DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

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THE PALYNOLOGY OF LIMESTONE NODULES AS AN AID IN DETERMINING THE AGE OF MARINE CRETACEOUS STRATA IN THE EROMANGA BASIN

GEOSCIENCE SURVEYS AND INFORMATION

by

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BIOSTRATIGRAPHY

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ABSTRACT

Limestone nodules are common occurrences in marine Cretaceous strata of the Eromanga Basin. In outcrop these weathered strata are palynologically barren and often frustrate attempts at dating and correlation. The palynology of three limestone nodules from different localities in the southwestern Eromanga Basin was undertaken to determine their usefulness in palynostratigraphic correlation. Abundant but variably preserved pollen, spores, dinoflagellates and acritarchs were recovered and are adequate to provide a correlation with established palynomorph assemblage zones adopted in subsurface sections in the Eromanga Basin.

INTRODUCTION

The weathered strata of surface exposures in the Eromanga Basin often frustrate attempts at dating and correlation. They are commonly lacking in macrofossils and palynomorphs, although foraminiferal faunas survive the extensive weathering and, in the absence of distinctive lithologies, may provide the only means of correlation. Ludbrook (1966) recovered enough foraminiferal material from the weathered and gypseous Cretaceous marine strata of the Eromanga Basin to make broad age designations. Where very weathered, however, the planktic and other calcareous component of the foraminiferal faunas are also dissolved out (Scheibnerova, 1982) and the remaining agglutinated component may not be adequate for detailed correlation.

An interesting feature of the marine Cretaceous strata is the frequent occurrence of large limestone nodules normally referred to as concretionary limestones (Freytag, 1966; Ludbrook, 1966; Griffiths, 1979). The limestones are highly variable in shape but 'cannonballs' and flattened ellipsoids are the most common (Freytag, 1966). Some may stretch over many metres as irregular shapes, at first along bedding planes but then to cut obliquely across adjacent beds.

Palynological examination of similar limestone nodules from the Early Cretaceous Wallumbilla Formation (Bulldog Shale equivalent) in Queensland revealed that they contain diverse, well preserved palynomorphs (Haig and Barnbaum, 1978). The presence of pollen and spores in combination with dinoflagellates would appear to offer a more detailed level of correlation than currently not available through the foraminiferal faunas. To test the usefulness of the nodules for palynological correlation a few samples were taken in the southwestern Eromanga Basin during mid 1983 as part of the Regional Geology CURDIMURKA 1:250 000 project. These include some from Bulldog Shale (Sample S5787) in Margaret Creek (Lat. 29°29'/Long. 136°52') and from sediments of unknown age collected by P.A. Rogers at Bluebush Dam (Sample S5793; Lat. 29°16'/Long. 137°29') and Lake Callara (Sample S5792; Lat. 29°00'/Long. 136°45').

A conventional laboratory treatment was carried out including crushing, boiling in conc. HCl followed by conc. HF, heavy liquid separation, oxidation in Schultze solution for 7 minutes, a very brief wash in 10% K_2CO_3 solution and mounting the residue in glycerine jelly.

PALYNOLOGY

The samples yielded abundant organic matter, including palynomorphs, although preservation of the latter is highly variable. Samples S5787 and S5793 are dominated by pollen and spores (80% and 95% respectively) whereas S5792 is dominated by dinoflagellates and acritarchs (70%). In the table below, S5787 is sample 1, S5793 is 2 and S5792 is 3.

