

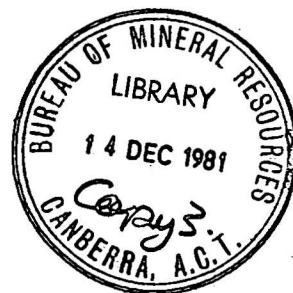
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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

Record 1981/71

GEORGINA RESEARCH

(for the period October 1980
to October 1981)

Compiled by

J.H. Shergold

Project Co-ordinator

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Preface

The following personnel have contributed information to this edition of Georgina Research:

S. Elgueta (ANU, RSES), M.E. Freeman (NTGS), M. Glikson (ANU, Biogeography), A. Hutton (Wollongong University), K.S. Jackson, J. Laurie (NTGS), B.M. Radke, M. Sandstrom (ANU, RSES), M. Schmitt (University of Würzburg), J.H. Shergold, C.J. Simpson, and P.N. Southgate (ANU, RSES).

Because major mapping, and field orientated sedimentological and geophysical projects in the Georgina Basin have been brought to fruition, insufficient new data are available to warrant regular quarterly reports. Accordingly, it is proposed to continue Georgina Research as an irregular newsletter, as and when sufficient information is available for dissemination. A good deal of detailed and time consuming geochemical and palaeontological research, in particular, is continuing in the Basin, and a variety of publications are in press or preparation.

Georgina Research is intended to inform those conducting research in the Basin of recent advances. Contributors are in general those who are working on material obtained through the BMR's Georgina Basin Project. Georgina Research is informal, and is not a publication. Results of research projects quoted in Georgina Research are not generally available, and the approval of individual contributors and/or their organisations must be obtained before such information is used elsewhere.

1. Lithostratigraphy

In the northeastern portion of the Georgina Basin, the uppermost 14 m of Thornton Limestone intersected in BMR Camooweal No. 2 has been logged in detail. Dolomite and dolomitic limestone is the dominant rock type. The core is substantially recrystallized and in places vuggy. Glauconite grains occur commonly in the intervals 119.4-125 m and 130-132 m, usually associated with phosphate grains or phosphate-cemented surfaces. Dolomitization and recrystallization are related to initial sediment types: mudstone and wackestone lithologies occur as mottled dolomitic limestones, whereas skeletal grainstone and coquina is generally dolomitized and recrystallized. Vugs, occurring in recrystallized grainstone and coquina layers, are commonly lined with pink saddle dolomite crystals which are associated with pyrite and galena.

In BMR Camooweal No. 2, the Thornton Limestone is overlain by brecciated Inca Formation. Breccia blocks are surrounded by a network of veins filled with pink saddle dolomite. Bedding planes within individual breccia blocks have been enhanced by solution compaction so that grain boundaries are fitted and marked by an anastomosing network of stylolite seams. Within individual blocks these seams are orientated parallel to each other, but between blocks the orientation varies. This suggests that brecciation and saddle dolomite crystal growth occurred after solution and compaction. Some stylolites have an amplitude up to 2 cm. The truncation of these against recrystallized areas of saddle dolomite is further support for a late diagenetic origin for the crystals.

Log of Thornton Limestone in BMR Camooweal No. 2.

118.76 - 119.3 m - Breccia, blocks of mudstone, wackestone, and a phosphatic lag overlie a scalloped disconformity surface; veins of saddle dolomite surround breccia blocks.

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- 119.3 m - Top of the Thornton Limestone; disconformity surface developed on a skeletal, phosphatic, glauconitic grainstone, multiple scalloped dissolution surfaces, crusted and coated grains common.
- 119.3 - 121.1 m - Light grey-pink recrystallized vuggy dolomite and saddle dolomite. Pyrite and galena in vugs associated with saddle dolomite. Original sediment type, skeletal grainstone and coquina, abundant glauconite and phosphate grains, phosphatic pavement at 119.90 m.
- 121 - 125 m - Mottled dolomitic limestone. Dominantly burrowed mudstone, with thin skeletal wackestone and packstone interbeds. Phosphate and glauconite grains in wackestone and packstone interbeds. Hyoliths, inarticulate brachiopods, molluscs and trilobites.
- 125 - 125 m - Cyclic sequence; sharp basal contact, skeletal grainstone and packstone grades up into a phosphatic, glauconitic packstone and wackestone overlain by a non phosphatic burrowed mudstone. Phosphatic pavement at 125.9 m.
- 126 - 130.2 m - Dolomite, light grey-pink, saddle dolomite common in vugs. Originally a skeletal grainstone and coquina, phosphate and glauconite grains. Pyrite common along stylolites and associated with saddle dolomite, rubble between 129.3 and 130.2 m.
- 130.2 - 132.4 m - Dolomite, medium to coarse grained, recrystallized, glauconite and phosphate grains increase in abundance towards phosphatic pavements which occur at 130.3, 131.2 and 132.3 m.

