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RECORD 1979/53

GEORGINA RESEARCH

June Quarter 1979

Compiled by

J.H. Shergold
Project Co-ordinator

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Preface:

This issue of Georgina Research is somewhat abbreviated by the depletion off Project Staff - J.M. Kennard has resigned from BMR, and M.R. Walter is visiting the Department of Earth and Space Sciences, University of California, Los Angeles for twelve months.

Georgina Research, June Quarter, contains contributions from B.M. Radke, P.J. Jones, J.H. Shergold, M. Idnurm, & D. Gibson (of BMR), N. Russell (CSIRO Fuel Geoscience Unit), P.M. Green (QGS), M.W. Sandstrom (ANU, RSES), E.C. Druce (Dept. Trade & Resources), and K. McKenzie (Riverina CAE, Wagga Wagga).

6 August 1979

1. Sedimentology

B.M. Radke has prepared manuscripts on the lithostratigraphy of the Ninmaroo Formation; and on the formation and occurrence of saddle dolomite. Six lithofacies are recognised in the Ninmaroo Formation, in general stratigraphic sequence as follows: ooid carbonate lithofacies, peloid carbonate lithofacies, flat-pebble conglomerate carbonate lithofacies, skeletal carbonate lithofacies, and a terrigenous lithofacies. A crystalline dolostone lithofacies is differentiated where primary features of the carbonate lithofacies have been obliterated by late diagenetic dolomitisation. Its relationship to other lithofacies may be conformable, interfingering, or cross-cutting along fault zones. The general sequence is diachronous, younging eastwards from north of the Toko Syncline to the southern Burke River Structural Belt.

Saddle dolomite is a variety of dolomite characterised by curved crystal faaes and cleavage, and sweeping extinction in cross-polarised light. The mineral occurs extensively in the Ninmaroo Formation in replacement dolostones that are structurally controlled, as well as a void-filling cement in veins and fault breccias. It is a late diagenetic phase with potential economic significance because of its recurring associations with base-metal mineralization. Pyrite, sphalerite, galena or fluorite are commonly associated as void-filling phases in breccias, vugs and stratiform cavities. Association with base-metal deposits has previously been reported from the Devonian Presqu'ile Dolomite at Pine Point, Canada; Carboniferous St Genevieve Formation, Illinois, and Triassic carbonates from Piedmont, Italy.

P.M. Green has developed a revised opinion of the depositional environment of the Georgina Limestone, which previous studies had suggested was deposited in shallow subtidal, intertidal and supratidal conditions. However, the presence of megaclasts (> 30 m thick) of algal reefal material suggests two possible depositional histories: part of the unit may have formed in high-energy conditions; thus the megaclasts could be forming a fore-reef breccia. Alternatively, the megaclasts may have been derived from another source and then deposited as a debris flow, suggesting that the Georgina Limestone or permit, may have been deposited in relatively deep water.

2. Palaeontology

Following notice of the composition of the conodont faunas of the Lower Ordovician Coolibah Formation (see Georgina Research, March Quarter), E.C. Druce has submitted the following information on the correlation of these assemblages which do allow some precision in correlation both with the Baltic Lower Ordovician and the platform sequences of North America.

