COMMONWEALTH OF AUSTRALIA.

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# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/22



# A PALYNOLOGICAL REPORT ON CONORADA OOROONOO NO.1. BORE, QUEENSLAND.

by

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CONTENTS

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## SUMMARY

Conorada Ooroonoo No. 1 bore, drilled in a position towards the north western side of the Eromanga Basin, penetrated strata of Jurassic and Cretaceous age before entering granite. A coal within the Jurassic section yielded Permian microfossils. Comparison of the spore and microplankton distribution in the Oooroonoo bore with sequences known from elsewhere in the Artesian Basin suggests that certain key species, characteristic of particular horizons, are recognizable over a wide area of the basin. A brief discussion of the problems involved in a determination of the age of sediments in the Artesian Basin is appended.

## INTRODUCTION

Conorada Petroleum Corporation, with the financial aid of the Commonwealth Government, drilled the off-structure stratigraphic bore, Ooroonoo No. 1, at Lat. $23^{\circ}10'50''$, Long. $141^{\circ}33'9''$, Brighton Downs 4-mile Sheet, north western Queensland to a depth of 3852 feet during July and August 1960.

The bore is of palynological importance since it is the first in the west of the Great Artesian Basin which has been regularly cored through the Cretaceous sequence at so close an interval as 200 feet and it thus provides the most adequate section yet available to which other sequences may be referred. The report should not be regarded therefore as final but as an indication of what additional information may be obtained from this section in the future.

Except in certain cores from the Jurassic section only one sample was taken from each core; all samples were subjected to a standard chemical processing technique.

MICRO-ORGANISM DISTRIBUTION AND AGE DETERMINATIONS

The species of both microspores and microplankton which have been observed so far from the Ooroonoo bore are listed in the accompanying chart where they are arranged in order of stratigraphic occurrence. The species are listed in alphabetical order in Appendix II. Many new species were observed in addition to those which can be compared with published types, but, at this stage, they are mentioned only where they seem to be of stratigraphic significance. The lithological sequence on the chart is reduced from the weekly drilling report; the formation names allocated to this sequence are those used by the well-site geologist.

No attempt has been made, except qualitatively, to assess the relative abundances of species or species groups in these samples. Certain abundance variations which may be of stratigraphic significance in the Cretaceous have been noted in the Warbreccan bores, but none of the findings from these bores have been made available while they lacked the necessary reference section for comparative purposes; the Ooroonoo bore fulfils many of the requirements of a reference section and the whole subject of this statistical approach will be reopened at a later stage.

The chart, therefore, displays the total ranges of the observed species. Modifications to the ranges shown due to observation failure, particularly of species of low abundance, could result from further work. This factor applies particularly to the results obtained from cores 10, 14, 18, 19, 20 in which the general concentration of micro-organisms is low.

What appear to be the important features of the distribution chart are as follows.

1. Samples from cores 18, 19, and 20 gave low yields but the presence of Zonalapollenites dampieri (33) in these cores is sufficient to state that strata between 3394 and 3664 feet are Jurassic in age. The lack of associate species prevents more exact determination of their actual age.
2. A shale from core 17, 3186-3196 feet, yielded abundant spores, among which Z. dampieri and Cicatricosisporites cooksoni (41) are considered to be significant. Z. dampieri is particularly abundant to a degree matched only by the Upper Jurassic strata of West Australia (Balme, 1957) and by some

levels in subsurface "Blythesdale Group" of the eastern margin of the Artesian Basin. C. cooksoni persistently appears at first in the top of subsurface "Walloon Coal Measures" of the Roma area and Balme considered the species to range from the Lower Callovian into the Lower Cretaceous.