(P.N. Southgate, ANU RSES)

In the same general area, Sara Elgueta (ANU, RSES) has produced a sedimentological study of the western zone of the Lady Annie phosphate district, as an MSc Thesis in the Australian National University. This Thesis is presently sub judice.

On the southern margin of the Georgina Basin, the lower-middle Cambrian stratigraphy of the Marqua-Hay River area is under revision following detailed analysis of BMR Tobermory No. 14 which was sited on the Marqua Monocline (see Gibson in Simpson 1980, Georgina Research, Record 1980/74). A sequence comparable with that of the Hay River coreholes drilled in 1977, was penetrated. A basal clastic sequence (Adam Shale), comprising interbedded purple, green and red shale and sandstone, is conformably overlain by a dolostone unit (Red Heart Dolomite) which contains late Early Cambrian or early Mid-Cambrian archaeocyathids. This sequence is overlain by a predominantly black shale/black carbonate interval (Hay River Formation) which is split into lower and upper parts by a persistent skeletal grainstone layer. Stratigraphic breaks occur below and above this grainstone (see biostratigraphic section of this report). The upper Hay River Formation passes conformably into a predominantly pale carbonate sequence, now referred to the Marqua Formation (revised lithostratigraphic unit). (J.H. Shergold).

2. Biostratigraphy

Analysis of phosphatised faunas in the Undilla-Riversleigh portion of the Georgina Basin, and on the Marqua Monocline, confirm the presence of stratigraphic hiatus of regional magnitude during the Middle Cambrian. The information generated is to be included in a detailed synthesis of the Middle Cambrian of the Basin. Twenty samples from the Middle Cambrian Thornton Limestone and Currant Bush Limestone at localities on the Undilla and Riversleigh 1:100 000 Sheet areas have yielded prolific phosphatised skeletal residues after acid treatment. Additionally, phosphatised stromatolites, referred to Ilicia cf. camposita Sidorov, have been recognised in the Riversleigh area 35 m above the base of the Thornton Limestone. Undetermined stromatolites

also occur at a prominent disconformity surface on top of the Thornton Limestone between Thornton Station and D-Tree-Bore. A variety of inarticulate brachiopods, molluscs, hyoliths, sponges and rare trilobites have been found phosphatised in the Thornton Limestone. The basal Currant Bush Limestone is also phosphatic and has yielded a prolific fauna which includes agnostid trilobites of the Euagnostus opimus Zone. This fauna confirms a time break between the Thornton Limestone and Currant Bush Limestone in the area between "Thornton" and D-Tree, since faunas representative of the Triplagnostus gibbus and Ptychagnostus atavus have not been recovered (P.N. Southgate, J.H. Shergold).

Palaeontological examination of BMR Tobermory 14, drilled in 1980, has been completed, and complements the faunal stratigraphy investigated earlier in the Hay River coreholes. In this hole the Red Heart Dolomite has yielded a poorly preserved phosphatic fauna, including inarticulate brachiopods, hyolithids, molluscs, sponges and a single trilobite fragment not unlike that of the Thornton Limestone. Succeeding black sediments of the lower Hay River Formation, however, contain species of Redlichia, Pagetia, Peronopsis and Xystridura, confirming an Ordian age for this part of the sequence. The supposed Templetonian is represented by a thin brachiopod coquina, as in BMR Hay River 11. The upper Hay River Formation, black shales and thin dark carbonates, has yielded agnostid trilobites representative of the Ptychagnostus punctuosus Zone, and the overlying Marqua Formation, predominantly pale carbonate, trilobites indicating the latest Middle Cambrian zone of Leipyge laevigata (J.H. Shergold).

