DEPARTMENT OF
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1979/39

GEORGINA RESEARCH

March Quarter 1979

Compiled by

J.H. Shergold, Project Coordinator.

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Preface

Georgina Research is a quarterly compilation of comments made by staff of BMR and other organisations on the progress of their research. Any worker from any organisation who works on BMR Georgina Basin Project materials is welcome to contribute to future issues of Georgina Research. At the present time, nineteen staff from BMR, three from the Geological Survey of Queensland, three from CSIRO Mineral Research Laboratories, and fourteen from other government and university departments are working on BMR Georgina Basin material.

This issue of Georgina Research contains contributions from P.E. Balfe (GSQ), J.P. Cull (BMR), J.J. Draper (GSQ), E.C. Druce (Trade and Resources), D.M. Finlayson (BMR), D. Gibson (BMR), P.M. Green (GSQ), P.L. Harrison (BMR), K. Jackson (BMR), P.J. Jones (BMR), J.M. Kennard (BMR), P.D. Kruse (University of Sydney), S.P. Mathur (BMR), M.D. Muir (BMR), B.M. Radke (BMR), J.H. Shergold (BMR), C.J. Simpson (BMR), P.N. Southgate (ANU), M.R. Walter (BMR), R.W.T. Wilkins (CSIRO, MRL), J. Williams (BMR), and G.C. Young (BMR).

25th April 1979

1. Sedimentology

J.M. Kennard (BMR) completed a petrologic and petrographic analysis of the Arrinthrunga Formation, an upper Cambrian epeiric carbonate formation which has a maximum observed thickness of 900 m in the Huckitta area. The formation consists of thrombolitic and variously laminated cryptalgal carbonate, ooid and peloid carbonate, lime mudstone, flat-pebble conglomerate, mixed carbonate-siliciclastic rocks, and siliciclastic sandstones. These rocks aggregate into eight distinct lithofacies: 1, very fine grainstone and mudstone lithofacies; 2, algal mound lithofacies; 3, mixed ooid-quartz sandstone lithofacies; 4, Eurowie Sandstone lithofacies; 5, algal laminate lithofacies; 6, ooid dolomite lithofacies; 7, peloid grainstone lithofacies; and 8, peloid lime mud lithofacies. A shoaling epeiric depositional environment is considered indicated by limited development of tidal features and the development of high salinities, as indicated by the occurrence of evaporitic minerals, the widespread preservation of algal mats, and general paucity and reduced diversity of fauna.

P.N. Southgate (ANU, RSES) has examined core from one of five holes drilled by Utah Development Co. in the vicinity of Totts Creek, Undilla area, in 1971. This material, stored at Redbank by the Geological Survey of Queensland, indicates several important stratigraphic features. Vuggy to cavernous recrystallised dolomite (Camooweal Dolomite lithology) extended to a depth of 110 m in Utah Development DDH No. 1, below which two-tone mottled limestone similar to surface outcrop of Mail Change Limestone dominates. This lithology interbeds with wavy laminate limestone at depth. The hole bottomed at 220 m in wavy laminate limestone which is similar to surface outcrops of V-Creek Limestone. In this hole chert was found only in near surface horizons.

J.J. Draper (GSQ) reserved the term Ethbuka Beds as a stratigraphic name, and prepared a definition for submission to the Queensland Stratigraphic Nomenclature Subcommittee. It is intended to publish a brief paper on the Ethabuka Beds in the Queensland Government Mining Journal.

The occurrence of hydrocarbons in the Ninmaroo Formation, and the thermal history of that formation, is being evaluated by B.M. Radke (BMR). Carbonates of the Ninmaroo Formation comprise dolostones, and both bituminous and non-bituminous limestones. In a breached dome structure at Mount Unbunmaroo in the Burke River Structural Belt, residues of hydrocarbons are still present as bitumens which infill interparticle pores in an otherwise light-coloured limestone. This occurrence indicates that prior to erosion of the dome liquid hydrocarbons were present in the permeable strata of the sequence. Source rock studies of adjacent fine-grained, bituminous limestones by D. McKirdy in 1976 indicated traces of hydrocarbons that are only formed at oil maturation temperatures.

A recent assessment of thermal history of Ninmaroo carbonates was made by R.S. Nicoll, who used conodont colour alteration as the determinative parameter. Two sections were studied, one on the Toomba Fault margin of the Toko Syncline, and the other from a dome structure at Mount Ninmaroo in the Burke River Structural Belt. CAI determinations indicated temperatures of 60 to 140^{o}C in the Toomba Fault region, and slightly lower temperatures of 50-90^{o}C at the Mount Ninmaroo section.

