Kathleen Grey

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STROMATOLITE BIOSTRATIGRAPHY AND PALYNOLOGY OF DRILLHOLE NTGS BR05DD01 (UNAPPROACHABLE 1:100 000 SHEET; BLOODS RANGE 1:250 000 SHEET) AMADEUS BASIN, NORTHERN TERRITORY, AUSTRALIA

by

Kathleen Grey

4 Wallis Lane, Lesmurdie, WA 6076

08 9291 3524 (kath.grey@gmail.com.au)

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Abstract

The upper part of drillhole NTGS BR05DD01 (held in the NTGS core library in Alice Springs, Northern Territory) was examined and sampled by Kath Grey and Peter Haines in March 2013 as part of ongoing studies of the Amadeus Basin by the Geological Survey of Western Australia and a collaborative project between Kath Grey and Professor Malgorzata Moczydłowska of Uppsala University on the biostratigraphy and paleoecology of Proterozoic acritarchs. Several stromatolite specimens in carbonate intervals were examined and identified. They consisted mainly of *Tungussia julia*, a stromatolite previously identified from the Julie Formation and its lateral equivalents across Australia. This, together with well-log interpretation, indicates that the Julie Formation and part of the overlying Arumbera Sandstone, not identified in the original well log, are present in the drillhole. Forty-seven palynological samples were prepared using standard maceration techniques. Initial examination indicates that all samples are barren of identifiable palynomorphs. This result is unexpected in the light of successful recovery of rich assemblages from other Amadeus Basin drillholes through the same interval. Further investigations are underway to determine if the problem lies with the preparation techniques applied.

Drillhole Specifications

Drillhole Id: BR05DD01 (Unique identifier 7922689)
Geological Terrane: Amadeus Basin
Total depth: 1224.98 m
Latitude: GDA 94 -24.4556878, Longitude: GDA94 130.3825099
94MGA: MGA zone 52, Bloods Range 1:250 000 sheet; Unapproachable, 1:100 000 sheet
Latitude: GDA 94 -24.4556878, Longitude: GDA94 130.3825099
Easting, 640126; Northing 7294621
Date drilled 08 September 2005
Dip -90°, Azimuth 360°
Logged by Greg Ambrose logged report ref NTGS Record 2010-015
Start of core depth: 55 m, examined from 142.6 m
End of core depth 1224.98 m, examined to 484 m.

Locality details and sampling

Drillhole BRD05DD01, a stratigraphic hole located on Bloods Range 1:250 000 sheet, 130 km southwest of the Mereenie Oil/gas Field, was drilled by the Northern Territory Geological Survey (NTGS) on a synclinal axis about 140 km east of the Western Australian border (24°26’60”S, 130°22’48”E). It was fully cored from 55 m to 1224.98 m (total depth) and intersected a Neoproterozoic succession extending from the Loves Creek Member of the Bitter Springs Formation to what was referred to as the Pertatataka Formation in the well completion report (Ambrose et al. 2010). For the present study, the core was examined between 142.6 m and the top of the Pioneer Sandstone at 484 m.

Stromatolites were present in a carbonate interval (details of depths and identifications are given in Dataset 1). Coupled with lithological and well log re-interpretations, the fossils confirm that the interval down to 153 m should be assigned to the Arumbera Sandstone and that the interval between 153 m and 191 m belongs to the Julie Formation (Grey et al., 2012).

The underlying Pertatataka Formation should coincide with the Ediacaran Leiosphere Assemblage (ELP) and Ediacaran Complex Acanthomorph Assemblage (ECAP) of Grey (2005). Forty-seven palynological samples were collected as specified in Dataset 2. Samples were prepared using standard maceration techniques by Global Geolab Ltd. (Manager: Russ Harms), 729B - 15th St. S.W., Medicine Hat, Alberta, Canada T1A 4W7. E-mail: global.geolab@memlame.com. However, none yielded identifiable palynomorphs.

Earlier studies on the lower part of the core indicated abundant stromatolites in the Bitter Springs Formation. They were photographed by Hill in 2009, identified from the photographs, and have been described previously by Grey et al. (2012).

