrucatus Couper 1953

Reference: Slide 790-1; coordinates 300-1021 (Wlt. 283). Hutton Sandstone.

Description: See Dettmann 1963 p. 29, Pl. 3 fig. 6-9.

Vertical distribution: Middle Jurassic to Lower Cretaceous, possibly lower Upper Cretaceous.

Genus Lycopodiumsporites Thiergart 1938 ex Delcourt & Sprumont 1955

Lycopodiumsporites circolumenus Cookson & Dettmann 1958

Reference: Slide 903-1; coordinates 367-1008 (Wlt. 318). Orallo Formation.

Description: See Dettmann 1963 pp. 44-45, Pl. 7 fig. 1-3.

Vertical distribution: Middle Jurassic to Lower Cretaceous.

Lycopodiumsporites nodosus Dettmann 1963

Reference: Slide 903-1; coordinates 468-1108 (Wlt. 318). Orallo Formation.

Description: See Dettmann 1963 p. 46, Pl. 7 fig. 13-16.

Vertical distribution: Upper Jurassic and Lower Cretaceous.

Genus Neoraistrickia Potonié 1956

Neoraistrickia truncata (Cookson 1953) Potonié 1956

1953 Trilites truncatus Cookson p. 471, Pl. 2 fig. 36.

1956 Neoraistrickia truncatus (Cookson) Potonié p. 34.

(For a more extended list of synonyms see Dettmann 1963 p. 36).

Reference: Slide 790-1; coordinates 436-1089 (Wlt. 283). Hutton Sandstone.

Description: See Dettmann 1963 p. 36, Pl. 5 fig. 4-5.

Vertical distribution: Middle Jurassic to Upper Cretaceous.

Genus Pilosisporites Delcourt & Sprumont 1955

Pilosisporites notensis Cookson & Dettmann 1958

Reference: Slide 906-1; coordinates 345-1109 (Wlt. 323). Wallumbilla Formation.

Description: See Dettmann 1963 p. 37-38, Pl. 4 fig. 1-5.

Vertical distribution: Aptian and Lower Albian.

Subturma ZONOTRILETES Waltz 1935

Genus Cingulatisporites Thomson (in Thomson & Pflug) 1953

Cingulatisporites saevus Balme 1957

Reference: Slide 790-1; coordinates 431-970 (Wlt. 283). Hutton Sandstone.

Description: See Balme p. 26, Pl. 4 fig. 57, Pl. 5 fig. 58-59.

Vertical distribution: Jurassic and Lower Cretaceous.

Genus Cingutriletes Pierce 1961 emend. Dettmann 1963

Cingutriletes clavus (Balme 1957) Dettmann 1963

1957 Sphagnites clavus Balme p. 16, V Pl. 1 fig. 4-6.

1963 Cingutriletes clavus (Balme) Dettmann pp. 69-70, Pl. 14 fig. 5-8.

Reference: Slide 773-2; coordinates 254-1119 (Wlt. 275). Blythesdale Formation.

Description: See Balme 1957 and Dettmann 1963. The polar thickening often tends to open as a ring by the forming of a more or less circular depression at the distal pole.

Vertical distribution: Middle Jurassic to Upper Cretaceous.

Genus Contignisporites Dettmann 1963

Contignisporites cooksonii (Balme 1957) Dettmann 1963

1957 Cicatricosisporites cooksonii Balme p. 19, Pl. 1 fig. 23-24, Pl. 2 fig. 25-26.

1963 Contignisporites cooksonii (Balme) Dettmann pp. 75-76, Pl. 15 fig. 11-16.

Reference: Slide 885-1; coordinates 490-1117 (Wlt. 315). Birkhead Formation.

Description: See Balme 1957 and Dettmann 1963.

Vertical distribution: Middle Jurassic to Lower Cretaceous.

Genus Coronatispora Dettmann 1963

Coronatispora perforata Dettmann 1963

Reference: Slide 903-1; coordinates 269-1030 (Wlt. 318). Orallo Formation

Description: See Dettmann p. 67, Pl. 13 fig. 17-25.