3. Upper Permian spores in a coal at "3190 feet" in core 17 were discovered independently by Dr. de Jersey of the Queensland Geological Survey. This discovery prompted examination of material from core 17 which was available to the B.M.R. other than the Jurassic shale; a coal, nominally from two feet above the shale, yielded Permian spores with no sign of intermixed Mesozoic forms. The assemblage is probably Upper Permian in age (in confirmation of Dr. de Jersey's opinion) because of the presence of Apiculatisporites filiformis (100), Verrucosisporites trisectus (105), both of which are restricted to the Newcastle Coal Measures of the Sydney Basin (Balme & Hennelly, 1956) and because of the presence of Quadrisporites horridus, a species of doubtful affinities but which has been appearing consistently at about the transition of the Permian to the Triassic in eastern Queensland.

4. Higher in the bore, no sudden changes occur in the spore sequence but the persistent microplankton between cores 12 and 4 (2308 to 836 feet) mark the marine Cretaceous section. The non-marine beds between cores 16 and 13 (2986 to 2376 feet) must occupy positions within the Upper Jurassic and the Lower Cretaceous, but the relative positions of the boundary between the systems cannot be determined precisely (see p. 7). To be in accordance with the published opinions of Balme (1957) and Cookson & Dettmann (1958), the boundary should be between cores 14 and 13 (2576 to 2376 feet). Cicatricosisporites australiensis (62) has not yet been observed in proven Jurassic strata (Balme, 1957) and it is confined in the Artesian Basin to the marine Cretaceous and occasionally some of the freshwater strata immediately below.

5. Within the marine Cretaceous there is little restriction on the ranges of spore species but the late appearance of Cingulatisporites euskirchenoides (82) and Polypodiaceoidites sp. nov. (83) seems to be important. The latter species, a psilate, monocolpate pollen, increases steadily in abundance throughout the bore until it forms a major component of the assemblages above the marine sequence. This higher "freshwater" sequence contains an assemblage with much in common to lower levels, but Trilobosporites trioreticulatus (88) Balmeisporites holodictyus (92) and the angiospermous

Praecolpate sp. nov. (94) help to distinguish these strata from those below. For reasons given later, this upper freshwater sequence occupies a time interval within either or both the Albian or the Cenomanian.

6. The microplankton of the Ooroonoo bore vary in both abundance and assemblage composition. Core 9, 1882 - 1892 feet, contains the greatest percentage of microplankton relative to the spore abundance of all the samples examined. Thereafter this proportion diminishes. Core 9 also contains the greatest variety of species. It has not yet been possible to allocate with confidence various microplankton from the Artesian Basin to the stages of the Lower Cretaceous. Cookson & Eisenack (1959, 1960) have described species from isolated samples within the basin, the ages of which have usually been obtained by many different means. Nevertheless, the distribution of the Ooroonoo microplankton confirms the stratigraphic sequence suggested by those authors in many instances and it is only a matter of time before even more stratigraphically useful species will be recognized. For example, the presence of Dingodinium cerviculum (2) and Micrhystridium sp. nov. (3) in core 11, 2288-2298 feet, and core 12, 2298-2308 feet, recalls that D. cerviculum was described initially from Aptian (Muderong Shale) of Western Australia and from a sample of "Roma Formation" from Batavia Downs, Cape York Peninsula. As these species, together with Pseudoceratium tetracanthum, are known from other oil bores in the Artesian Basin, they may be considered as reliable markers of a lower section of the marine Cretaceous. However, whereas D. cerviculum undoubtedly is of widespread occurrence, no previous record of Micrhystridium sp. nov. has been made except in this western part of the basin. Morphologically the species is little different from types known from Ordovician strata of West Australia and invariably all the Mesozoic specimens are either light brown in colour or transparent, never taking stain in the manner of undoubtedly Mesozoic types. The possibility must be born in mind that this species could be derived, perhaps from Palaeozoics of the Georgina Basin, although specimens appear only in the lower section of the marine Cretaceous. Virtually no material from the Georgina Palaeozoics has yet been examined for microplankton.