Some 24 genera and 41 species or subspecies of Idamean and immediately post-Idamean trilobites have been described from the Pomegranate Limestone and lowest part of the Chatsworth Limestone in the central portion of the Burke River Structural Belt. Revisions have been made to earlier published taxa by Whitehouse, Öpik and Henderson. The zonation proposed by Henderson for Georgina Limestone sequences at Glenormiston can also be applied in the Burke River area, but it is difficult to differentiate the Erinxanium sentum Zone from earlier and

younger assemblages. The incoming of the Irvingella tropica Zone is regarded as introducing an as yet un-named biochronological stage which succeeds the Idamean (J.H. Shergold).

3. Geochemistry

Research has actively proceeded on samples generated by the 1980 Georgina Basin Oil Shale Drilling Programme, and earlier source rock drilling in the Toko Syncline and Burke River area.

Samples from BMR coreholes Mt Isa No. 1, Camooweal No. 2, Duchess 15A and Tobermory 14 have been subjected to examination using reflected light and fluorescence microscopy (A. Hutton, Wollongong University). The biological origin of kerogens in Camooweal 2 is being investigated using vitrinite reflectance and electron microscope techniques (M. Glikson, ANU Biogeography). Interpretation of this research is not yet available.

Characterization of the organic matter associated with the unweathered Cambrian phosphorites and siltstones from BMR drillcore Duchess 14 is continuing, with emphasis on the kerogen and humic acid fractions. In addition to C, H, N, and organic sulphur analysis, these fractions have been analysed for their phosphorus and $\delta^{13}\text{C}$ contents in order to interpret the source and depositional environment of the organic matter in these sediments. A general feature of the organic matter of the Beetle Creek phosphorites appears to be a relatively high content of humic acid carbon compared to the siltstones of the Inca Formation, which have negligible amounts of humic acids. This may reflect different depositional and diagenetic environments for the phosphorites and siltstones. The presence of humic acids in such old sediments is unusual, but they can not be recent contaminants since the $\delta^{13}\text{C}$ values of approximately $-32^{\circ}/\text{oo}$ are similar to values of kerogen fractions from the same samples, and very different from modern humic acid $\delta^{13}\text{C}$ values. The presence of humic acid carbon in the sediments indicates a very low stage of thermal maturation, and this is supported

by reflectance measurements of vitrinite-like particles in the kerogen fraction, which have \bar{R}_o values of 0.2-0.4%. Correlation of these measurements, with molecular parameters of maturation, such as ratios of diasteranes to regular steranes in the extractable hydrocarbon fraction, is in progress (M. Sandstrom, ANU, RSES).

The petroleum potential of the Toko Syncline has been re-evaluated using recently obtained geochemical data: total organic carbon calculated on a whole rock basis, total extractable matter, and liquid chromatograph separation of the extractable organic matter. Proterozoic and Ordovician formations rated poorly as source rocks in all coreholes examined. Equivalents of the Red Heart Dolomite and Hay River Formation in Netting Fence No. 1, and the Georgina Limestone in Mt Whelan No. 1 have proved to be the most promising hydrocarbon source rock intervals (K.S. Jackson).

A viscous oily vug filling from BMR Duchess 15A has been analysed, and is interpreted as an oil stained core. The sample yielded low pristane to phytane ratios; had a limited range of n-alkanes; and had high pristane to $n.C_{17}$ and phytane to $n.C_{18}$ ratios. The oil stain either originated from marine source rocks which were mature, or the oil has been biodegraded by bacterial activity (K.S. Jackson).

Inorganic geochemical samples from the Hay River Formation in BMR Tobermory 14 have been analysed, and can be compared with values obtained from BMR Hay River 11 and 11A. These values reflect the amount of carbonate in these sequences. Higher organic carbon and sulphur can be correlated with enrichment in Mo, Th, U, Ni, Zn, and V values, and with fewer carbonate and more black shale intervals. There is a general fall off in base metal values over the more calcareous intervals of core (J.H. Shergold).

4. Maps

A 1:250,000 special geological sheet covering the Toko Syncline and adjacent parts of the southern margin of the Georgina Basin is in preparation. This sheet will cover all the areas from which new information has been produced on the Adam, Toko, Abudda Lakes and Mount Whelan, revised 1:100 000 Sheet areas. Additional photo-geological interpretation has been undertaken on the adjacent Marqua, Mount Barrington, Mirrica Bore, Barrington Peak, Neeyamba Hill and Glenormiston 1:100 000 Sheet areas to complete the 1:250 000 coverage (C.J. Simpson, B.M. Radke).