Both studies indicate a moderate thermal history for the Ninmaroo Formation in the two tectonised areas of its regional distribution. Consequently, it is concluded that hydrocarbons migrated through the Ninmaroo Formation and were trapped in dome structures, but there is no evidence to indicate that there has been subsequent 'overcooking' of these hydrocarbons.

2. Palaeontology

I.N. Krylov (Geological Institute, Moscow) returned to Australia during the March quarter and resumed research on Georgina Basin stromatolites. A distinctive columnar branching stromatolite was described from erratics in the Yardida Tillite. This is unlike known stromatolites from surrounding regions, which were also studied. The Yardida stromatolite will be described in a paper on the Carpentarian stromatolites of the MacArthur Basin and Lawn Hill Platform (M.R. Walter, BMR).

An assemblage of organic-walled microfossils was extracted from a sample of Adam Shale at 63.5 m in BMR Hay River DDH 11B by M.D. Muir (BMR). It contains numerous filaments, plus an assemblage of spheroidal acritarchs which could be assigned an Early Cambrian age.

The archaeocyathan fauna, which occurs in the upper part of the Mount Baldwin Formation in the Huckitta area, is also present in the Red Heart Dolomite in BMR Hay River DDH 11A and 11B, and in the Todd River Dolomite of the northeastern Amadeus Basin. The fauna provides an approximate correlation datum for these units, being Atdabanian to early Lenian in age (middle to late Early Cambrian on the Siberian biostratigraphic scale, late Early to early Mid Cambrian on the Australian scale.). Several elements of this archaeocyathan fauna are known additionally from the Adelaide 'Geosyncline' (P.D. Kruse, Univ. Sydney).

J.H. Shergold (BMR) has obtained a phosphatised shell/tube fauna from the Red Heart Dolomite in BMR Hay River DDH 11B at intersections 54.70-55.00 and 58.60-58.80 m from surface. This fauna contains a tommotiid (aff. Camenella Missarzhevsky), an inarticulate brachiopod, Anabarites sp., Chancelloria sp., an indeterminate hyolithid fragment and sundry problematical items.

Shergold, P.J. Jones (BMR) and K. MacKenzie (Riverina CAE, Wagga Wagga) have also examined phosphatic residues from the Monastery Creek Member of the Beetle Creek Formation in the Duchess area, which contain various bradoriid crustacea, trilobites, various inarticulate brachiopods, molluscs (Mellopegma, monoplacophoran, Protowenella?), hyolithids, chancelloriids and a form similar to Pleodiaria, miscellaneous forms like Hertzina, Coleoides, and problematica.

E.C. Druce (Dept Trade & Resources) has completed an analysis of conodont faunas of the Coolibah Formation which comprises a mixture of species known from the Baltic area (North Atlantic fauna), from North America (Midcontinent fauna) and from South America (Juanagnathus fauna), as well as a large number (over a third of the fauna) of apparently endemic forms. Form species such as Multicornus anonymus Moskalenko, previously only known from the Siberian Platform, USSR, are also present. About half the species and a considerable majority of the specimens are hyaline and some samples contain elements which appear to be albid precursors of hyaline forms or hyaline successors to albid forms.

Within the Coolibah Formation three distinct faunal assemblages are present: the earliest one can be equated with Fauna 4 of the uppermost Kelly Creek Formation, with the presence of Acodus deltatus Lindstrom, Chosondonina cf. C(?) lunata Harris & Harris, n. gen. A and sp., Scandodus costatus Abaimova, and Triangulodus brevibasis (Sergeeva). This is succeeded by Fauna 5, characterised by the presence of protoprioniodids (all illustrated but not named from both Europe and North America) as well as Oistodus multicorrugatus Harris, Belodella jemtlandica Lofgren, Juanagnathus n. sp. and Paroistodus n. sp. A.

The uppermost beds of the Coolibah Formation have yielded a distinctive fauna (Fauna 6) which includes n. gen. B. n. sp. A, Multicornus anonymus Moskalenko, and an indeterminate genus and species, assemblage A. Most of the species in Fauna 5 do not occur in Fauna 6, but they do reappear in faunas from the overlying Nora Formation and thus Fauna 6 may represent a change in environment and the introduction of a laterally contiguous and environmentally restricted fauna rather than a universal successor fauna.

G.C. Young (BMR) continued preparation of Devonian fish from the base of the Dulcie Sandstone (Huckitta area). This fauna contains acanthodians, euarthrodires and Wuttagoonaspis, and is apparently the same as that occurring in the Cravens Peak Beds.

3. 1:100 000 Scale maps

The Adam Special 1:100 000 Geological Series Sheet was published during the March quarter (M.R. Walter, BMR).