POLLEN AND SPORES	SAMPLES 1	2	3
Aequitriradites spinulosus (Cookson & Dettman) Cookson & Dettmann 1961		X	X
Aequitriradites verrucosus (Cookson & Dettman) Cookson & Dettmann 1961		X	
Alisporites grandis (Cookson) Dettmann 1963	X	X	X
Alisporites similis (Balme) Dettmann 1963	X	X	X
Anapiculatisporites pristidentatus Reiser & Williams 1969	X		
Annulispora folliculosa (Rogalska) de Jersey 1959	X	X	X
Baculatisporites comaumensis (Cookson) Potonie 1956	X	X	X
Biretisporites spectabilis Dettmann 1963	X	X	X
Callialasporites dampieri (Balme) Sukh Dev 1961		X	X
Callialasporites segmentatus (Balme) Srivastava 1963		X	
Ceratosporites equalis Cookson & Dettmann 1958	X	X	X
Cibotiumspora jurienensis (Balme) Filatoff 1975			X
Cicatricosisporites australiensis (Cookson) Potonie 1956		X	X
Cicatricosisporites ludbrookii Dettmann 1963			X
Classopolis chateaunovi Reyre 1970	X		X
Contignisporites cooksonii (Balme) Dettmann 1963		X	
Contignisporites multimuratus Dettmann 1963			X
Crybelosporites striatus (Cookson & Dettmann) Dettmann 1963		X	
Cyathidites australis Couper 1953	X	X	X
Cyathidites concavus (Bolkhovitina) Dettmann 1963	X	X	
Cyathidites minor Couper 1953	X	X	X
Cycadopites nitidus (Balme) de Jersey 1964	X	X	X
Cyclosporites hughesii (Cookson & Dettmann) Cookson & Dettmann 1959		X	X
Dictyophyllidites crenatus Dettmann 1963		X	X
Dictyotosporites complex Cookson & Dettmann 1958		X	
Dictyotosporites speciosus Cookson & Dettmann 1958	X	X	
Foraminisporis asymmetricus (Cookson & Dettmann) Dettmann 1963		X	
Foraminisporis dailyii (Cookson & Dettmann) Dettmann 1963		X	
Foveosporites canalis Balme 1957		X	
Foveotriletes parviretus (Balme) Dettmann 1963		X	
Gleicheniiditties circinidites (Cookson) Dettmann 1963	X	X	X
Gleicheniidites senonicus Ross emend Skarby 1964		X	

Ischyosporites crateris Balme 1957		X	X
Laevigatosporites ovatus Wilson & Webster 1946	X	X	
Leptolepidites major Couper 1958	X	X	X
Leptolepidites verrucatus Couper 1953	X	X	X
Lycopodiumsporites circolumenus Cookson & Dettmann 1958	X	X	
Lycopodiumsporites eminulus Dettmann 1963	X		X
Lycopodiumsporites facetus Dettmann 1963	X	X	
Microcachryidites antarcticus Cookson 1947	X	X	
Neoraistrickia truncatus (Cookson) Potonie 1956		X	X
Osmundacidites wellmanii Couper 1953		X	X
Osmundacidites dubius Burger 1980		X	
Phimopollenites pannosus (Dettmann & Playford) Dettmann 1973			X
Pilosisporites grandis Dettmann 1963		X	
Pilosisporites notensis Cookson & Dettmann 1958			X
Podocarpidites ellipticus Cookson 1947	X	X	X
Polycingulatisporites densatus (de Jersey) Playford & Dettmann 1965		X	X
Reticulatosporites pudens Balme 1957			X
Retitriletes austroclavatidites (Cookson) Doring, Krutzsch, Mai & Schulz 1963	X	X	X
Retitriletes rosewoodensis (de Jersey) McKellar 1974	X	X	
Sestrosporites pseudoalveolatus (Couper) Dettmann 1963		X	X
Staplinisporites caminus (Balme) Pocock 1962		X	
Stereisporites antiquasporites (Wilson & Webster) Dettmann 1963	X	X	X
Stereisporites pocockii Burger 1980		X	
Trilobosporites tribotrys Dettmann 1963		X	
Triporoletes reticulatus (Pocock) Playford 1971		X	X
Trisaccites microsaccatus (Couper) Couper 1960	X	X	X
Vitreisporites pallidus (Reissinger) Nilsson 1958		X	

DINOFLAGELLATES AND ACRITARCHS

Adnatosphaeridium tutulosum (Cookson & Eisenack) Morgan 1980	X		
Apteodinium granulatum Eisenack 1958	X		
Cannosphaeropsis peridictya Eisenack & Cookson 1960			X
Cannosphaeropsis sp.	X		
Chlamydophorella nyei Cookson & Eisenack 1958	X		X
?Chlamydophorella solida Morgan 1980	X		
Cleistosphaeridium aciculare Davey 1969	X	X	X