Vertical distribution: Upper Jurassic, Neocomian, probably Aptian.

Genus Murospora Somers 1952

Murospora florida (Balme 1957) Pocock 1961

1957 Cingulatisporites floridus Balme p. 36, Pl. 5 fig. 60-61.

1961 Murospora florida (Balme) Pocock p. 1233, Fig. 1, fig. 6-7.

Reference: Slide 901-2; coordinates 440-982 (Wlt. 317). Blythesdale Formation.

Description: See Balme 1957, Dettmann 1963 p. 70, Pl. 14 fig. 9.

Vertical distribution: Middle Jurassic to Neocomian.

Genus Nevesisporites De Jersey & Paten 1964

Nevesisporites vallatus De Jersey & Paten 1964

Reference: Slide 788-1; coordinates 320-994 (Wlt. 282). Birkhead Formation.

Description: See De Jersey & Paten pp. 8-9, Pl. 5 fig. 11-15, Pl. 6 fig. 1-2.

Vertical distribution: Jurassic and Neocomian.

Remarks: Closely comparable with Jurassic and Cretaceous spores attributed by Dettmann (1963) and Playford & Dettmann (1965) to the genus Foraminisporis Krutzsch. This formgenus is defined as azonate; having a two-layered intrapunctate exine, distally verrucate to baculate-echinate, proximally irregularly verrucate and perforated by "Durchlöcherungen" (Krutzsch 1959).

Dettmann reports the holotype of the type species (F. foraminis, Middle Eocene, Germany, Krutzsch p. 130, Pl. 19 fig. 203-206) as having an equatorially weakly thickened exine. The Australian types are distinctly cingulate, apparently one-layered; they are therefore closer in age and morphology to N. vallatus. It seems therefore logical to place the Australian Foraminisporis types and N. vallatus into one (redefined?) genus (Nevesisporites?).

Suprasubturma PERINOTRILITES Erdtman 1947 emend. Dettmann 1963

Genus Crybelosporites Dettmann 1963

Crybelosporites punctatus Dettmann 1963

Reference: Slide 1208-2; coordinates 320-1063 (Wlt. 511). Wallumbilla Formation.

Description: See Dettmann p. 81, Pl. 18 fig. 7-11.

Vertical distribution: Aptian, Albian, probably Cenomanian (Burger, in prep.)

Crybelosporites striatus (Cookson & Dettmann 1958) Dettmann 1963

1958 Perotrilites striatus Cookson & Dettmann p. 43, Pl. 1 fig. 8-12.

1963 Crybelosporites striatus (C. & D.) Dettmann p. 81, Pl. 18 fig. 1-6.

Reference: Slide 905-3; coordinates 378-1008 (Wlt. 322). Wallumbilla Formation.

Description: See Dettmann 1963.

Vertical distribution: Albian, Cenomian.

Crybelosporites stylosus Dettmann 1963

Reference: Slide 773-1; coordinates 396-674 (Wlt. 275). Blythesdale Formation.

Description: See Dettmann p. 82, Pl. 18 fig. 12-20.

Vertical distribution: Neocomian and lower Aptian.

Genus Perotrilites Couper 1953

Perotrilites pseudoreticulatus Couper 1953

Reference: Slide 788-1; coordinates 230-1140 (Wlt. 282). Birkhead Formation.
Description: Trilete, azonate, amb rounded triangular. Trilete mark distinct, almost reaching to equator, accompanied by low and narrow lips. Exine two-layered; inner layer psilate, about 1 micron thick, outer perinous layer hyaline, proximally attached at contact area and showing faint radial folding. At equator and distal face only casually attached, loosely enveloping the spore body and showing foldings as sinuous narrow "muri" that give the spore a crenated, frayed outline.
Thickness probably less than 1 micron.
Diameter of spore 30-45 micron.
Vertical distribution: Middle Jurassic.
Remarks: Almost identical as the holotype of the species (Couper 1953 p. 32, Pl. 3 fig. 30), described form the Ohika Beds in New Zealand, regarded as Upper Jurassic.