The Coolibah Formation has yielded typical Arenig forms including Acodus deltatus Lindstrom, Protopanderodus rectus (Lindstrom) (which can extend into the Llanvirnian), Scolopodus rex Lindstrom, and Triangulodus brevibasis (Sergeeva), and also a very questionable Oepikodus evae communis (Ethington). These species suggest a correlation with an interval between the Protopanderodus rectus/Oelandodus costatus and Prioniodus crassulus Assemblage-Zones in Oland, Sweden, corresponding perhaps to the uppermost part of Lindstrom's Prioniodus elegans Zone and his overlying Prioniodus evae Zone - essentially the latest Latorpian (B1) of Sweden. The only anomaly is the occurrence of T. brevibasis which, in Sweden, has a first occurrence in the younger Volkhovian (B11), and thus the Coolibah Formation may straddle the Latorpian/Volkhovian boundary. Some support for this correlation is evident when the faunas of the Coolibah Formation and the San Juan Limestone of Argentina are compared: the earliest faunas of the Coolibah Formation are comparable to local Assemblage-Zone B of Serpagli (1974) (with the presence of Scolopodus rex, and the more questionable Prioniodus evae communis, Scandodus robustus Serpagli Protopanderodus leonardii Serpagli), whereas the younger faunas are comparable to his local Assemblage-Zone C (with the presence of Oistodus multicorrugatus Harris and a possible reutterodid). Serpagli correlated his zone B with the Baltic Prioniodus evae Zone and his zone C with the overlying Baltic zones of Baltoniodus navis and Baltoniodus triangularis, thus encompassing the latest Latorpian and earliest Volkhovian.

The faunas of the Coolibah Formation correlate with Fauna E of the North American cratonic sequence (Ethington & Clark, 1971), having yielded typical El Paso and Ninemile Formation conodonts. Fauna E appears to overlap in time Fauna 1 of Sweet, Ethington & Barnes (1971), and the Coolibah contains typical elements of Fauna 1, including Protopanderodus aff. P. asymmetricus Barnes & Poplawski, Protoprioniodus n. sp. and Oistodus multicorrugatus Harris. According to Sweet and others (1971), the Canadian/Whiterock boundary (traditionally the Lower/Middle Ordovician boundary) falls within the interval characterised by Fauna 1.

P.J. Jones and K.G. McKenzie have completed a short paper on 'Partially preserved soft anatomy of a Middle Cambrian bradoriid (Ostracoda) from Queensland', which has implications as to the origins of the Crustacea.

J.H. Shergold has completed a manuscript in which twenty-four genera and forty-one species or subspecies of trilobites are described from collections of Pomegranate Limestone on the southern part of the Duchess 1:250 000 Geological Series Sheet area, central portion of the Burke River Structural Belt, western Queensland. Three genera, Chalfontia, Mecophrys and Winsteria, are new, and four are left under open nomenclature. Of the forty-one specific taxa, six are new: Kormagnostella inventa, Pseudagnostus idalis sagittus, Protemnites burkensis, Mecophrys mecophrys, Mecophrys selenis and Winsteria nepotina. Fifteen species are left in informal nomenclature. Additions and revisions are made to earlier published taxa by Whitehouse, Opik and Henderson. In particular, the genus Protemnites is revived.

Material from Idamean localities collected during 1967, 1969 and 1974 is described, and permits a more rigorous assessment of the biostratigraphy than was hitherto possible. The zonation proposed by Henderson (1976) for Glenormiston sequences can be applied in the Burke River Structural Belt, but the Erixanium sentum Assemblage-Zone can only be differentiated from the earlier Proceratopyge cryptica and later Stigmatoa diloma assemblages with difficulty. It is recommended that the incoming of the Irvingella tropica Assemblage-Zone be regarded as introducing a younger biochronological stage than the Idamean, which has been informally designated previously as the post-Idamean/pre-Payntonian interval.

3. Geochemistry

N. Russell has recognised a number of kerogen types in BMR Hay River corehole and PAP Netting Fence No. 1 samples. These include the following: rounded kerogen particles, kerogen partings, porous kerogen, interstitial kerogen ("pyrobitumen"), and undifferentiated types.

1. The rounded kerogen particles are 40-100 um in diameter; the margins of these particles are plicated, or exhibit irregular embayments, which may represent an original surface texture or the result of corrosion. Many of the rounded kerogen particles contain fine-grained mineral matter. A scanning electron microscope/energy dispersie system study of the mineral matter indicates that radioactive elements (thorium and/or uranium) are present in those kerogen particles that exhibit a higher reflectivity core. The increase in reflectivity is ascribed to radiation damage caused by these radioactive elements. Apart from an increase in reflectivity, the radiation damaged organic matter also exhibits weak pleochroism and moderately strong anisotropy.

