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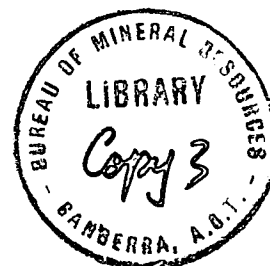
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DEPARTMENT OF
MINERALS AND ENERGY



BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

RECORD 1974/29



GEOLOGICAL SOCIETY OF AUSTRALIA
SPECIALIST GROUP IN PALAEOLOGY
MEETING, HOBART, FEBRUARY 1974
ABSTRACT OF PAPERS PRESENTED BY BMR PALAEOLOGISTS

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THE PRECAMBRIAN-CAMBRIAN BOUNDARY IN AUSTRALIA:
UNDEREXPLOITED GROUPS OF FOSSILS OF POTENTIAL
USEFULNESS FOR CORRELATION

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It is becoming apparent that there was a widespread marine transgression in Australia at about the time now defined as the Precambrian-Cambrian boundary. As a result most of the rocks representing this time are sandstones, siltstones, shales and dolomites. With extremely rare exceptions, the only fossils these contain are tracks and trails, soft bodied metazoans, stromatolites, acritarchs and perhaps algae. The oldest abundant shelly fossils are archaeocyathans and various phosphatic forms.

Most definitions of the Precambrian-Cambrian boundary depend on metazoan shelly fossils (Clout, 1968, also used the stromatolite Conophyton). Microscopic and macroscopic algae had already evolved to form a diverse flora by this time. The ultimate dependence of animals on plants ensures that significant floristic changes will correspond to faunal innovations. This is clearer for the time interval considered here than for later times, since all the known plants were small and aquatic, making them readily available as food to the relatively small and aquatic animals of the time. Recognition of this community structure will facilitate correlation of the Precambrian-Cambrian boundary by delimiting it from both sides and by encouraging the use of a wide range of fossils found in a very wide variety of facies.

Archaeocyatha: The basal stage of the Russian Early Cambrian, the Tommotian, is divided into three successive zones using mainly archaeocyathans but also other shelly fossils. Numerous archaeocyathans are known from the Tommotian. As a phylum they are readily identifiable, diverse, abundant fossils with short-lived taxa (the whole phylum lived only from the Early to Middle, and possibly Late Cambrian), and are therefore particularly useful as index fossils. Genera are widespread: there are many in common between Antarctic, Australian, Canadian, Moroccan and Siberian occurrences.

There are species in common between Australia and Antarctica and Canada and Siberia. They occur abundantly in rocks older than those containing trilobites in Siberia and Australia. The shelly faunas of the lower Wilkawillina Limestone and lower Ajax Limestone in South Australia (Daily's Faunal Assemblage I) are not well dated. They are probably Tommotian. This is suggested by Walter's (1967) correlations using archaeocyathan genera and families and by Daily's (1972) correlations of older trace fossil assemblages and slightly younger shelly faunas.

Daily has recently made a small collection of archaeocyathans from near the base of the Ajax Limestone and I have obtained specimens from only 50 metres above the base of the Wilkawillina Limestone. These are the oldest known South Australian archaeocyathans. In the Georgina Basin the Mount Baldwin Formation contains archaeocyathans and other shelly fossils. Further collecting in this formation could produce archaeocyathan faunas older than any known in the Adelaide Geosyncline.

The only biostratigraphic study of Australian archaeocyathans has been my own preliminary effort (Walter, 1967) and at present no one is continuing this work. At the very least these fossils will enable correlation of rocks one or two zones above the presently accepted base of the Cambrian and further searching could well produce basal Tommotian faunas, particularly in the Georgina Basin.

Stromatolites: The present state of stromatolite biostratigraphy is that it is a method that should work, evolution within the algae will readily explain apparent temporal changes in stromatolite assemblages, and that at present most data support the concept, although there are important anomalies. Cloud (in Cloud & Semikhatov, 1969) used the stromatolite Conophyton in a definition of the Proterozoic - Palaeozoic boundary, but new data have invalidated this and in any case the base of the Palaeozoic as defined by Cloud is not the base of the Cambrian. Walter and Preiss (Preiss, 1972; Walter, 1972; Walter and Preiss, 1972) have shown that Lower and Middle Cambrian stromatolites in Australia have a distinctive Girvanella-like microstructure unlike any Australian Precambrian stromatolites. This microstructure also occurs in Cambrian stromatolites in North America and the USSR. The Russians have used stromatolites to subdivide the uppermost Precambrian (Vendian) and distinguish it from the Cambrian. In the Adelaide

Geosyncline, Amadeus Basin, Georgina Basin and the Kimberley region there are stromatolitic sequences straddling the Precambrian-Cambrian boundary. This is particularly so in the first two basins where stromatolites immediately underlie and overlie the probable boundary position. These are being studied.