Subturma HILATES Dettmann 1963

Genus Aequitriradites Delcourt & Sprumont 1955 emend. Cookson & Dettmann 1961

Aequitriradites spinulosus (Cookson & Dettmann 1958) Cookson & Dettmann 1961

1958 Cirratriradites spinulosus Cookson & Dettmann p. 113, Pl. 18 fig. 9-13, Pl. 19 fig. 1-2, 5-7.
1961 Aequitriradites spinulosus (C. & D.) Cookson & Dettmann p. 427, Pl. 52 fig. 7-12.
(For a more extended list of synonyms see Dettmann 1963 p. 93).
Reference: Slide 905-2; coordinates 428-1075 (Wlt. 322). Wallumbilla Formation.
Description: See Cookson & Dettmann 1958.
Vertical distribution: Upper Jurassic, Lower Cretaceous, probably Cenomanian (Burger, in prep.).

Aequitriradites tilchaensis (Cookson & Dettmann 1958) Cookson & Dettmann 1961

1958 Cirratriradites tilchaensis Cookson & Dettmann p. 113, Pl. 18 fig. 7-8.
1961 Aequitriradites tilchaensis (C. & D.) Cookson & Dettmann p. 427.

Reference: Slide 905-2; coordinates 505-956 (Wlt. 322). Wallumbilla Formation.
Description: See Cookson & Dettmann 1958.
Vertical distribution: Recovered from 1 sample in the Albian.

Aequitriradites verrucosus (Cookson & Dettmann 1958) Cookson & Dettmann 1961

1958 Cirratriradites verrucosus Cookson & Dettmann p. 112, Pl. 18 fig. 2-6.
1961 Aequitriradites verrucosus (C. & D.) Cookson & Dettmann p. 427, Pl. 52 fig. 2-6.

Reference: Slide 901-1; coordinates 461-1113 (Wlt. 317). Blythesdale Formation.

Description: See Dettmann 1963 p. 92, Pl. 22 fig. 1-5.

Vertical distribution: Upper Jurassic and Lower Cretaceous.

Genus Couperisporites Pocock 1962

Couperisporites tabulatus Dettmann 1963

Reference: Slide 906-2; coordinates 364-960 (Wlt. 323). Wallumbilla Formation.

Description: See Dettmann p. 95, Pl. 21 fig. 12-19.

Vertical distribution: Recovered from 1 sample in the Aptian.

Genus Rouseisporites Pocock 1962

Rouseisporites reticulatus Pocock 1962

Reference: Slide 901-1; coordinates 393-1132 (Wlt. 317). Blythesdale Formation.

Description: See Dettmann 1963 p. 97, Pl. 23 fig. 4-9.

Vertical distribution: Aptian, Albian, possibly Cenomanian (Burger, in prep.).

Turma	MONOLETES Ibrahim 1933
Suprasubturma	ACAVATOMONOLETES Dettmann 1963
Subturma	AZONOMONOLETES Luber 1935

Genus Reticuloidosporites Pflug 1953

Reticuloidosporites arcus (Balme 1957) Dettmann 1963

1957 Polypodiidites arcus Balme p. 28, Pl. 6 fig. 67.
1963 Reticuloidosporteis arcus (Balme) Dettmann p. 86, Pl. 19 fig. 12-14.

Reference: Slide 790-1; coordinates 265-1073 (Wlt. 283). Hutton Sandstone.

Description: See Dettmann 1963.

Vertical distribution: Middle Jurassic to Albian.

Anteturma POLLENITES Potonié 1931
Turma SACCITES Erdtman 1947
Subturma MONOSACCITES Chitaley 1951 emend. Potonié & Kremp 1954

Genus Tsugaepollenites Potonié & Venitz 1934 emend. Potonie 1958

Tsugaepollenites segmentatus (Balme 1957) Dettmann 1963

1957 Zonalapollenites segmentatus Balme p. 33, Pl. 8 fig. 91-92.
1963 Tsugaepollenites segmentatus (Balme) Dettmann p. 101, Pl. 24 fig. 11-16.