C.J. Simpson and B.M. Radke (BMR) added corrections and completed reappraisal of geological problems on the Toko 1:100 000 Sheet. Throughout that part of the Toko Syncline contained within the Toko Sheet area several rather regularly spaced northeast-trending cross-faults, all downthrown to the south, have been mapped. Some small occurrences originally thought to be Cravens Peak Beds have been reinterpreted as Tertiary fluviatile drainage deposits associated with fault scarps. A new Tertiary unit has been delineated. The partly silicified formation is in places preserved in remnants of a fossil drainage channel which closely approximates the position of the Toko Syncline fold axis.

The geology of the Mount Whelan 1:100 000 Sheet area has been compiled and currently is awaiting checking (P.M. Green, GSQ).

4. GSQ drilling

For a synthesis of results from the GSQ drilling program in the Mount Whelan 1:250 000 Sheet area, a draft has been completed by P.M. Green and P.E. Balfe (GSQ), and preliminary editing is currently in progress. During the latter stages of these investigations, wireline log correlations of the GSQ stratigraphic holes with AOD Ethabuka No. 1 and PAP Netting Fence No. 1 were completed. This study indicated a need for revision of earlier stratigraphic assessment of the Kelly Creek Formation-Ninmaroo Formation section in GSQ Mount Whelan No. 2. The Kelly Creek Formation has been extended downward at the expense of the Ninmaroo Formation, and presently interpreted as consisting of three units: a lower unit of sandy limestone and limestone, a middle dolostone unit, and an upper arenaceous unit. The lower and middle units were previously included in the Ninmaroo Formation (P.M. Green, P.E. Balfe, GSQ).

5. Geochemistry

D. Gibson (BMR) reports that only 44 cm of good quality oil shale occurs in the whole 250 m of BMR Mount Isa No. 1. Samples have been sent to the Australian Coal Industry Research Laboratories for Fisher Analysis.

Geochemical analyses on samples from GSQ Mount Whelan No. 1 gave the following interesting results: anomalous Pb (1100 ppm), Zn (780 ppm) and Ba (2600 ppm) in Thorntonia Limestone equivalents; and high Ba (1200-7300 ppm) in the lower 150 m of Georgina Limestone (J.J. Draper, GSQ).

K. Jackson (BMR) is continuing total organic carbon analysis on GSQ Mount Whelan Nos 1 and 2 samples, and these, together with samples from Hay River coreholes, have been submitted to AMDEL for vitrinite reflectance studies. Three samples analyses for TOC from the tillitic sequence in BMR Hay River No. 10 gave values between 0.31-0.90% C in whole rock.

R.W.T. Wilkins (CSIRO, MRL) has completed more work on fluid-inclusion homogenisation temperatures in quartz crystals derived from the Red Heart Dolomite in the Desert Syncline, Hay River area. Twenty-one homogenisation temperatures between 174-225°C were obtained from aqueous inclusions apparently in immiscibility relationship with hydrocarbon gas. A realistic minimum temperature for the growth of the crystal sampled is 250°C, with a suitable correction for pressure at the time of trapping to be added. The 174°C temperature likewise came from a primary inclusion, so that even during growth there were fluctuations in temperature of the growth medium. Organic material in the co-existing hydrocarbon inclusion softens or melts at higher temperatures, but these may be degradation products.

The 250°C temperature is too high for formation waters with no heat source other than the normal geothermal gradient. Thrity-eight new salinity determinations on the aqueous fluids in the analysed sample range between 7.8-9.2 wt % NaCl equivalent. There is no need to postulate an igneous source for this solution, though it could have been mobilised by an intrusive body.

6. Geophysics

A crustal survey of the Georgina Basin has been scheduled for August 1979, when it is planned to record shots from Tennant Creek and Mount Isa, and complete a reconnaissance traverse between the two localities (D. Finlayson, J. Williams, BMR).

P.L. Harrison (BMR) and S.P. Mathur (BMR) have reinterpreted gravity models along lines of section through the Georgina Basin recently analysed by Tucker et al. (Georgina Research, September and December 1978 Quarters). The following results have been obtained: 1, Palaeozoic strata are less than 500 m thick over the northern half of the basin, but in the south there are three separate thicker accumulations - the Toko Syncline (up to 5000 m), the Burke River Structural Belt (1000 m), and Dulcie Syncline (1000 m); 2, the distribution of Adelaidean strata is more complex, with eight separate depressions containing over 1000 m of rocks, four containing 6000 m or more, with the greatest thickness (10 000 m) in the Toko Syncline. Although Adelaidean rocks have been intersected in drillholes, the values

quoted here for thickness are based on gravity modelling. The densities used in modelling Adelaidean sediments was the same as for granite (2.70 g/cm^3), compared to 2.80-2.85 g/cm^3 for basement. Some gravity lows may be explained either as sediment or granite.

