DEPARTMENT OF MINES
SOUTH AUSTRALIA

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NOTES ON THE MEETING OF THE BAAS BECKING LABORATORY, 2ND APRIL, 1974

by

W.V. PREISS

PALAEONTOLOGY SECTION

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INTRODUCTION

The author was invited to attend as departmental delegate at the Baas Becking Geobiological Laboratory biannual meeting. The meeting was held at Bruce Hall, Australian National University, on the morning of 2nd April, 1974. The author also took the opportunity of conferring with Dr. M.R. Walter (Bureau of Mineral Resources) and of examining his recently collected but as yet not studied stromatolite material from the Amadeus and McArthur Basins.

NOTES ON THE PAPERS PRESENTED

8.30 a.m. Dr. I.E. Newnham: Opening Remarks.

8.35 a.m. Dr. A.J. Gaskin: Geobiological Research Programme.

Dr. Gaskin outlined six major topics (geochemistry, fuels, fluids, nickel, mineral deposits and techniques) currently being worked on by C.S.I.R.O. staff at N. Ryde and Perth, and how they relate to the interests of the Baas Becking Laboratory. The present Baas Becking Staff are Drs. Trudinger, Lambert, Bubela, Jones, Skyring, Downes, Rickard, Donnelly, John Oehler and Dorothy Oehler.

Four papers on the theme "Precambrian Life" were presented

9.15 a.m. Dr. John Oehler. Precambrian Life and the search for Ore.

Major events in early Earth history and the evolution of life were outlined. Three of the best known Precambrian fossil occurrences are the Fig Tree Group of South Africa, the Gunflint Iron Formation of Canada, and the Bitter Springs Formation of Central Australia, respectively of the order of

three, two and one billion years old. The Fig Tree microfossils are simple spheroidal procaryotic forms. Carbon isotope studies suggest they were already photosynthetic. Gunflint microfossils include iron bacteria and filamentous algae. The Bitter Springs Formation contains the first definite evidence of eucaryotic organisms with sexual reproduction. The rapid evolution of the five kingdoms of organisms towards the end of the Precambrian is attributed to the high degree of variability made possible by meiosis and recombination of genetic material in sexual reproduction.

The following age limits for major events of Earth history were suggested:-

Accretion of the Earth	4 700 - 4 000 m.y.
Core - Mantle separation	4 700 - 3 500 m.y.
Origin of oceans and atmosphere	4 700 - 3 800 m.y.
Oldest water-laid sediments	3 800 - 3 700 m.y.
Oxygenated atmosphere	2 200 - 1 800 m.y.
Biological Events:	
Origin of life	3 800 - 3 400 m.y.
Oldest fossils	3 400 - 3 200 m.y.
Origin of photosynthesis	3 400 - 3 100 m.y.
Oldest stromatolites	3 100 - 2 800 m.y.
Origin of eucaryotes	1 900 - 1 300 m.y.
Origin of metaphytes (higher plants)	1 400 - 1 300 m.y.
Origin of sexual reproduction	? 1 300 - 800 m.y.
First organisms with hard parts	Approx. 600 m.y.

A programme was then outlined for studying the relationship of microorganisms to mineralization in black shales. In particular, is the organic matter enriched in metals? If so, do the individual microfossils contain metals, either absorbed on to cell walls or concentrated inside cells by an active process? Modern stromatolites from the Coorong are being culti-

vated in the laboratory to study whether and how metals may be concentrated by algae.

9.55 a.m. Mr. K. Plumb (BMR)

Australian Precambrian Micropalaeontology - A Progress Report

A collecting trip was conducted by Mr. Plumb and Dr. Marjorie Muir of Imperial College, London, in 1972. The areas visited were selected on the basis of four criteria:

(1) Undisturbed Precambrian sedimentary basins with carbonates, cherts, stromatolites and black shales.

(2) Those associated with mineralization.

(3) Those with known microfossils.

(4) Those giving maximum stratigraphic and areal coverage.

The McArthur Group was given prominence in the study, since its stratigraphy is well known, and it contains a major orebody. In addition, it helps to fill a gap in our knowledge of microorganisms between the Bitter Springs and Gunflint microfloras. Microfossils are now known from the McArthur Group, Roper Group, South Alligator Group and the Bungle Bungle Dolomite. The Hamersley Group and the Archaean sediments at Kalgoorlie are rich in organic matter but contain no useful microfossils.

The McArthur Group contains the HYC orebody, from which Dr. Muir has extracted organic material including amorphous spheres and colonial cells. Chert lenses in the dolomite contain what she has identified as the manganese bacterium *Metallogenium*. The remainder of the microflora has similarities both to that of the Bitter Springs Formation and the Gunflint Iron Formation, but the deficiency of filamentous forms is attributed to the fact that this microflora does not occur in stromatolites. In addition two rather complex microorganisms of uncertain affinities were found. These are considered to represent a considerable evolutionary advance on the Gunflint microflora. The Bungle Bungle Dolomite of the East Kimberleys contains were preserved filaments (occurring in stromatolites), and tetrads of cells. The cell contents are possibly enclosed

WATSON, S.J., 1965. An appraisal of the S.Aust. Mines Dept. seismic survey on the Lower Yorke Peninsula. South Australia. Unpubl. Rept. for Beach Petroleum N.L.