Reference: Slide 903-2; coordinates 232-1096 (Wlt. 318). Orallo Formation.
Description: See Balme 1957, Dettmann 1963.
Vertical distribution: Lower and Middle Jurassic.

Turma POROSES Naumova 1939 emend. Potonié 1960

Genus Classopollis Pflug 1953 emend. Pocock & Jansonius 1961

Remarks: Several types were observed in the microfloras, resembling the following species: C. pflugii Pocock & Jansonius 1961, C. simplex De Jersey & Paten, C. classoides (al. torosus?) Pflug emend. Pocock & Jansonius 1961 and C. cf. multistriatus Burger 1965. No closer study was made as most of the material was not suitable for detailed morpho-analysis.

MICROPLANKTON

The supra-generic Dinoflagellate Cyst classification is discussed in Sarjeant & Downie 1966. For a more extensive list of morphological references see Downie & Sarjaent 1964, Sarjaent & Downie 1966 and Davey et al. 1966.

Class DINOPHYCEAE Pascher
Cyst-Family DEFLANDREICEAE Eisenack 1954 emend. Sarjeant & Downie 1966

Genus Dingodinium Cookson & Eisenack 1958

Dingodinium cerviculum Cookson & Eisenack 1958

Reference: Slide 773-1; coordinates 390-973 (Wlt. 275). Blythesdale Formation.
Description: See Cookson & Eisenack p. 40, Pl. 1 fig. 12, 14.
Vertical distribution: Aptian and lower Albian.

Cyst-Family MUDERONGIACEAE Neale & Sarjeant 1962 emend. Sarjeant & Downie 1966

Genus Muderongia Cookson & Eisenack 1958

Muderongia tetracantha (Gocht 1957) Alberti 1961

1957 Pseudoceratium ? tetracanthum Gocht p. 168, Pl. 18 fig. 7-9,

1961 Muderongia tetracantha (Gocht) Alberti p. 14, Pl. 2 fig. 14-18.

Reference: Slide 905-3; coordinates 414-1097 (Wlt. 322). Wallumbilla Formation.

Description: See Gocht 1957 and Alberti 1961.

Vertical distribution: Aptian and lower Albian.

Cyst-Family PSEUDOCERATIACEAE Eisenack 1961 emend. Sarjeant & Downie 1966

Genus Odontochitina Deflandre 1935

Odontochitina operculata (Wetzel 1933) Deflandre & Cookson 1955

1933 Ceratium (Euceratium) operculatum Wetzel p. 170, Pl. 11 fig. 21-22.

1955 Odontochitina operculata (Wetzel) Deflandre & Cookson p. 291, Pl. 3 fig. 5-6.

(For a more extensive list of synonyms see Davey et al. 1966).

Reference: Slide 1208-1; coordinates 461-1134 (Wlt. 510). Wallumbilla Formation

Description: See Deflandre & Cookson 1955.

Vertical distribution: Albian, possibly Cenomanian (Burger, in prep.).

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FIGURE 2 : COMPARISON OF STRATIGRAPHIC NOMENCLATURES

Formations	
Wallumbilla Formation	
Blythesdale Formation	Minmi Mbr.
	Mooga Sst. Mbr.
Orallo Formation	
Gubberamunda Sandstone	
Injune Creek Group	Westbourne Fm.
	Birkhead Fm.
"Hutton Sandstone"	

A.A.O. No. 1 (Roma)	IFP-AUS 459 *
Roma	F
Blythesdale	E
Walloon	D
Bundamba	C

A.A.O. Pickanjinnie No. 1		Tissot (1962)
Roma		F
Blythesd.	Transition	
	Mooga	E
	Fossil Wood	
	Gubberamunda	
Walloon		D 3
		D 1-2
Bundamba		C