Report

From 142.6 m to 153.0 m, the core consists mainly of chocolate brown and light brown silty, fine-grained sandstone. None of this interval contains stromatolites, nor does the lithology appear suitable for palynology. Based on earlier well-log interpretations (Haines et al., 2012; Grey et al., 2012) and stromatolite identifications in the underlying carbonate, this interval is interpreted as Arumbera Sandstone. A contact at 153 m is gradational from fine-grained sandstone to fine-grained carbonate. Lithology above 153 m is generally unsuitable for palynology, although a few of the siltier intervals were sampled (Dataset 2). Carbonate becomes more predominant below about 177 m and down to about 191 m, and in places is stromatolitic (identifications are discussed in detail below and listed in Dataset 1). Based on the stromatolite identifications within this interval, and well log interpretations (Grey et al., 2012), this part of the core can be correlated with the Julie Formation.

A contact between the carbonate unit and an underlying, predominantly siltstone and mudstone interval at 191 m marks the top of the Pertatataka Formation. The contact between the Pertatataka Formation and underlying Pioneer Sandstone lies at 484 m. The lithology of the Pertatataka Formation appears to be highly suitable for palynology and was sampled extensively (Dataset 2). Intervals below the top of the Pioneer Sandstone were not examined as part of this study.

Stromatolite biostratigraphy

Stromatolites are abundant in the lower part of BR05DD01 in the Bitter Springs Formation and have been identified as taxa belonging to the Cryogenian *Acaciella australica* Assemblage (Grey et al., 2012). The stromatolites above the Pertatataka Formation are very different in appearance and the presence of *Tungussia julia* indicates that the upper part of the core (previously included in the Pertatataka Formation, belongs to the Julie Formation and Arumbera Sandstone. Stromatolites were not sampled, but were identified in situ in the core. Some of the stromatolitic intervals consist of flat lying or convex laminae that do not provide enough information for identification because of the narrowness of the core. Elsewhere, branching patterns and details of the laminae can be identified.

A well preserved columnar stromatolite is present at 185.5 m, but insufficient data is available for identification. At 188.75 to 189.3 m, *Tungussia julia* is present and shows tungussiform (complex, randomly oriented, divergent) branching with columns up to 4 cm in diameter, with some recumbent (near horizontal) columns, a characteristic of this taxon. Columns are irregular, lack a wall, have ragged margins, and have wavy, poorly defined laminae.

Another well preserved specimen of *Tungussia julia* is present from 189.5 to 189.7 m. This appears to be part of either a single, large bioherm, or comprise several, stacked bioherms. It shows tungussiform and partly recumbent branching, and branching appears highly complex, multifurcate and very irregular, and appears to develop from small nodes. Larger branches are up to 7 cm in diameter, whereas smaller ones are 0.7 to 2 cm in diameter. Column margins have numerous bumps and lack a wall. Laminae are poorly defined, highly irregular and have a low degree of inheritance. Interspaces are filled in places with dark, silty mudstone.

The lower part of a *Tungussia julia* bioherm with divergent branching is present between 189.5 and 190.0 m and resembles the specimens described above. The upper part of the bioherm may have been eroded.

A poorly preserved stromatolite, ?*Tungussia julia*, is present between 190.25 and 191.0 m and could be the upper part of a bioherm sitting on the top of the Pertatataka Formation.

Although many researchers do not accept or have reservations about stromatolite correlation and biostratigraphy, ongoing studies of Neoproterozoic basins in Australia are producing excellent, predictable results (Grey et al., 2012). A database is currently being compiled for the Geological Survey of Western Australia and contains records of several hundred Neoproterozoic stromatolite samples from all across Australia. They show consistent distribution patterns throughout the Neoproterozoic succession. *Tungussia julia* is highly diagnostic of the Julie Formation and its lateral equivalents in several tectonic units. It was first recorded from the Julie Formation in the Amadeus Basin (Walter, et al., 1979). A specimen from the then top of the Wonoka Formation, now basal Bonney Sandstone, described by Preiss in the same paper, was called *T*. cf. *julia,* but was subsequently recognized as *Tungussia julia* (Grey, 2005). It is also present in the Egan Formation (Grey and Corkeron, 1998), in drillcore in the Elkera Formation in the Georgina Basin, in the Wilari Dolomite Member in Murnaroo 1 (Grey, 2005) and in field outcrops in the western Amadeus Basin (Allen et al., 2012; Grey et al., 2012). In most of these occurrences, *T. julia* is associated with a high positive $\delta^{13}C$ excursion (Grey et al, 2011).