The rounded kerogen bodies are assumed to represent algal bodies or acritarchs. This rounded dispersed organic matter is sporópollenin, or a sporopollenin precursor, i.e. a "liptinitic" kerogen. Reflectivity values (R_o average) of 0.50 to 0.75% were recorded for the low reflectivity margins of the rounded kerogen particles in the core sample from 6414 feet (1954.9 metres) in the Netting Fence No.1 borehole. A reflectivity value of 0.48% was recorded for the low reflectivity margin of a rounded kerogen particle in the core sample from 6420 feet (1956.8 metres) in the same borehole. If it is assumed that the lower reflectivity margins of the rounded kerogen particles have suffered no, or minimal, radiation damage, then the sporopollenin in these rocks has a R_o average value of 0.5-0.6%.

2. The kerogen "partings" exhibit relatively high relectivities and a moderately strong anisotropy; they exhibit the general characteristics of an "anthracitic" vitrinite or semifusinite (low reflectivity inertinite). The best examples of the kerogen "partings" were observed in BMR 74715794; these

"partings" exhibit R_o average values of about 2%. In general, a vitrinite reflectivity of about 2% is thought to be equivalent to a temperature of 220 °C, i.e. the middle of the zeolite facies temperature range.

The origin of the kerogen "partings" is uncertain. The absence of lignin, or lignin precursors, in Lower Palaeozoic rocks does not preclude the formation of a "vitrinitic" type of kerogen, since the latter may be derived from chitinous material, e.g. graptolite sheaths, etc. Alternatively, the kerogen "partings" could represent altered (oxidized or biochemically altered) sporopollenin, i.e. an "inertinitic" kerogen.

3. BMR 74715795 was observed to contain a number of irregular flakes of kerogen with a "mottled", porous texture. This kerogen exhibits a wide range of R_o average values, i.e. 1.0-2.5%. Clear, non-porous projections are observed on some of the irregular flakes. These projections have a R_o average value of 1.0-1.3%, which may represent a more meaningful value for reflectivity vis a vis maximum palaeo-temperature estimates.

4. Interstitial kerogen ("pyrobitumen") is observed in the core sample from 6414 feet (1954.9 metres) in the Netting Fence No. 1 borehole and BMR 74715794 and BMR 74715795. The interstitial kerogen exhibits a "micaceous" aspect and it is usually intergrown with euhedral/subhedral mineral grains (carbonate and/or quartz). This type of kerogen exhibits R_o average values in the 1.80-2.30% range. The interstitial kerogen yields similar reflectivity values to those obtained for the kerogen "partings" occurring in the same rock.

5. An example of "graphitic" carbonaceous material (R_o average = 2.73-4.4%) was observed in the core sample from 6414 feet (1954.9 metres) in the Netting Fence 1 borehole. Taken in isolation this kerogen type would suggest greenschist facies conditions; however, it occurs in a rock containing kerogen particles with very low reflectivity values.

A narrow selvage of kerogen (R_o average = 1.01-1.48%) is observed to surround an admixture of kerogen and mineral matter in BMR 74715795. SEM/EDS study of the mineral matter indicates that it is a form of calcium phosphate. This body may represent a partially flattened sporomorph.

M.W. Sandstrom has completed additional elemental analyses on phosphorites and shales from BMR Duchess 14. Organic carbon values measured to date range from 2.5 to 4.8% for the Inca shale, and 0.2 to 1.2% for the Monastery Creek Phosphorite Member of the Beetle Creek Formation. Phosphorous is less than 0.5% in the Inca Shale, but ranges between 14 and 34% in the Beetle Creek phosphorites. For comparison, two outcrop samples of the Beetle Creek phosphorites give 0.12-0.25% total carbon and 0.014-0.016% organic carbon, illustrating a reduction in organic carbon by a factor of about 100 as a result of surficial weathering.