Algae: The oncolite-forming (blue-green?) alga Girvanella first appears at or about the base of the Tommotian in Siberia (Voronova and Missarzhevskiy, 1969). With it occur the (red?) algae Epiphyton and Renalcis, both unknown from the Precambrian but abundant in the Lower Cambrian. Epiphyton occurs in the Lower Cambrian of the Adelaide Geosyncline (Walter, 1967) and Girvanella commonly occurs there, in the Amadeus Basin and elsewhere. Numerous new algae first appear in Lower Cambrian rocks (Johnson, 1966).

Numerous microscopic fossil algae have been described from Precambrian black cherts and argillites. Assemblages vary with age and are quite diverse. Such occurrences are common and some of the best known finds are from the Adelaide Geosyncline and Amadeus Basin. Little is known about facies control but undoubtedly these microfossils will become biostratigraphically useful. There needs to be a study of Cambrian forms.

Acritarchs: Most Precambrian and Cambrian acritarchs are probably algae but since their affinities are obscure this noncommittal classification is used. Acritarchs are widely used in biostratigraphy. According to Downie the group Disphaeromorphitae is known only from the late Precambrian. Near the base of the Cambrian three new groups appear; these are the Acanthomorphitae, Diacromorphitae and Oomorphitae. The oldest acanthomorphs and oomorphs are in the basal Cambrian Blue Clay of the Baltic region. Precambrian and Cambrian Acritarch Assemblage Zones have been recognized in the USSR and China. These methods have not been extended to Australia, although there are records of Precambrian and Cambrian acritarchs here (Timofeev and Combaz). Suitable rock types are present here and the latest Precambrian of the Amadeus Basin is presently under study. The very large Precambrian acritarch Chuaria (Ford and Breed, 1973) has recently been found in the basal Arumbera Sandstone.

PRECISION IN CORRELATING THE CAMBRIAN-ORDOVICIAN
BOUNDARY IN AUSTRALIA

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Although sections which straddle the Cambrian-Ordovician boundary have been known in Australia for many years, it is only recently that detailed biostratigraphic results have been published. Because they were the first group to be dealt with in detail, the boundary, at present, is defined in terms of conodonts.

The boundary is drawn at a diagnostic faunal change. A lower fauna, composed of virtually unornamented, thin-walled simple cones associated with W shaped forms, is restricted to the Cambrian. This fauna is known from the Acerocare Zone (6a) of the Acado-Baltic region and is thus of latest Cambrian age. An upper fauna, representing a considerable diversification of ornamented forms from two simple ancestors, is characterised by the incoming of Cordylodus proavus. The cordylodid sequence has been divided into six successive assemblage-zones in Australia, of which the upper two zones are equivalent to the late Tremadocian of the Acado-Baltic area. The early Tremadocian of the Baltic area comprises the Dictyonema Shale from which conodont faunas are known, but not yet published. The unpublished results suggest that some of the four lower zones of the Australian conodont zonation can be recognized, lending strength to the view that the incoming of Cordylodus proavus is, at least, a close approximation to the boundary between the Acerocare Zone and the basal Tremadocian. If we accept that the Tremadocian should belong in the Ordovician rather than the Cambrian, then Cordylodus proavus is a satisfactory guide to the base of the Ordovician.

The Late Cambrian and Tremadocian conodonts show no noticeable provincialism and do not appear to be facies controlled. Complete skeletons were probably composed of very similar units and preferential preservation of disjunct units does not appear to pose problems. The presence of six conodont zones in Australia during Tremadocian time indicates that a conodont zone spans approximately a million years, an order of precision half that seen in Devonian conodont zones, and in Jurassic ammonite zones.

Although Late Cambrian and Early Ordovician conodonts have not been studied in the detail to which those of later time intervals have been subjected we do have reasonable world wide information.

The sequence of faunas described from Australia has also been described, independently, from North and Central America, where the Cambrian-Ordovician boundary is similarly and coincidentally drawn at the incoming of Cordylodus proavus. In addition to the above, the Late Cambrian fauna is also known from Iran, Kazakhstan, and China. Tremadocian faunas similar to the Australian sequence have also been reported from the south east Siberian Platform, South Korea and New Zealand.

Thus although the Cordylodus proavus Zone is known definitely in only Australia, North and Central America, and Siberia, the world wide occurrence of both ancestors and descendants demonstrate its potential usefulness in recognizing the Cambrian-Ordovician boundary.