7. Less certain at present is the reliability and persistence of microplankton at higher levels in the sequence. Odontochitina operculata (18) is widely distributed and has been recorded from both the Albian and Cenomanian of the Gearle Siltstone of Western Australia (Cookson & Eisenack 1958). Where P. tetracanthum is present it is difficult on occasions to distinguish the usually fragmentary remains of the two species so that doubt has remained previously as to the lowest occurrence of O. operculata. Nevertheless, there are indications that species of the genus Odontochitina may provide useful markers of several stages of the Australian Cretaceous (Cookson & Eisenack, 1960; Evans, 1961). Species of Diconodinium also are widespread in the marine Cretaceous and may be useful for subdivision of the Artesian Basin sequence.

Allocation of the marine beds in the Ooroonoo bore to the Aptian and the Albian on the basis of spores and microplankton is therefore still provisional and there is nothing to contradict the evidence of Dickins (1960) which shows that the allocation of the Wilgunya Formation, below the Toolebuc Member, to the Aptian is correct (see p. 7 ).

## COMPARISONS WITH OTHER BORES IN THE ARTESIAN BASIN

The Ooroonoo bore lies to the north of the line formed by D.F.S. Innamincka No. 1 and D.F.S. Betoota No. 1 bores, to the east of which occurs the group of W.O.L. Warbreccan Nos. 1, 2, and 3 bores. Palynological information from these bores is available in varying detail. Cores at 500 feet intervals and cuttings at 100 feet have been examined from Innamincka No. 1 but the core interval was too great to provide a check on the absolute ranges of the species found. Only selected main and sidewall cores have been examined from Betoota. Cretaceous samples of cores from Warbreccan Nos. 1, 2, and 3 bores and of cuttings at 100 feet intervals from Nos. 1 and 3 bores were made available for examination previously by the Queensland Geological Survey; as with the Innamincka bore, insufficient stratigraphic control on the true fossil ranges in these bores was available. However, reference to the Ooroonoo section shows definite similarities in the sequences which would permit a first approximation to subsurface correlation as follows.

1. Knowledge of the Jurassic spore distribution in these bores is incomplete. Probable representatives of the "Walloon Coal Measures" were encountered at Betoota, but nothing adequately resembling the Upper Jurassic assemblage of Ooroonoo, core 17, has been observed yet. The best comparison is first made in the beds immediately below the microplankton bearing shales in Innamincka at 3942 feet in which a rich assemblage resembling that of Ooroonoo core 13 are known. However, C. australiensis has not been seen at this horizon in the Innamincka bore.

2. D. jurassicum and Micrhystridium sp. nov. are known from cuttings of the Innamincka bore at 3800 feet only, that is 100 feet above the freshwater beds where they are associated also with P. tetracanthum. This association suggests a comparison with a level in the Ooroonoo bore somewhere below core 9 where P. tetracanthum alone is found and above core 11 in which D. jurassicum and Micrhystridium sp. nov. occurred. The same three species were associated also in Warbreccan No. 1, core 5, 2568 - 2587 feet, that is at approximately 380 feet above the freshwater sediments. A sidewall core in the Betoota bore, just above the base of the marine shales, yielded Broomea micropoda (6), Micrhystridium sp. nov. Pseudoceratium cf. turneri (12) and Styxisporites linearis (66) the presence of which supports the contention that these species are characteristic of a lower zone in the marine Cretaceous of the area.

Because of the lack of palynological, correlation, between bore and outcrop sections it is difficult to describe the subsurface horizons in terms of the accepted surface formations. However a sample from the Netting bore, Paton Downs station, which could have come from no higher than 200 feet above a main freshwater aquifer, at the top of Longsight Sandstone (J.N. Casey, pers. comm.) and which, therefore, is in the lower Wilgunya Formation, yielded a good microplankton assemblage that included P. turneri, B. micropoda and D. cerviculum. Thus, there appear to be certain species of microplankton of restricted vertical range and wide geographical distribution which could serve to distinguish the lower 200 to 400 feet of the marine sequence and which probably are Aptian in age.