Cleistosphaeridium polypes (Cookson & Eisenack) Davey 1969			X
Coronifera oceanica Cookson & Eisenack 1958	X	X	X
Craspedodinium indistinctum Cookson & Eisenack 1974	X		
Cribroperidinium muderongense (Cookson & Eisenack) Davey 1969			X
Cyclonephelium compactum Deflandre & Cookson 1955	X	X	X
Cyclonephelium distinctum Deflandre & Cookson 1955			X
Diconodinium cristatum Cookson & Eisenack emend. Morgan 1977		X	X
Diconodinium davidii Morgan 1975	X		X
Diconodinium dispersum (Cookson & Eisenack) Cookson & Eisenack 1960 emend. Morgan 1977			X
Disphaeria macropyla Cookson & Eisenack 1960	X		
Endoceratium exquisitum Morgan 1980			X
Endoceratium ludbrookiae (Cookson & Eisenack) Loeblich & Loeblich 1966			X
Epelidosphaeridia pentagona Morgan 1980			X
Exochosphaeridium phragmites Davey et al. 1966			X
Florentinia deanei (Davey & Williams) Davey & Verdier 1973			X
Gonyaulacysta cassidata (Eisenack & Cookson) Sarjeant 1966			X
Gonyaulacysta helicoidea (Eisenack & Cookson) Sarjeant 1966	X		
?Heterosphaeridium conjunctum Cookson & Eisenack 1969	X		
Heterosphaeridium heteracanthum (Deflandre & Cookson) Eisenack & Kjellstrom			X
Kleithriasphaeridium readei (Davey & Williams) Davey & Verdier 1976			X
Membranosphaera norvickii Burger 1980	X		
Membranosphaera romaensis Burger 1980	X		
Muderongia sp.			X
Odontochitina operculata (Wetzel) Deflandre & Cookson 1955	X	X	
Oligosphaeridium complex (White) Davey & Williams 1966			X
Oligosphaeridium pulcherrimum (Deflandre & Cookson) Davey & Williams 1966		X	X
Palaeostomocystis scrobiculata (Deflandre & Cookson) Cookson & Eisenack 1974	X		
Protoellipsodinium densispinum Morgan 1980	X		
Pseudoceratium turneri Cookson & Eisenack 1958			X
Spinidinium boydii Morgan 1975			X

Spiniferites ramosus ramosus (Ehrenburg) Loeblich & Loeblich 1966	X		
Spiniferites wetzeli (Deflandre) Sarjeant 1970	X		
Tenua colligata Morgan 1980	X	X	X
Veryhachium reductum (Deunff) Jekhowsky 1961	X	X	X

PALYNOMORPH ZONATION

In the pollen and spore fraction of the palynomorphs the most frequently occurring taxa include Cyathidites minor (the most common), C. australis, Baculatisporites comaumensis, Gleicheniidites circinidites, Stereisporites antiquasporites, Podocarpidites ellipticus and Microcachryidites antarcticus. Unfortunately these have little stratigraphic value in the Cretaceous. Key indicator species are present in samples 2 and 3 and provide the means for correlation with established palynological zonations. Although only long ranging pollen and spore species are found in sample 1, the presence of key dinoflagellate species provides the means for correlation and in the other two samples, corroborates the zonation based on pollen and spores.

The ranges of key zonal indicator species encountered in the limestone nodules are given in Figure 1. Established spore pollen units on the diagram are those of Dettmann and Playford (1969). More recent work on Eromanga Basin sediments, however, shows that many species have greater ranges than recognised by Playford and Dettmann (1969). This explains why the nominate species Dictyotosporites speciosus and Cyclosporites hughesii extend back beyond the bases of their zones.

A possible correlation between palynostratigraphic and lithostratigraphic units is also given in Figure 1. Although this is a useful diagram to show approximate current relationships between the two kinds of units, these relationships are likely to be different in other distant parts of the Eromanga Basin because of the time transgressive nature of units across the basin or change in the future as more information becomes available.