_____ 1966. Report on refraction survey, Yorke Peninsula. South Australia. Unpubl. Rept. for Beach Petroleum N.L.

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_____ 1966. Experimental marine seismic survey of St. Vincent Gulf area; for Beach Petroleum N.L. (S.Aust. Dept. Mines open file Env. 679 - unpublished).

_____ and STACKLER, W.F., 1966. Stansbury seismic and gravity survey O.E.L. 24 South Australia; for Beach Petroleum N.L. (S.Aust. Dept. Mines open file Env. 566 - unpublished).

_____ 1967. Yorketown - Pt. Vincent seismic survey O.E.L. 24 South Australia; for Beach Petroleum N.L. (S.Aust. Dept. Mines open file Env. 723 - unpublished).

_____ and SPRIGG, R.C., 1968. St. Vincent Gulf marine seismic survey O.E.L. 24 S.A; for Beach Petroleum N.L. (S.Aust. Dept. Mines open file Env. 976 - unpublished).

_____ 1969. Marine reflection seismic survey of Troubridge Island area O.E.L.24 S.A. for Beach Petroleum N.L. (S.Aust. Dept. Mines open file Env. 1102 - unpublished).

in a membrane, suggesting that they are eucaryotic. The flora is very similar to that of the Amelia Dolomite of the McArthur Group; the two formations were now thought to be approximately correlative. The McMinn Shale of the Roper Group unconformably overlying the McArthur Group contains larger fossils resembling sea-weeds.

It was emphasized that much of the silicification of rocks in Australia is due to deep weathering in the Tertiary. Micro-organisms can be introduced into rocks during this silicification and great care is needed to ensure that the microfossils are indigenous to the original rock and really of Precambrian age.

Further studies of microfossils will be directed towards testing their time ranges, facies control and potential for broad correlations, and investigating their spatial association with metal concentrations.

10.45 a.m. Dr. Dorothy Oehler

Ultrastructure and Chemistry of Precambrian Fossils

Dr. Oehler considered further the question of the age of the microfossils, and presented four criteria which support a Precambrian age.

(1) The microfossils include well preserved forms with no known modern counterpart.

(2) The assemblages are mostly blue-green algae and bacteria. If they were Tertiary, one would expect higher algae to be present also.

(3) Assemblages from different areas but of the same age are similar.

(4) Assemblages of different ages show different stages of evolutionary complexity.

Two major topics were then discussed:

(1) Transmission Electron microscopy of the Ultrastructure of Microorganisms

Of all the organic matter in rocks less than one percent is preserved as the intact remains of organisms. Those from the Bitter Springs Formation cherts were extracted by maceration and studied optically. The 10 micron diameter cells consistently contain a black spot, interpreted as an original

morphological feature. The cells were then studied by electron microscopy, and it was noticed that unlike modern micro-organisms, these did not require staining to bring out the contrast of the cell walls and organelles. This suggested that there was a concentration of metals in the cells making them electron dense. Cells were seen to contain electron-opaque membrane-bounded organelles (chloroplasts?), an internal cell membrane, cytoplasmic material (now particulate), a cell wall and particulate matter around the outside (originally a sheath?). The presence of electron-opaque spots on the cell walls will be investigated by microprobe analysis to determine whether they are metal concentrations.

(2) The Carbon isotope ratios of Archaean sediments

Within the Onverwacht Group, low in the Archaean sequence of South Africa, there is a discontinuity (12 parts per thousand) in the δC^{13} values of the sediments. Sediments above a marker horizon have δC^{13} values normal for organic matter preserved in sedimentary rocks (δC^{13} = -29%) while those below are enriched in the heavier isotope (δC^{13} = -17%). This discontinuity could be due to a geological event altering the distribution of carbon isotopes in the carbon reservoir, or it could mark the beginning of a biological fractionating process (such as photosynthesis). Archaean sediments of Western Australia will now be studied to try to determine whether the discontinuity reflects a world-wide event. If so it may provide a basis for correlating Archaean sequences.

11.20 a.m. Dr. Malcolm Walter

Stromatolites and the location of ore bodies

The occurrence of orebodies in reefs was discussed with reference to the Devonian Pine Point Deposit of Canada. Here metals were dissolved out of shales in the back reef facies and precipitated within the reef. The important factors appear to have been the organic content and permeability of the reef.

The nature of stromatolites was briefly described, using modern examples from the Coorong and Shark Bay.

An example of a Precambrian stromatolitic reef occurs in the Athapuscow Aulacogen, Canada; it is a wide carbonate platform with well developed fore-reef breccias at its margin, where it intertongues with basinal turbidites. The stromatolites are cut by tidal channels perpendicular to the reef edge.

Although there is no mineralization in this reef, there are mineralized stromatolite reefs in Zambia.

The uses of stromatolites were summarized. Since they are limited to the photic zone, they indicate depths of water of less than 120 m. Stromatolites of different morphology are useful for intrabasinal rock correlation. They can indicate current directions and the directions of shorelines by their elongation. Asymmetric stromatolites lean towards the sediment supply. Certain stromatolites with high growth relief (e.g. large *Conophyton*) must have grown subtidally.

An example of a copper-mineralized stromatolite bed was illustrated.

The relation of phosphorite to stromatolites in India was pointed out, especially since one species of the blue-green alga *Nostoc* is known to concentrate phosphate. It was suggested that stromatolites be routinely analysed for phosphate.

W. V. Preiss

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