Palynology

Forty-seven palynological samples were prepared using standard maceration techniques by Global Geolab Ltd. (Manager: Russ Harms), 729B - 15th St. S.W., Medicine Hat, Alberta, Canada T1A 4W7. E-mail: global.geolab@memlame.com. Initial examination of the prepared slides indicates that all samples are barren of identifiable palynomorphs. This result is unexpected in the light of successful recovery of rich assemblages from other Amadeus Basin drillholes through the same interval. Further investigations are underway to see if the problem lies with the preparation techniques applied.

Normally lithology in the Pertatataka Formation is ideal for palynology and when examined, the lithology in core BR05DD01 appeared to have good potential. Recovery rates in Proterozoic rocks are often poorer than in the Phanerozoic, although these vary in successions of all ages depending on numerous factors such as depth of burial (thermal maturity), distance from shore, position in sea-level cycles and can be affected by other factors, including preparation. Medium-grey mudstone to siltstone usually provides the highest yields. Sampling every few metres at regular intervals as lithology permits, overcomes some of the problems and makes it possible to identify intervals with overall good preservation and intervals with overall poor preservation. This was intended to be a preliminary study, so several lithological variants were sampled and samples were spaced about 50 m apart. Samples were prepared by standard techniques because the modified technique developed by Grey (1999) for Ediacaran samples is time consuming and expensive.

Yields were extremely low and preservation was poor. No identifiable palynomorphs were recovered from any of the samples. They contained only a few poorly preserved organic fragments and some minor contamination. It is difficult to account for such poor yields. There is a possibility that large specimens were broken up by preparation methods that were too vigorous. However, had that been the case, the samples would probably have contained a large amount of fine organic debris in the samples, but samples appear to be pretty clean. Even if the ECAP specimens were removed by the preparation methods employed, the lower assemblage of more robust leiospheres should have been present in the lower samples, but they were not present either. Thermal maturity slides that are used to test depth of burial were not prepared, so it is difficult to assess the nature of the problem. The next step will be to prepare the samples using the modified techniques of Grey (1999) to test if the problems could be a product of methodology. Preparation using non-vigorous techniques and filtration instead of heavy mineral separation were found to increase yields considerably in other Neoproterozoic samples from Australia (Grey, 1999, 2005)

Conclusions

Stromatolite biostratigraphy was highly successful, and enabled the interval between 177 m and 191 m to be reassigned from the Pertatataka Formation to the Julie Formation, and indicates that the interval above 177 m must be Arumbera Sandstone. By contrast, palynological results were disappointing and no meaningful results have been obtained to date.

Recommendations for further work

Stromatolite biostratigraphy will be incorporated in a future publication. In the meantime, the small amounts of unprocessed residue that remain will be subjected to further preparation and testing in the laboratories of Uppsala University in an effort to determine whether preparation methods account for the barren samples. A further report will be provided when this additional investigation has been concluded.

References

Allen H-J, Grey K and Haines PW 2012, Neoproterozoic Stromatolite biostratigraphy in the western Amadeus Basin, In: Ambrose, G.J. and Scott, J. (Eds). Central Australian Basins Symposium III. Petroleum Exploration Society of Australia, Special Publication, 1-11.

Ambrose GJ, Dunster JN, Munson TJ and Edgoose CJ, 2010. Well completion reports for NTGS stratigraphic drillholes LA05DD01 and BR05DD01, southwestern Amadeus Basin. Northern Territory Geological Survey, Record 2010–015, 30p.

Grey, K, 1999, A modified palynological preparation technique for the extraction of large Neoproterozoic acanthomorph acritarchs and other acid insoluble microfossils: Geological Survey of Western Australia, Record 1999/10, 23 p.

Grey, K, 2005, Ediacaran Palynology of Australia: Association of Australasian Palaeontologists, Memoir 31, Canberra, 439p.

Grey, K. and Corkeron, M, 1998, Late Neoproterozoic stromatolites in glacigenic successions of the Kimberley region, Western Australia: evidence for a younger Marinoan glaciation: Precambrian Research, v. 92, p. 65–87).

Grey, K, Hill, AC and Calver, CR 2011, Biostratigraphy and stratigraphic subdivision of the Cryogenian successions of Australia in a global context: *in* The geologic record of Neoproterozoic glaciations *edited by* E Arnaud, GP Halverson and G Shields-Zhou, Geological Society, London, Memoirs, v. 36, p. 113-134.