U.K.A. Cabawin No. 1 Lithology	U.K.A. Cabawin No. 1 Palynology**	Tissot (1962)
Roma	Roma	
	Blythesdale	
Blythesdale	Walloon	D 3
Walloon		D 1-2
Bundamba	Bundamba	C

* Intervals shown on unpublished lithological log drawn in 1961/1962 and available at the Bureau of Mineral Resources

** DeJersey & Dearne, and Evans: Appendix 1 to UNION-KERN-A.O.G. Cabawin No. 1, Queensland (1964)

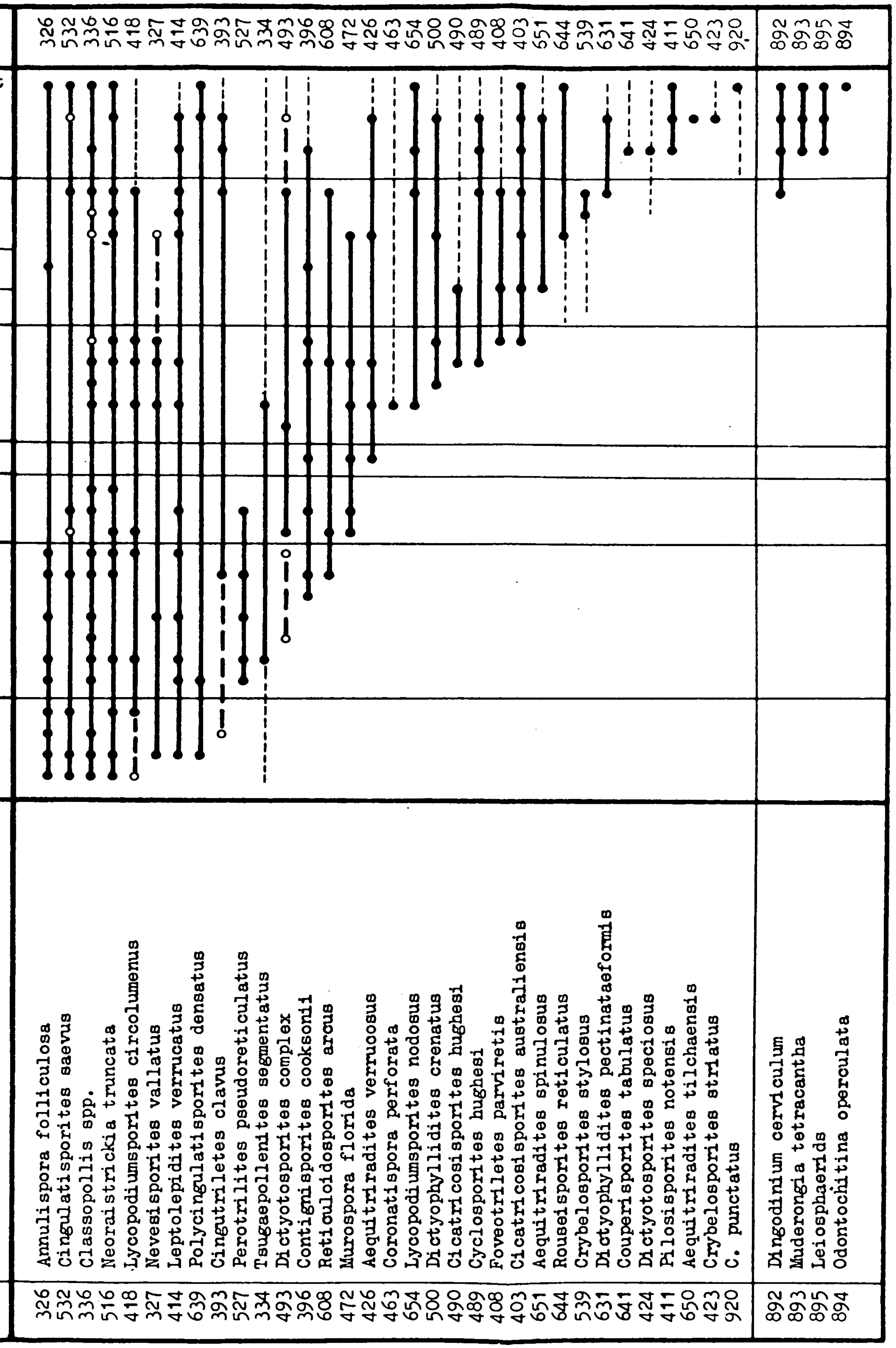
FIGURE 3 : CORRELATION OF STRATIGRAPHY WITH SPORE ZONATIONS

AGE	STRATIGRAPHY		SPORE UNITS	DINOFLAGELLATE ZONES	MICROFLORAL ASSEMBLAGES Dettmann 1963	MICROFLORAL ASSEMBLAGES Balme 1957
ALBIAN	WALLUMBILLA FM.	Coreena Mbr.	K1d	M. tetr/O. op.	Speciosus	
APTIAN		Doncaster Mbr.	K1b–c	Dingodinium cerviculum		
	BLYTHESDALE FM.	Minmi Mbr.			Stylosus	
NEOCOMIAN			K1a			IIB
		Mooga Sst. Mbr.				
UPPER JURASSIC	ORALLO FORMATION		J6			IIA
	GUBBERAMUNDA SANDSTONE					
	INJUNE CREEK GROUP	WESTBOURNE FORMATION	J5			
MIDDLE JURASSIC		BIRKHEAD FORMATION	J4			I
LOWER JURASSIC	"HUTTON SANDSTONE"		J3			

To accompany Record 1968/24.