In North America the detailed conodont stratigraphy parallels a detailed trilobite stratigraphy. The Cambrian-Ordovician boundary has long been recognized in terms of trilobites as the boundary between the Saukia Zone (Cambrian) and the Symphysurina Zone (Ordovician). This latter zone has now been divided, the lowest part being generally recognized as the Missisquoia Zone. Comparison with conodont zonation shows that in sections as far apart as Texas and Alberta Cordylodus proavus has a first occurrence at or near the base of the Corbinia apopsis Subzone, the uppermost of four

subzones of the Saukia Zone. Although this subzone is extremely thin and probably represents a short time interval there was non coincidence between the conodont boundary and the traditional trilobite boundary.

However, conodont and trilobite faunas from Mexico suggest that sauikiids may range into the Lower Tremadocian. Faunas from Afghanistan support this interpretation; palaeontological proof was provided by the recovery of a mixed trilobite fauna in which Acado-Baltic early Tremadocian forms co-existed with sauikiids.

The continual use of the demise of the sauikiids as the basis for delineating the Cambrian-Ordovician boundary could lead to pitfalls similar to the use of the "last" graptolite to define the lower boundary of the Devonian. The use of trilobites, although obviously useful in local correlation may be inhibited by the occurrence of biomeses, sudden non-evolutionary changes in faunas not obviously associated with lithological changes.

Other groups which may prove useful in delineating the boundary include brachiopods and molluscs. Phosphatic brachiopod faunas have not been fully described but appear to offer some promise although slow and minor morphological changes may detract from precision. The molluscs were in the process of rapid evolution and may be a useful tool although ecological factors hinder their use.

At the present time conodonts offer the most precise method of correlating the latest Cambrian and Early Ordovician; zones of a million years duration can be recognized and major evolutionary changes occurred coevally world-wide. Their ease of recovery and of identification are added benefits. The only drawback to their use is difficulty in recovering them from indurated and silicified clastic sediments.

ANTIARCHAN FISHES AND MIDDLE - UPPER DEVONIAN CORRELATION

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Four genera of antiarchan fishes are at present known from Australian Devonian rocks. Bothriolepis, the most widespread form, occurs in lower Frasnian strata in the Canning Basin and is associated with a Cyrtospirifer fauna of similar age in eastern Australia. It appears near the base of the Frasnian also in the western U.S. and the Baltic region of western Europe, but in southern China is reported from Eifelian strata. Some Australian occurrences may therefore be Middle Devonian in age. The genus Remigolepis was originally described from Famennian strata in east Greenland. It also occurs in Scotland and several localities in N.S.W. The Australian occurrences may however be somewhat older than those of the type locality. The Victorian genus Hillsaspis Stensio shows close affinity to Dianolepis Chang from the Middle Devonian of Yunnan Province in southern China, and the Middle Devonian European genus Asterolepis has been reported from Australia but apparently occurs in the Famennian in China. A better understanding of the Chinese or European affinities of Australian antiarchs is required before they can be fully utilised as index fossils for non-marine Middle - Upper Devonian sequences.

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BIOSTRATIGRAPHY, CHRONOLOGY AND THE CONTINENTAL MAMMAL
RECORD OF AUSTRALIA AND NEW GUINEA

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The chronological ranking of the Tertiary marsupial faunal assemblages in Australia and New Guinea, summarized by Stirton, Tedford and Woodburne in 1968 has served adequately since then. The scheme is however probably subject to substantial errors from several sources; future revision of this chronology is to be expected and should surprise no one. Twenty years after the commencement of the first chronologically and stratigraphically orientated work on Australian Tertiary fossil mammals seems an opportune time to appraise past evidence and that generated since 1968 and to comment on the degree to which the correlations are sound.

The stability of the mammalian chronological framework depends on:

1. The physical succession of strata.
2. Sites where land mammals occur in strata interbedded with dated marine rocks.
3. The occurrence of mammals in rocks which contain volcanic material amenable to radiometric dating.
4. The correlation, using palynology, of non-marine rocks containing fossil mammals with rocks from marine sequences containing dateable invertebrates.

Stage of evolution comparisons have figured largely in our ordering of both stratigraphically superposed and geographically separated faunas and we acknowledge that such arrangements are open to question.

Fossil mammal palaeontology and chronology are developing disciplines in Australia and there is no choice but to investigate and develop local geological sections, demonstrate local physical, biostratigraphic and chronostratigraphic correlations and extend these within Australia and New Guinea to achieve an increasingly stable and refined series of local and potentially continental correlations unique to the region.