Margaret Creek - Bulldog Shale

The components of the pollen and spore assemblage from the limestone nodule in Bulldog Shale are generally long ranging, and only Dictyotosporites speciosus is of any stratigraphic significance. This taxon is the nominate species for the Dictyotosporites speciosus pollen and spore zone of Dettmann and Playford (1969) (Fig. 1). Recent work in the Eromanga and Surat basins shows that this species extends at least from the upper Cicatricosisporites australiensis zone to the early part of the Coptospora paradoxa zone (Burger 1980, 1982; Morgan 1980). Thus, only a broad age designation ranging from Late Neocomian to Middle Albian can be made on the basis of the presence of Dictyotosporites speciosus.

The dinoflagellate assemblage is more informative and the presence of Odontochitina operculata in the absence of Pseudoceratium turneri and Endoceratium ludbrookiae indicates that the assemblage belongs to the Odontochitina operculata dinoflagellate zone of Aptian age (Fig. 1). The presence of Diconodinium davidii, places the assemblage in the informal subzone c (Fig. 1) whereas Gonyaulacysta cassidata, which has its oldest occurrence near the top of the subzone (Morgan 1980), further suggests that the assemblage may lie within the earlier part of the subzone, or an Middle Aptian age.

This age designation implies that the limestone nodule from Margaret Creek is possibly from the younger part of the Bulldog Shale.

Bluebush Dam

A much richer pollen and spore assemblage was recovered from this limestone nodule and an Early to Middle Abian designation is made on the basis of the following evidence. The assemblage is at least as old as the Crybelosporites striatus zone of Playford and Dettmann (1969) and as young as the middle Coptospora paradoxa zone, which marks approximately the youngest occurrences of Dictyotosporites speciosus and Cyclosporites hughesii (Burger 1980, 1982; Morgan 1980). This is also in agreement with the presence of Pilosisporites grandis and Trilobosporites tribotrys, which are largely restricted to the Coptospora paradoxa zone (Dettmann 1963; Playford & Dettmann 1969; Burger 1980). The absence of the angiosperm pollen Phimopollenites pannosus indicates that the assemblage is no younger than the top of the Coptospora paradoxa zone (Fig. 1).

Recovery of dinoflagellates from the sample was poor and key indicator species, apart from Odontochitina operculata, were not encountered. The pollen and spore assemblage, however, shows that the dinoflagellate assemblage should lie in the uppermost Pseudoceratium turneri (subzone c) or the lowermost Endoceratium ludbrookiae (subzone a) zones (Fig. 1). Morgan (1980) notes that the oldest occurrence of Diconodinium cristatum is at the top of the Pseudoceratium turneri subzone b (or lowermost Coptospora paradoxa spore/pollen zone), which is consistent with the age determination made above.

On these grounds the limestone nodule from Bluebush Dam was recovered either from the Coorikiana Sandstone Member of the Oodnadatta Formation or from the beds immediately overlying the Coorikiana Member.

Lake Callara

This nodule produced the most diverse assemblage. Phimopollenites pannosus is the most important of the pollen and spore assemblage and indicates a Late Albian or younger age (Fig. 1), a conclusion supported by the dinoflagellate assemblage, in particular, the presence of the nominate species Endoceratium ludbrookiae. The assemblage, however, may be correlative with Endoceratium ludbrookiae subzone a, since the youngest occurrence of Endoceratium exquisitum is within the subzone and the youngest occurrences of Pseudoceratium turneri and Spinidinium boydii are at or near the top of the subzone (Morgan 1980). It is interesting to note that one specimen of Diconodinium dispersum was recorded in the sample and the oldest occurrence of this species is used to designate the base of Endoceratium ludbrookiae subzone c.

On the above palynological evidence the limestone nodule from Lake Callara was obtained from possibly the upper part of the Oodnadatta Formation.

CONCLUSIONS

Limestone nodules are characteristic of Cretaceous shallow water marine strata, in particular the Bulldog Shale and Oodnadatta Formation, and are a useful means of dating the palynologically barren strata immediately adjacent. They will thus be of great utility in determining the relative stratigraphic position of strata in isolated outcrops and other ambiguous locations in the Eromanga Basin.