FIGURE 4 : VERTICAL DISTRIBUTION OF UPPER MESOZOIC SPORES IN THE SURAT BASIN

STRATIGRAPHY		SPORE UNITS	MFP	CORE NO	WELL	DEPTH
WALLUMBILLA FORMATION	Coreena Mbr.	K1d	1208		Cabawin	105 ft
		K1d	905	1	Cabawin	570
	Doncaster Mbr.	K1b-c	906	2	Cabawin	1108
BLYTHESDALE FORMATION	Minmi Mbr.	K1b-c	773	1	Pickanjinnie	200
		K1b-c	878	1	Roma	220
		K1a	901	3	Cabawin	1582
	Nullawurt/ Kingull Mbr.	K1a	879	2	Roma	489
		K1a	1177	swc	Cabawin	1848
	Mooga Sst. Mbr.	K1a				
ORALLO FORMATION		K1a	880	3	Roma	879
		K1a	902	4	Cabawin	2100
		J6	881	4	Roma	1041
		J6	903	5	Cabawin	2429
		J6	904	6	Cabawin	2781
GUBBERAMUNDA SANDSTONE		J6	882	5	Roma	1446
Injune Creek Group	WESTBOURNE FORMATION	J5	884	7	Roma	1705
		J5	775	4	Pickanjinnie	1810
		J5	898	8	Cabawin	3796
	BIRKHEAD FORMATION	J5	913	9	Cabawin	4201
		J5	776	5	Pickanjinnie	2150
		J5	885	8	Roma	2177
		J4	787	9	Roma	2248
		J4	938	11	Cabawin	4903
		J4	788	10	Roma	2598
		J4	789	11	Roma	2717
"HUTTON SANDSTONE"		J4	939	12	Cabawin	5527
		J4	778	8	Pickanjinnie	2955
		J4	790	12	Roma	2911
		J3	779	9	Pickanjinnie	3280