3. Distinctive and persistent key species from higher in the sequence are not obvious. Odontochitina operculata (18) is of universal distribution; Deflandre & Cookson (1955) recorded the species only from Albian and Cenomanian samples in Western Australia so that its presence marks a higher horizon than the D. cerviculum beds. Hystrychodinium cf. oligacanthum (28) was

described from (?) Albian strata and has been seen in Albian (Gearle Siltstone) of W.A. and in cores 5 and 6 (2516 to 3022 feet) of Innamincka No. 1; it may be considered as a widespread but rare species of the younger Cretaceous beds of the Artesian Basin.

4. The next obvious point of correlation is marked by the final disappearance of the microplankton from the scene. Caution must be taken in the use of this horizon as it does not correspond in each bore with the highest point to which foraminifera range: microplankton in the Ooroonoo bore occur in core 4, 836-846 feet, but the foraminifera were found only as high as core 5, 1038-1048 feet, (Belford, 1960); in the Innamincka bore the highest microplankton were found at 2400 feet whereas the foraminifera persisted to 1700 feet (Ludbrook, 1959). Coinciding with the disappearance of the microplankton and persisting above and below it is the characteristic occurrence of C. euskirchenoides and T. trioreticulatus and the existence of megaspores such as Balmeisporites holodictyus and Pyrolobospora reticulatus (Belford, 1960). More detailed comparison of the spore distribution is required before a check on the position of the highest microplankton in relation to time is known.

## PROBLEMS OF AGE DETERMINATION

It has been customary to use the European time scale as a means of dating the Australian Cretaceous sequence. Within the Artesian Basin Whitehouse (viz. 1955) suggested that Aptian (Roma Formation) and Middle and Upper Albian (Tambo Formation) were present. Dickins (1960) has demonstrated that the molluscan faunas of these two formations are very different, the difference being reflected in the Lower and Upper Wilgunya Formations of the Boulia area respectively. However, virtually no adequate control on the microplankton and spores of the basin is yet available in terms of the European time-scale. Only in West Australia certain assemblages have been associated directly with other marine faunas. Thus Oxfordian - Kimmeridgian microspores (Balme, 1957) and microplankton (Cookson and Eisenack, 1958, 1960b) have been described from the water bores at Broome, in the Canning Basin, where an associated macrofauna was also discovered (Teichert, 1941). Balme, Cookson and Eisenack at the same time have described microfloras and faunas from subsurface Lower Cretaceous strata, the age of which is based primarily on associated foraminifera. Unfortunately no definite Tithonian or Neocomian strata have been examined to date; only the section of the Omati well, Papua, (Cookson & Eisenack, 1958) shows the transition of the microfossils from

Jurassic to Cretaceous in one bore sequence but here also macrofossil control is lacking. It is therefore difficult at present to ascribe with certainty only a Cretaceous age to the microplankton and certain microspores of the Ooroonoo bore since the character of Neocomian and Tithonian species is as yet unknown. Likewise it is also difficult to distinguish Aptian from Albian species and to pick the boundary between the stages on the present knowledge of these microfossils.

Nevertheless a changing microplankton and microspores sequence definitely exists in the Australian Mesozoic. The Artesian Basin is probably the only section of the continent where no reasonable doubt exists that a continuous sequence from the Jurassic into the Lower Cretaceous is present, and while difficulties of applying the European time-scale to this sequence remain there is a case for the erection of a palynological zonal scale which would more completely serve the needs of stratigraphic subsurface correlation in the Artesian Basin. However, until such a zonal scale is established the conventional labels must and, in any case, should always be applied. Within the Artesian Basin it is suggested that the system boundary between the Jurassic and the Cretaceous occurs within the "Blythesdale Group" (as suggested by Whitehouse in his table, (1955, fig. 12). On a palynological basis, as exemplified by the Ooroonoo bore, this would be a more accurate position than that arbitrarily chosen by Tweedale (in Hill, Denmead et al., 1960 p. 310) at the base of the Group. On microspores, the position could be chosen at the commencement of the Cicatricosisporites australiensis microflora until proved otherwise.