Table 1. Organic geochemical analyses of sediments from BMR Duchess 14 Drillhole

SAMPLE	DEPTH (m)	FORMATION	ORGANIC CARBON (%)	TOTAL EXTRACT[1] ugm/gm	mg/gCorg[2]	SAT-URATE[1] F1	AROM-ATIC[1] F2	F1/F2
74715671	79.1	INCA	2.82	2006.7	71.2	360	139.2	2.59
74715672	82.5	BEETLE CK	1.16	83.2	7.2	14.1	16.5	0.85
74715673	82.9	"	0.22	19.2	8.6	1.0	1.3	0.72

1. ugm/gm sediment, dry wt. 2. total extract, mg/g organic carbon

Preliminary organic geochemical analyses of samples from Duchess 14 are listed in Table 1. The relatively high amount of extractable organic material in the sample from Inca Shale is similar to values reported for the Phosphoria Black Shale (Wyoming, USA) and illustrates the potential source rock characteristics of this unit. The phosphatic sediments are generally lower in extractable organic material, but are characterised by higher amounts of aromatic relative to saturated hydrocarbons, which probably reflects different source and/or diagenetic histories of the phosphatic and shale units. Further detailed characterisation of the organic material in these samples is continuing.

D. Gibson has arranged for several samples of core from BMR Mount Isa No. 1 to be analysed for oil yield by Fischer Analysis (pyrolysis) by the Australian Coal Industry Research Laboratory at Rockhampton, and for source rock analysis by Robertson Research. Only preliminary figures for source rock analysis are available to date.

Results received so far are:

Sample number	Sample depth (m)	A	B	C	D	E	F	G	H
1	53.78-.83	4(0.6)	0.85	679	35	41	-	-	-
2	55.83-.87	4(0.125)	-	-	-	-	-	-	-
3	100.38-.41	75(7.6)	-	-	-	-	-	-	-
4	107.56-.63	104(9.2)	16.28	8278	395	76	429°	703	114	500
5	117.43-.49	81(7.5)	-	-	-	-	-	-	-
6	119.41-.49	100(9.8)	16.60	6645	810	25	432°	592	93	500
7	138.53-.59	21(2.0)	4.57	2596	615	19	432°	797	36	400
8	138.60-.64	5(0.2)	-	-	-	-	-	-	-
9	188.37-.45	56(5.5)	8.99	4413	1030	37	430°	703	63	200
10	188.58-.61	41(3.4)	-	-	-	-	-	-	-
11	250 (approx)	-	3.26	1275	60	28	429°	739	24	100

A. Measured oil yield by Fischer Assay in litres/tonne (and mass % oil)

B. Total organic carbon %

C. Total extract ppm

D. Hydrocarbons ppm

E. Alkanes % hydrocarbon

F. Temperature of maximum rate of pyrolysis

G. Hydrogen index

H. Potential yield ppm

Samples 1, 2, 7, 8, 11 are laminated limestone/dolomite and organic rich shale; samples 3, 4, 5, 6 are massive oil shale; and samples 9, 10 are brown-stained carbonates.

Sample 9 has a production index of 0.1; and samples 4, 6, 7, 9, 11 are excellent oil source rocks at a higher level of maturity. These results show that the petroleum source rock potential in this part of the Georgina Basin sequence is high. The oil shale units are thin in this hole but are thought to be much thicker elsewhere in the basin.

4. Palaeomagnetism

M. Idnurm reports that twenty one specimens from the 1977 tillite sampling, representing approximately 10% of the total number of specimens, have been demagnetised in detail, to determine the general magnetic characteristics of the material, and what demagnetisation treatments, etc., are required to obtain meaningful results. This pilot study has shown that: material from Central Mount Stewart and Mount Cornish has a strong and generally stable remanence, whereas the material from the Field River Beds is magnetically weak and generally unstable; the measurements group around a shallow easterly direction which is consistent with measurements reported from the Areyonga Formation of the Amadeus Basin and from the Tapley Hill Formation and Merinjina Tillite of the Adelaide Geosyncline; the scatter of the stable directions is greater than normally encountered in palaeomagnetic work, and at this stage the directions of the three tillite groupings are statistically indistinguishable from one another.