— observed vertical range

-------- known extension in Queensland from published data

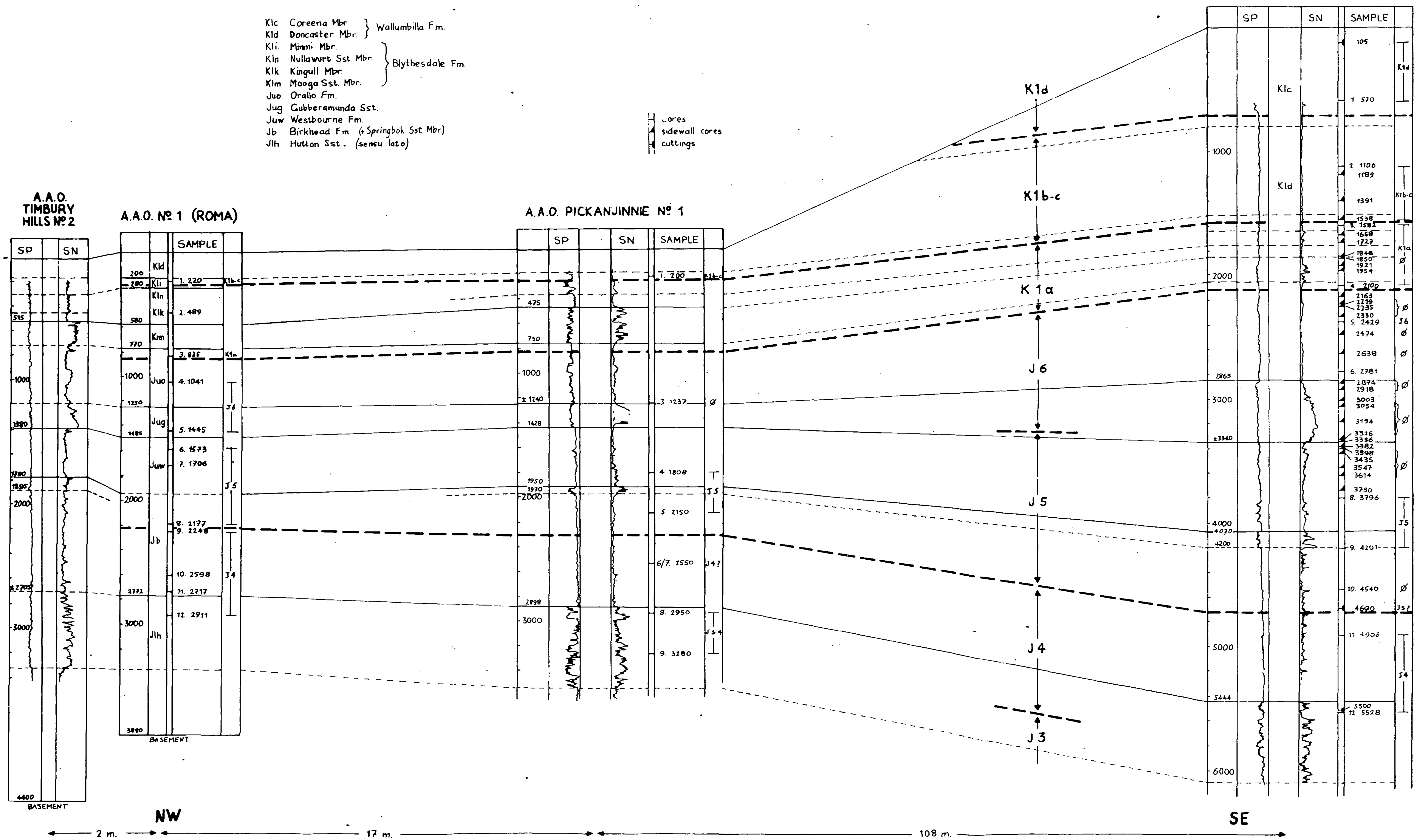
● presence

○ possible presence

FIGURE 5. CORRELATION OF SOME WELLS IN THE SURAT BASIN

Klc Coreena Mbr } Wallumbilla Fm.
Kld Doncaster Mbr.
Kli Minmi Mbr.
Kln Nullawurt Sst Mbr. } Blythesdale Fm.
Klk Kingull Mbr.
Klm Mooga Sst. Mbr.
Juo Orallo Fm.
Jug Gubberamunda Sst.
Juw Westbourne Fm.
Jb Birkhead Fm (+ Springbok Sst Mbr.)
Jlh Hutton Sst.. (sensu lato)

cores
sidewall cores
cuttings



To accompany Record 1968/24.

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