In conjunction with the BMR Arunta Complex Project and the Northern Territory Geological Survey, a revised edition of the Huckitta 1:250 000 is being prepared. The Dneiper 1:100 000 Sheet has been completed from limited ground observation and colour air photo-interpretation. A dyeline of the 1:100 000 preliminary geology and photo-compilation sheets have already been released. Jinka and Jervois 1:100 000 Sheets remain in preparation (M.E. Freeman, J. Laurie, NTGS; C.J. Simpson).

Mapping of Middle Cambrian lithofacies patterns by P.N. Southgate (ANU, RSES) will be included in revised editions of the Undilla and Riversleigh 1:100 000 Sheet area.

5. Publications

Papers published or on open file 1980/81:

- KENNARD, J.M., 1981: The Arrinthrunga Formation, Georgina Basin, central Australia. Bureau of Mineral Resources, Geology & Geophysics of Australia, Bulletin 211: 61 pp.
- JONES, P.J., & MCKENZIE, K.G., 1981: Flemingopsis, a new name for the Cambrian phosphatocopine ostracode genus Flemingia Jones & McKenzie 1980. Alcheringa, 5(3): 310.
- RADKE, B.M., 1980: Saddle dolomite: an indicator of late diagenetic mineralisation in carbonates. Programmes & Abstracts, 4th Australian Geological Convention, Hobart, 14-18 January, 1980: 59.
- RADKE, B.M., 1980: Cambro-Ordovician epeiric carbonate sedimentation: the Ninmaroo Formation, Georgina Basin. Programmes & Abstracts, 4th Australian Geological Convention, Hobart, 14-18 January 1980: 70.
- RADKE, B.M., 1980: Carbonate textures after Cambro-Ordovician sabkha deposits. Programmes & Abstracts, 4th Australian Geological Convention, Hobart, 14-18 January, 1980: 74.
- RADKE, B.M., 1980: Model for cyclic sedimentation in epeiric carbonates of the Georgina Basin. Geological Society of Australia, Australasian Sedimentologists' Group Conference, Canberra, 1-2 December, 1980, Abstracts, 2: 37.
- RADKE, B.M., 1981: Lithofacies of the Ninmaroo Formation in GSQ Mount Whelan No. 2. Bureau of Mineral Resources, Geology & Geophysics of Australia, Professional Opinion, 81/010 (unpubl.).
- RADKE, B.M., & MATHIS, R.L., 1980: On the formation and occurrence of saddle dolomite. Journal of Sedimentary Petrology, 50(4): 1149-1168.
- SANDSTRÖM, M.W., 1979: Organic geochemistry of some Cambrian phosphorites. In DOUGLAS, A.G. & MAXWELL, J.R. (Eds) Advances in organic geochemistry, pp. 123-131. Pergamon Press, Oxford.

- SHERGOLD, J.H., 1981: Palaeontological determinations of phosphatic samples from the Undilla and Riversleigh 1:100 000 Sheet areas, Georgina Basin. Bureau of Mineral Resources, Geology & Geophysics of Australia, Professional Opinion, 81/021 (unpubl.).
- SIMPSON, C.J., 1980: Georgina Basin Project. In CASEY, J.N., Geological Branch Annual Summary of Activities, pp. 167-174. Bureau of Mineral Resources, Geology & Geophysics of Australia Record, 1980/61 (unpubl.).
- SIMPSON, C.J., 1980: Georgina Research for the period April-September 1980. Bureau of Mineral Resources, Geology & Geophysics of Australia Record, 1980/74 (unpubl.).
- SIMPSON, C.J., 1981: Georgina Basin Project. In PAINE, A.G.L. (Ed.) BMR 80. Bureau of Mineral Resources, Geology & Geophysics of Australia, Yearbook, pp. 49-53.
- TURNER, S., JONES, P.J., DRAPER, J.J., 1981: Early Devonian thelodonts (Agnatha) from the Toko Syncline, western Queensland, and a review of other Australian discoveries. BMR Journal of Australian Geology & Geophysics, 6, 1981: 51-69.
- WALTER, M.R., 1980: Adelaidean and early Cambrian stratigraphy of the southwestern Georgina Basin: correlation chart and explanatory notes. Bureau of Mineral Resources, Geology & Geophysics of Australia, Report 214, BMR Microform MF 292.
- WARREN, R.G., 1980: The Arunta Block in the Huckitta 1:250 000 Sheet area: a review of data to June 1980. Bureau of Mineral Resources, Geology & Geophysics of Australia Record, 1980/45 (unpubl.).