The boundary between the Aptian and the Albian must also remain a problem. While the mollusca show a distinctive break between the "Roma" and the "Tambo" Formations (Dickins, 1960) neither they nor the microfossils can supply proof of the non-sequence between the formations suggested by Whitehouse (e.g. 1955). The boundary between the D. cerviculum and the O. operculata microfaunas may correspond approximately to the stage division but it is thought that at present such an approximation may be greater than that already available from macrofaunas and any decision on this boundary in terms of the microfossils must be postponed.

The final problem remains of the age, in terms of the European time scale, of the Winton Formation. Previously only few plants had been obtained from this formation and it was unknown how much, if any, of the Upper Cretaceous was represented by these beds. Palynologically the Winton Formation is little different from the Albian "Tambo" Formation. The lack of microplankton from the upper beds is the only major difference between the formations but the spore content of these upper beds suggests that nothing younger than the Cenomanian is represented by the Winton Formation. A sequence of Upper Cretaceous microplankton is known in West Australia (e.g. Cookson & Eisenack, 1960a) from sections dated by means of pelagic foraminifera. Unfortunately the associate microspore assemblage is unknown, but recent work in Victoria (Evans, 1961) has revealed the presence of a Lower to Upper Cretaceous microfossil sequence very similar to that of West Australia in which the main members of the Artesian Basin Winton microspore assemblage are associated with Albian or Cenomanian microplankton. These microspores are succeeded by a different assemblage in which angiosperm pollens rapidly form a major proportion of the total and none of which have yet been observed in the Winton.

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## APPENDIX I

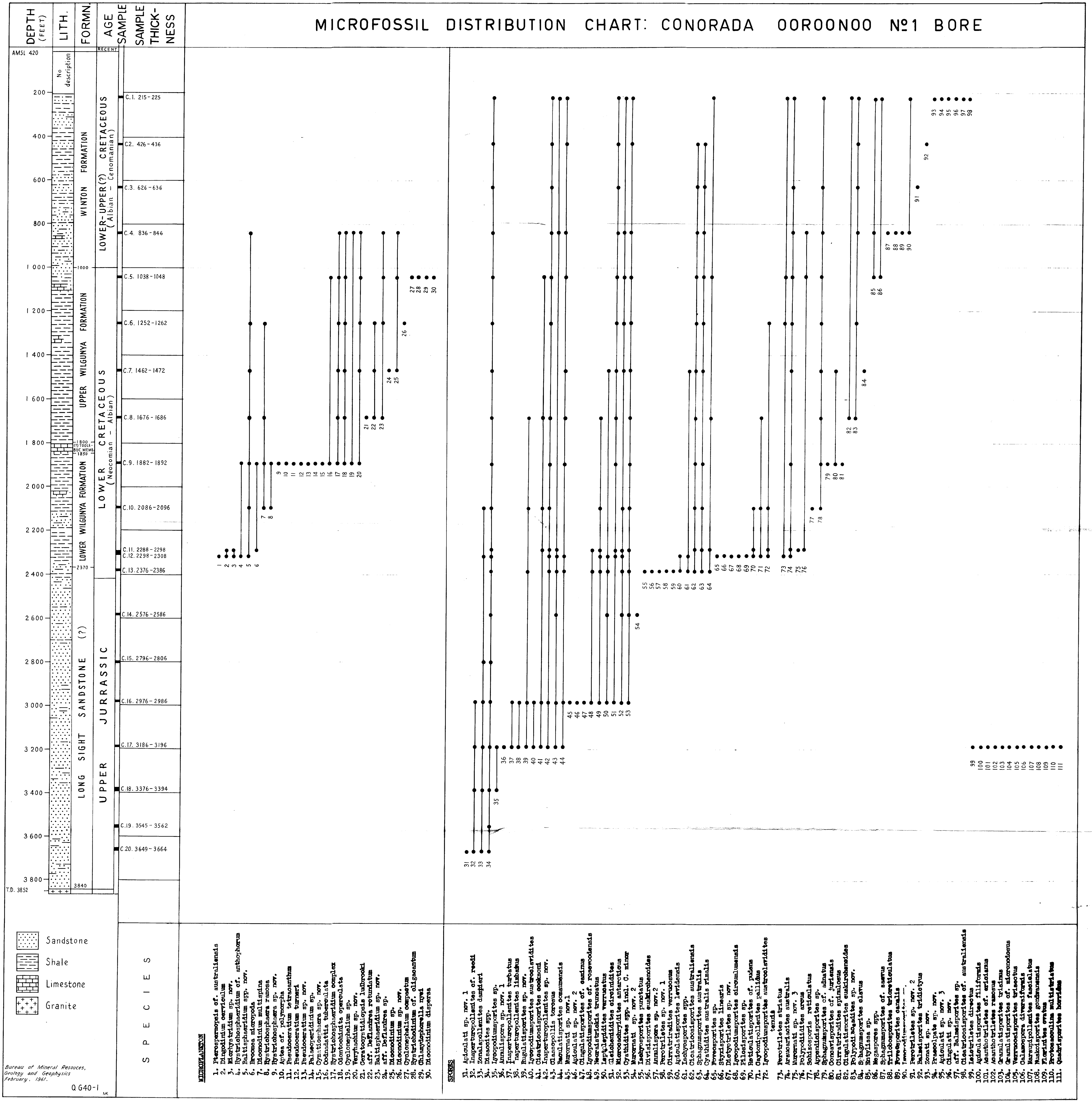
Samples from Conorada Ooroonoo No. 1 bore which have been examined palynologically so far in the Bureau of Mineral Resources came from the following depths. Each sample has been allocated a reference number under which permanent slides from the preparations are recorded in the Bureau palaeontological collection. These numbers and the depths from which the samples were taken are listed below.