P.L. Harrison (BMR) has completed seismic and gravity modelling along seven traverses across the western margin of the Toko Syncline and the Toomba Fault. To obtain a close fit between calculated and observed gravity profiles, it appears that several kilometres of Adelaidean strata must underlie Palaeozoic sediments on the western margin of the Syncline. Two traverses indicate up to 2 km of strata west of the Toomba Fault. On three traverses over this fault shallow reflection and refraction data indicate a near-surface wedge of low velocity (2000 m/sec) rocks up to 200 m thick near the Toomba Fault. Inclusion of this wedge as a low-density layer in the models has improved the fit of the observed gravity. The low velocity of these rocks suggests they may be Cretaceous or Tertiary sediments deposited during rejuvenation of the Toomba and related faults.

J.P. Cull (BMR) has started heat flow measurements on core from GSQ Mount Whelan No. 1. Thermal gradients measured in shallow boreholes depend primarily on the thermal conductivity of the rocks encountered at each depth. However, heat flow remains constant and if values can be determined from near surface data it is possible to make estimates of temperature at greater depths while allowing for changes in thermal conductivity. These data may provide major constraints in formulating thermo-tectonic models of basin formation. Accurate thermal histories are also required in assessing levels of hydrocarbon maturation. Furthermore regions of high heat flow may contain significant geothermal resources of low enthalpy.

Thermal conductivities have been measured on 13 cores from GSQ Mt Whelan No. 1: nine of these were basement samples which will be analysed for U, K, and Th content for later estimates of heat production. Values of 1.81, 3.18, 3.12, 6.19, and 3.63 $Wm^{-1}K^{-1}$ were obtained for thermal conductivity at depths of 433.7, 439.3, 441.7, 462.1 m, and basement (610 m) respectively. The thermal gradient varies in the range 20-35.0^{o}C/km, indicating a heat flow of about 105 mW m^{-2} - consistent with regional trends but exceeding the world average (62 mW m^{-2}). Further cores in the interval 200-400 m are required to confirm this preliminary determination.

7. Publications

The following papers were published during the Quarter.

1. BUREK, P., WALTER, M.R., WELLS, A.T., 1979 - Magnetostratigraphic tests of lithostratigraphic correlations of late Proterozoic rocks in central Australia. BMR Journal of Australian Geology and Geophysics, 4(1): 47-55.

2. COOK, P.J., & SHERGOLD, J.H. (Eds), 1979 - Proterozoic and Cambrian Phosphorites. 106 p., ANU Press, Canberra.

3. DRUCE, E.C., & SHERGOLD, J.H., 1978 - Annotated bibliography of the Georgina Basin. Report Bureau of Mineral Resources, Geology and Geophysics of Australia, 211, BMR Microform MF77.

4. HARRISON, P.L., 1979 - Recent seismic studies upgrade the petroleum prospects of the Toko Syncline. APEA Journal, 19(1): 30-45.

The following papers have been prepared or are in press as of 31 March 1979:

1. DRAPER, J.J. Rusophycus (early Ordovician ichnofossil) from the Mithaka Formation, Georgina Basin. BMR Journal of Australian Geology and Geophysics.

2. GREEN, P.M. A review of exploration in the Boulia 1:250 000 Sheet area. Queensland Mining Journal.

3. KRUSE, P.D., & WEST, P.W. Early Cambrian Archaeocyatha of the Amadeus and Georgina Basins - an interbasin connection. BMR Journal of Australian Geology and Geophysics.

4. SHERGOLD, J.H. Late Cambrian trilobites of the Chatsworth Limestone, western Queensland. Bulletin Bureau of Mineral Resources, Geology and Geophysics of Australia, 186.

5. SHERGOLD, J.H., & DRUCE, E.C. (in press) Upper Proterozoic and Lower Palaeozoic rocks of the Georgina Basin. In STEPHENSON, P.J., & HENDERSON, R.A. (Eds) Geology of northeastern Australia. Proceedings 3rd Australian Geological Convention, Townsville.

6. SHERGOLD, J.H., & WALTER, M.R. Stratigraphic drilling in the Georgina Basin, 1977-78. Record Bureau of Mineral Resources, Geology and Geophysics of Australia, 1979/36.

7. WALTER, M.R. Adelaidean and Early Cambrian stratigraphy of the south-western Georgina Basin: correlation chart and accompanying notes. Report Bureau of Mineral Resources, Geology and Geophysics of Australia, 214, BMR Microform 92.

8. WALTER, M.R., KRYLOV, I., & PREISS, W.V., Adelaidean (late Proterozoic) stromatolites from central and South Australia. Alcheringa.

9. WALTER, M.R., SHERGOLD, J.H., MUIR, M.D., & KRUSE, P.D. Early Cambrian and latest Proterozoic stratigraphy, Desert Syncline, southern Georgina Basin. BMR Journal of Australian Geology and Geophysics.