The following papers are in preparation, have been submitted for publication, or are in press as of the end of September 1981:

- DRUCE, E.C. - The Kelly Creek Formation and its conodont faunas, Georgina Basin, Western Queensland and Northern Territory. Alcheringa.
- DRUCE, E.C. - The Coolibah Formation and its conodont fauna, Georgina Basin, Queensland and Northern Territory. Bureau of Mineral Resources, Australia, Bulletin.
- DRUCE, E.C. - Conodonts of the Nora Formation and Carlo Sandstone: Georgina Basin, Queensland and Northern Territory. Bureau of Mineral Resources, Australia, Bulletin.
- DRUCE, E.C., SHERGOLD, J.H., & RADKE, B.M. - A reassessment of the Cambrian-Ordovician boundary section at Black Mountain, western Queensland, Australia. In Biostratigraphy of the Cambrian-Ordovician Boundary, University of Wales Press.
- ELGUETA, Sara - Sedimentological study of the western zone of the Lady Annie phosphate district, Queensland, Australia. M.Sc. Thesis, Australian National University (unpubl.).
- GREEN, P.M. - Petrology and sedimentology of the Georgina Limestone, Georgina Basin, Queensland. Queensland Government Mining Journal.
- JACKSON, K.S. - Geochemical evaluation of the petroleum potential of the Toko Syncline, Georgina Basin, Queensland, Australia. BMR Journal of Australian Geology & Geophysics.
- KENNARD, J.M. - Stratigraphic field sections and drillhole logs of the Arrinthrunga Formation, Georgina Basin, central Australia. Bureau of Mineral Resources, Australia, Record, 1980/75 (unpubl.).
- RADKE, B.M. - Lithostratigraphy of the Ninmaroo Formation (Upper Cambrian-Lower Ordovician), Georgina Basin. Bureau of Mineral Resources, Australia, Report 181, Microform 153.

- RADKE, B.M. - Late diagenetic history of the Ninmaroo Formation, Georgina Basin, Central Australia. BMR Journal of Australian Geology & Geophysics.
- RADKE, B.M. - Sabkha overprint in the Ninmaroo Formation (Upper Cambrian-Lower Ordovician) Georgina Basin. Journal of Sedimentary Petrology.
- RADKE, B.M., & MATHIS, R.L. - On the formation and occurrence of saddle dolomite: reply to discussion. Journal of Sedimentary Petrology.
- SCHMITT, M., & SOUTHGATE, P.N. - A phosphatic stromatolite, Ilicta cf. composita Sidorov, from the middle Cambrian of northern Australia. Alcheringa.
- SHERGOLD, J.H. - Idamean (late Cambrian) trilobites, Burke River Structural Belt, western Queensland. Bureau of Mineral Resources, Australia, Bulletin 187.
- SHERGOLD, J.H., COOPER, R.A., DRUCE, E.C., & WEBBY, B.D. - Synopsis of selected sections of the Cambrian/Ordovician boundary in Australia, New Zealand and Antarctica. In Biostratigraphy of the Cambrian-Ordovician Boundary, University of Wales Press.
- SIMPSON, C.J., WALTER, M.R., WILKINS, R.W.T., & RUSSELL, N. - Mineralisation of the Hay River area, Northern Territory.
- SOUTHGATE, P.N. - Cambrian skeletal halite crystals and experimental analogues. Sedimentology.
- WALTER, M.R. - Late Proterozoic tillites of the southwestern GEorgina Basin, Australia. In HARLAND, W.B. (Ed). Pre-Pleistocene tillites: a record of the Earth's glacial history.
- WARREN, R.G. - Geology and tectonic setting of the easternmost outcrops of the Arunta Block. Bureau of Mineral Resources, Australia, Record.