| | | | | |
|---|---|---|---|---|
| MFP 917 | Core 1 | 221'10" | - 222'3" | |
| MFP 918 | " 2 | 426' | - 436' | (2'6"-2'10") |
| MFP 919 | " 3 | 626' | - 636' | (6' -6'4") |
| MFP 920 | " 4 | 836' | - 846' | (2'6"-2'11") |
| MFP 921 | " 5 | 1038' | -1048' | (4' -4'5") |
| MFP 922 | " 6 | 1252' | - 1262' | (4' -4'5") |
| MFP 923 | " 7 | 1462' | -1472' | (8' -8'5") |
| MFP 924 | " 8 | 1676' | -1686' | (2'5"-2'9") |
| MFP 925 | " 9 | 1882' | -1892' | (0' -0'4") |
| MFP 926 | " 10 | 2086' | -2096' | (2'0"-2'4") |
| MFP 927 | " 11 | 2288'-2298' | | (0' -0'4") |
| MFP 928 | " 12 | 2298' | -2308' | (8' -8'4") |
| MFP 942 | " 13 | 2376 | -2386' | (4'0"-4'5") |
| MFP 943 | " 14 | 2576' | -2586' | (2'0"-2'4") |
| MFP 944 | " 15 | 2796' | -2806' | (8'0"-8'4") |
| MFP 945 | " 16 | 2976' | -2986 | (2'0"-2'5") |
| MFP1117 | " 17 | 3186' | -3196' | ( 8"-12") |
| MFP 946 | " 17 | 3186' | -3196' | (2'0"-2'4") |
| MFP1118 | " 18 | 3379' | -3394' | (6'0"-6'4") |
| MFP 947 | " 19 | 3545' | -3562 | (0' -0'4") |
| MFP1119 | " 19 | 3545' | -3562' | (10'-10'3") |
| MFP1120 | " 20 | 3649' | -3664' | (2'0"-2'4") |
| MFP 948 | " 20 | 3649' | -3664' | (4'0"-4'4") |
| MFP 827 | cuttings | 3810' | | |
| MFP 826 | " | 3812' | | |
| MFP 825 | " | 3820' | | |
| MFP 832 | " | 3824' | | |
| MFP 831 | " | 3826' | | |
| MFP 830 | " | 3830' | | |
| MFP 829 | " | 3835' | | |
| MFP 834 | " | 3840' | | |
| MFP 833 | " | 3845' | | |
| MFP 835 | " | 3849' | | |