Whether tillites of different ages can be distinguished palaeomagnetically or not depends on: the difference in the respective ages; the inherent scatter in the remanence directions; and the number of samples available (the greater this number, the smaller the error circle). From the results of the pilot study, we expect the 95% confidence circles of the Central Mount Stewart and Mount Cornish tillites to be less than 20^{o} after all the specimens have been measured. Assuming a pole drift of 0.3 degrees per million years, we would therefore expect the resolution to be approx. 60 m.y. The 95% confidence circle for the Field River Beds is however expected to be considerably larger than 20^{o}, and the present sampling would certainly have to be augmented to give a reasonable resolution. Resumption of measurements on the Georgina Basin tillites is planned for the second half of 1979.

5. Maps

Toko 1:100 000 has been drawn and reduced by BMR Drafting Office. Abudda Lakes 1:100 000 has been compiled and submitted for drafting (J.H. Shergold). The Mount Whelan 1:100 000 preliminary sheet is in an advanced state of preparation by GSQ (P.M. Green, GSQ).

6. Publications

No papers were published during the June Quarter but the following have been prepared or are in press at 30 June 1979:

DRAPER, J.J. (in press) Rusophycus (early Ordovician) ichnofossil from the Mithaka Formation, Georgina Basin. BMR Journal of Australian Geology and Geophysics, 4(4).

GREEN, P.M. Mineral exploration in the Boulia 1:250 000 Sheet area. Queensland Government Mining Journal.

GREEN, P.M., & BALFE, P.E. Stratigraphic drilling in the Mount Whelan 1:250 000 Sheet area, 1977. Queensland Government Mining Journal.

KENNARD, J.M. The Arrinthrunga Formation, Upper Cambrian epeiric carbonates in the Georgina Basin, central Australia. Bureau of Mineral Resources Geology and Geophysics of Australia, Bulletin.

McKENZIE, K.G., & JONES, P.J. Partially preserved soft anatomy of a Middle Cambrian bradoriid (Ostracoda) from Queensland. Search.

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

SHERGOLD, J.H., & DRUCE, E.C. Upper Proterozoic and Lower Palaeozoic rocks of the Georgina Basin. IN STEPHENSON, P.J., & HENDERSON, R.A. (Eds) Geology of northeastern Australia. Proc. 3rd Aust. geol. Convn, Townsville, 1978.

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

TUCKER, D.H., WYATT, B., DRUCE, E.C., MATHUR, S., & HARRISON, P.L. (in press) The crustal geology of the Georgina Basin. BMR Journal of Australian Geology and Geophysics, 4(3), 209-226.

WALTER, M.R. Adelaidean and Early Cambrian stratigraphy of the southwestern Georgina Basin: correlation chart and accompanying notes. Bureau of Mineral Resources Geology and Geophysics of Australia, Report 214.

WALTER, M.R. Late Proterozoic tillites of the southwestern Georgina Basin, Australia. IN HARLAND, W.B. (Ed.) Pre-Pleistocene tillites of the world.

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

WALTER, M.R., SHERGOLD, J.H., MUIR, M.D., & DRUSE, P.D. (in press) Early Cambrian and latest Proterozoic stratigraphy, Desert Syncline, southern Georgina Basin. BMR Journal of Australian Geology and Geophysics, 4(4).

WYATT, B.W., & TUCKER, D.H. The Georgina Basin: Sixties data, seventies interpretation, for eighties discoveries. Journal of the Society of Australasian Exploration Geophysicists, Abstract.