Grey K, Allen H-J, Hill A, Haines PW 2012, Neoproterozoic biostratigraphy of the Amadeus Basin. In: Ambrose, G.J. and Scott, J. (Eds). Central Australian Basins Symposium III. Petroleum Exploration Society of Australia, Special Publication, 1-18.

Haines PW, Allen H.-J, Grey K and Edgoose C 2012, The western Amadeus Basin: revised stratigraphy and correlations, In: Ambrose, G.J. and Scott, J. (Eds). Central Australian Basins Symposium III. Petroleum Exploration Society of Australia, Special Publication, 1-6.

Walter MR, Krylov IN and Preiss WV, 1979. Stromatolites from Adelaidean (Late Proterozoic) sequences in central and South Australia. *Alcheringa*, 3, 287–305.

Appendix 1. Taxonomic citations

Names of authors of scientific names have been omitted in the text and instead are presented here. Names are the names of authors of taxa, not references, and therefore they are not necessarily cited in the reference list.

Stromatolites

Acaciella australica (Howchin 1914) Walter 1972
Tungussia julia Walter and Krylov *in* Walter et al., 1979

Dataset 1: Stromatolites examined in drillhole

Identified by K. Grey, 18.03.2003

Depth from m	Depth to m	Identification
185.5	185.5	not identifiable
185.5	185.5	not identifiable
188.75	189.3	*Tungussia julia*
189.5	189.7	*Tungussia julia*
189.5	190.0	*Tungussia julia*
190.25	191.0	?*Tungussia julia*.

Dataset 2: Palynology samples

Collected by K. Grey, 18.03.2003

GSWA No.	Depth from (m)	Depth to (m)	Description	Result
139048	155.28	155.28	chocolate-brown to light-grey siltstone	Barren
139049	159.24	159.24	brownish-grey siltstone	Barren
139050	161.05	161.05	greyish-brown laminated siltstone	Barren
139051	166.97	166.95	medium-grey siltstone	Barren
139052	170.5	170.5	medium-grey siltstone	Barren
139053	177.75	177.75	medium-grey siltstone	Barren
139054	185.75	185.75	medium-grey siltstone	Barren
139055	189.5	190.10	medium-grey siltstone in stromatolite	Barren
139056	190.25	190.25	medium-grey siltstone in stromatolite	Barren
139057	191.3	191.3	medium-grey siltstone	Barren
139058	193.9	193.9	greyish-brown laminated siltstone	Barren
139059	197.3	197.3	grey siltstone	Barren
139060	201.25	201.25	greyish-brown laminated siltstone	Barren
139061	209.9	209.9	grey siltstone	Barren
139062	217.5	217.5	grey siltstone	Barren
139063	221	221	grey siltstone	Barren
139064	231.4	231.4	grey siltstone	Barren
139065	236.4	236.4	grey siltstone	Barren
139066	244.2	244.2	grey siltstone	Barren
139067	251.2	251.2	grey siltstone	Barren
139068	261.5	261.5	grey siltstone	Barren
139069	268.4	268.4	grey siltstone	Barren
139070	279.9	279.9	grey siltstone	Barren
139071	288.49	288.49	grey siltstone	Barren
139072	303.7	303.7	grey siltstone	Barren
139073	315.49	315.49	grey siltstone	Barren
139074	324.5	324.5	grey siltstone	Barren
139075	336.9	336.9	grey siltstone	Barren
139076	344.9	344.9	grey siltstone	Barren
139077	348.6	348.6	grey siltstone	Barren
139078	357.5	357.5	grey siltstone	Barren
139079	363.5	363.5	grey siltstone	Barren
139080	369.05	369.05	grey siltstone	Barren
139081	378.5	378.5	grey siltstone	Barren
139082	386.6	386.6	grey siltstone	Barren
139083	398.05	398.05	grey siltstone	Barren
139084	406.5	406.5	grey siltstone	Barren
139085	415.9	415.9	grey siltstone	Barren
139086	425.9	425.9	grey siltstone	Barren
139087	432.5	432.5	grey siltstone	Barren
139088	438.4	438.4	grey, coarse siltstone	Barren

139089	453	453	grey, coarse siltstone	Barren
139090	462.25	462.25	grey siltstone	Barren
139091	471.6	471.6	grey siltstone	Barren
139092	482.5	482.5	grey siltstone	Barren
139093	484.4	484.4	grey siltstone, top of Pioneer Sandstone	Barren