# APPENDIX II

## SPECIES CHECK LIST

| | Chart No. |
|---|---|
| **MICROPLANKTON** | |
| Aptea cf. polymorpha | 10 |
| Baltisphaeridium sp. nov. | 23 |
| B. spp. | 5 |
| Broomea micropoda | 6 |
| Ceratocystidiopsis ludbrooki | 21 |
| Chlamydophorella nyei | 29 |
| Cyclonephelium compactum | 27 |
| C. sp. | 19 |
| Cymatiosphaera sp. nov. | 15 |
| aff. Deflandrea rotundatum | 22 |
| aff. Deflandrea sp. | 24 |
| Diconodinium dispersa | 30 |
| D. multisina | 7 |
| D. sp. nov. | 26 |
| D. spp. | 25 |
| Dingodinium cerviculum | 2 |
| Hystrichodinium cf. oligocanthum | 28 |
| Hystrichosphaera ramosa | 8 |
| H. sp. nov. | 9 |
| Hystrichosphaeridium cf. anthophorum | 4 |
| H. complex | 17 |
| Micrhystridium sp. nov. | 3 |
| Odontochitina operculata | 18 |
| Oodnadattia tuberculata | 16 |
| Palaeoperidinium sp. | 14 |
| Pseudoceratium tetracanthum | 11 |
| P. turneri | 12 |
| P. sp. nov. | 13 |
| Pterospermopsis cf. australiensis | 1 |
| Veryhachium sp. nov. | 20 |
| | |
| **SPORES** | |
| Acanthotriletes ericianus | 101 |
| A. ramosus | 102 |
| Annulispora sp. nov. 1 | 36 |
| A. sp. nov. 2 | 57 |
| Apiculatisporites filiformis | 100 |
| A. levidensis | 60 |
| Apiculati sp. nov. 1 | 31 |
| A. sp. nov. 2 | 46 |
| A. sp. nov. 3 | 95 |
| Appendicisporites sp. | 78 |
| Araucariacites australis | 74 |
| Baculatisporites comaumensis | 44 |
| Balmeisporites tridictyus | 92 |
| aff. Balmeisporites sp. | 97 |
| Calamospora diversiformis | 106 |
| Caytonipollenites pallidus | 71 |
| Cicatricosisporites australiensis | 62 |
| C. cf. australiensis | 98 |
| C. cooksoni | 41 |
| Cingulatisporites cf. caminus | 47 |
| C. euskirchenoides | 82 |
| Cingulati sp. nov. | 96 |
| Cirratriradites spinulosus | 81 |


MICROFOSSIL DISTRIBUTION CHART: CONORADA OOROONOO №1 BORE
DEPTH (FEET)
LITH.
FORMN.
AGE
SAMPLE
SAMPLE THICK-NESS
AMSL 420
No description
WINTON FORMATION
UPPER WILGUNYA FORMATION
LOWER WILGUNYA FORMATION
LONG SIGHT SANDSTONE (?)
RECENT
LOWER-UPPER(?) CRETACEOUS (Albian - Cenomanian)
LOWER CRETACEOUS (Neocomian - Albian)
UPPER JURRASSIC
(?) TOOLE-BUC MEMB.
T.D. 3852
C.1. 215-225
C.2. 426-436
C.3. 626-636
C.4. 836-846
C.5. 1038-1048
C.6. 1252-1262
C.7. 1462-1472
C.8. 1676-1686
C.9. 1882-1892
C.10. 2086-2096
C.11. 2288-2298
C.12. 2298-2308
C.13. 2376-2386
C.14. 2576-2586
C.15. 2796-2806
C.16. 2976-2986
C.17. 3186-3196
C.18. 3376-3394
C.19. 3545-3562
C.20. 3649-3664
Sandstone
Shale
Limestone
Granite
SPECIES
MICROPLANKTON
SPORES
Bureau of Mineral Resources, Geology and Geophysics February, 1961.
Q G40-1