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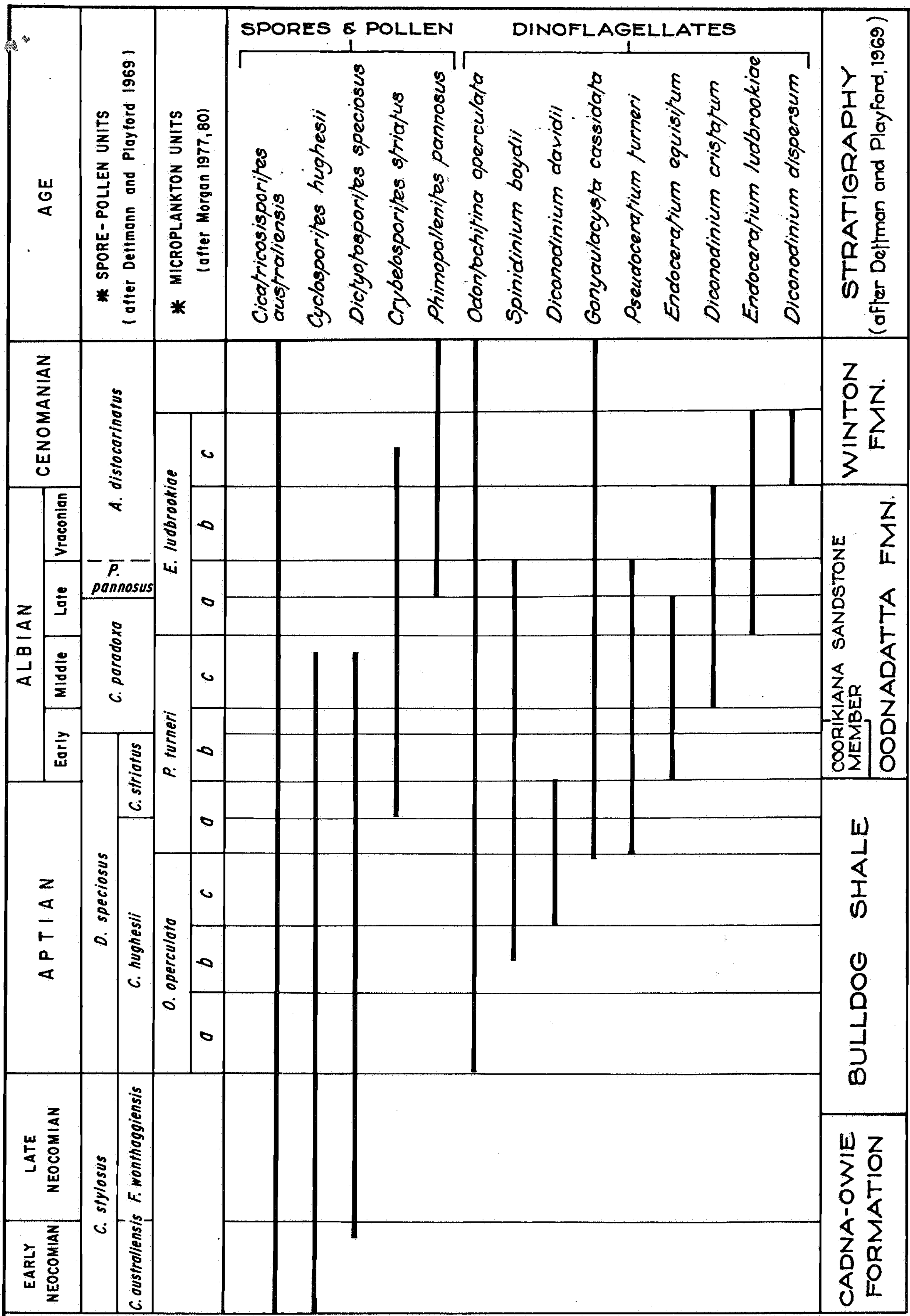

* Stratigraphic ranges of spores and pollen based on Burger (1980, 1982) and Morgan (1980), and dinoflagellates on Morgan (1980).

Figure 1

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PALYNOLOGY OF LIMESTONE NODULES
EROMANGA BASIN

STRATIGRAPHIC RANGES OF KEY PALYNOMORPHS

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