STRATIGRAPHIC TERMINOLOGY OF THE EARAHEEDY GROUP, NABBERU BASIN

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ABSTRACT

A sequence of Lower Proterozoic rocks in the eastern part of the Nabberu Basin is defined as the Earaheedy Group. Two subgroups are recognized, which reflect two major transgressive-regressive cycles of sedimentation. The lower is the Tooloo Subgroup, which consists of a basal clastic unit (Yelma Formation) overlain by iron-formation and shale (Frere Formation) with a carbonate and clastic unit (Windidda Formation) at the top. The Minigarra Subgroup consists of three predominantly clastic formations (Wandiwarra Formation, Princess Ranges Quartzite and Wongawol Formation) overlain by the Kulele Creek Limestone, with a clastic and minor carbonate unit (Mulgarra Sandstone) at the top of the sequence. The Earaheedy Group is possibly equivalent to parts of the Padbury Group in the western part of the Nabberu Basin, and either unconformable on, or equivalent to, parts of the sequence in the Glengarry Sub-basin.

INTRODUCTION

Lower Proterozoic sedimentary rocks flank the northern margin of the Archaean Yilgarn Block over a distance of 700 km between longitudes 117°E and 124°E. They are overlain unconformably in the north by the Middle Proterozoic Bangemall Group, in the east by Phanerozoic sediments of the Officer Basin, and in the west they become involved in the Gascoyne Mobile Belt. The term Nabberu Basin was introduced by Hall and Goode (1975) to include the repository of all these Lower Proterozoic rocks. Bunting and others (1977) express doubts on the validity of the term, but for the purposes of the present paper the term Nabberu Basin is used in the sense of Hall and Goode. The eastern part of the basin now forms a broad, east-southeast-trending synclinorium with a gently dipping southern limb and a tightly folded, and in places overturned northern limb. In the Glengarry Sub-basin gently folded sediments extend southwards onto the Yilgarn Block, and to the west the Padbury Group (Barnett, 1975) is tightly folded between Archaean basement highs.

Geologists of the Broken Hill Proprietary Co. Ltd (B.H.P.) began mapping the eastern part of the Nabberu Basin in 1973 and subsequently continued westwards into the Peak Hill and Robinson Range 1:250 000 Sheet areas and eastwards into the Stanley and Kingston 1:250 000 Sheet areas. New stratigraphic names were invoked to describe the sequence in the eastern part of the Nabberu Basin. These names have appeared in publications without adequate definition.

Systematic mapping of the eastern part of the Nabberu Basin by the Geological Survey of Western Australia began in the Kingston Sheet area in 1975, although parts of the southern and eastern edges had been mapped in 1973 (Bunting and Chin, 1975; Bunting, Jackson and Chin, 1975) and in 1972 by the Bureau of Mineral Resources (Jackson, in prep.). Mapping was completed in the Nabberu, Stanley and Wiluna 1:250 000 Geological Sheet areas in 1976 and mapping in the Glengarry 1:250 000 Geological Sheet area is in progress.

The purpose of this paper is to define the stratigraphic units used by B.H.P. which, with minor modifications, were used in the G.S.W.A. mapping.

STRATIGRAPHY

The area occupied by the Earaheedy Group is shown in Figure 22. Eight formations are recognized, comprising some 6 000 m of shallow water marine sediments. The type sections have all been established on the southern limb of the main synclinorium because of relatively easy access, better exposure and lack of structural complexity compared with the northern limb.

The unconformity between the Earaheedy Group and the underlying Archaean granitic and metamorphic rocks is well exposed in parts of the southern limb of the synclinorium, over the Malmac Dome (Horwitz, 1976) and in the northwest Nabberu Sheet area. To the west, however, the Earaheedy Group appears to be underlain by a thick sequence of sedimentary and basaltic rocks which may be either equivalent to, or unconformable beneath, the Yelma Formation. A similar situation exists along the central part of the northern limb of the synclinorium where a mixed unit of slate, phyllite, arenite and chert lies north of, and stratigraphically below, the arenites of the Yelma Formation. For the present these older rocks are excluded from the Earaheedy Group.

The division of the Earaheedy Group into the Tooloo and Miningarra Subgroups is based on the recognition of two distinct cycles of sedimentation, each comprising a transgressive phase followed by a period of regression. The subgroups are locally separated by a disconformity.

TOOLOO SUBGROUP

The Tooloo Subgroup consists of the Yelma, Frere and Windidda Formations.

Yelma Formation

The Yelma Formation is named from exposure 6 km northwest of Yelma outstation in the Kingston Sheet area. It is the unit of medium to coarse-grained quartz-rich clastic rocks which lies unconformably on the Archaean basement and conformably below the Frere Formation. At the type section, between grid references 473711 and 473712 on the Kingston Sheet, the formation is about 130 m thick. It thins to about 10 m in the southeastern part of the basin (Bunting and others, 1975).

The type Yelma Formation consists of buff-weathering, white to cream, medium to very coarse-grained, clean quartz sandstone, in places arkosic, with minor bands of quartz pebble or quartz cobble conglomerate near the base. The sandstone is generally flat bedded, with occasional cross bedding and ripple marks, and rare mud pellets. Thin chert and silicified carbonate beds occur locally within the sandstone along the southern limb of the synclinorium. On the northern limb the formation is much thicker (up to 500 m) and contains shale and chert beds. It is equivalent to the Malmac Formation of Horwitz (1976).

Frere Formation

The Frere Formation is a sequence of dominantly ferruginous chemical sediments and fine-grained clastics with minor carbonates and is named from the Frere Range along the northern side of Lake Nabberu in the Nabberu Sheet area. The base is taken at the top of the quartz sandstone of the Yelma Formation. In the Kingston Sheet area the top is taken at the first carbonate band which marks the base of the Windidda Formation, whereas to the west and around the northern side of the synclinorium, it is taken at the base of the fine-grained clastic sediments of the Wandiwarra Formation in which there are only rare and thin bands of iron-formation.

The type section is in the Frere Range in the Nabberu Sheet area, between grid references 364804 and 367809, where the middle part of the formation is well exposed in gorges. The total thickness of the formation is estimated to be 1 300 to 2 000 m, shallow dips making accurate measurement difficult.

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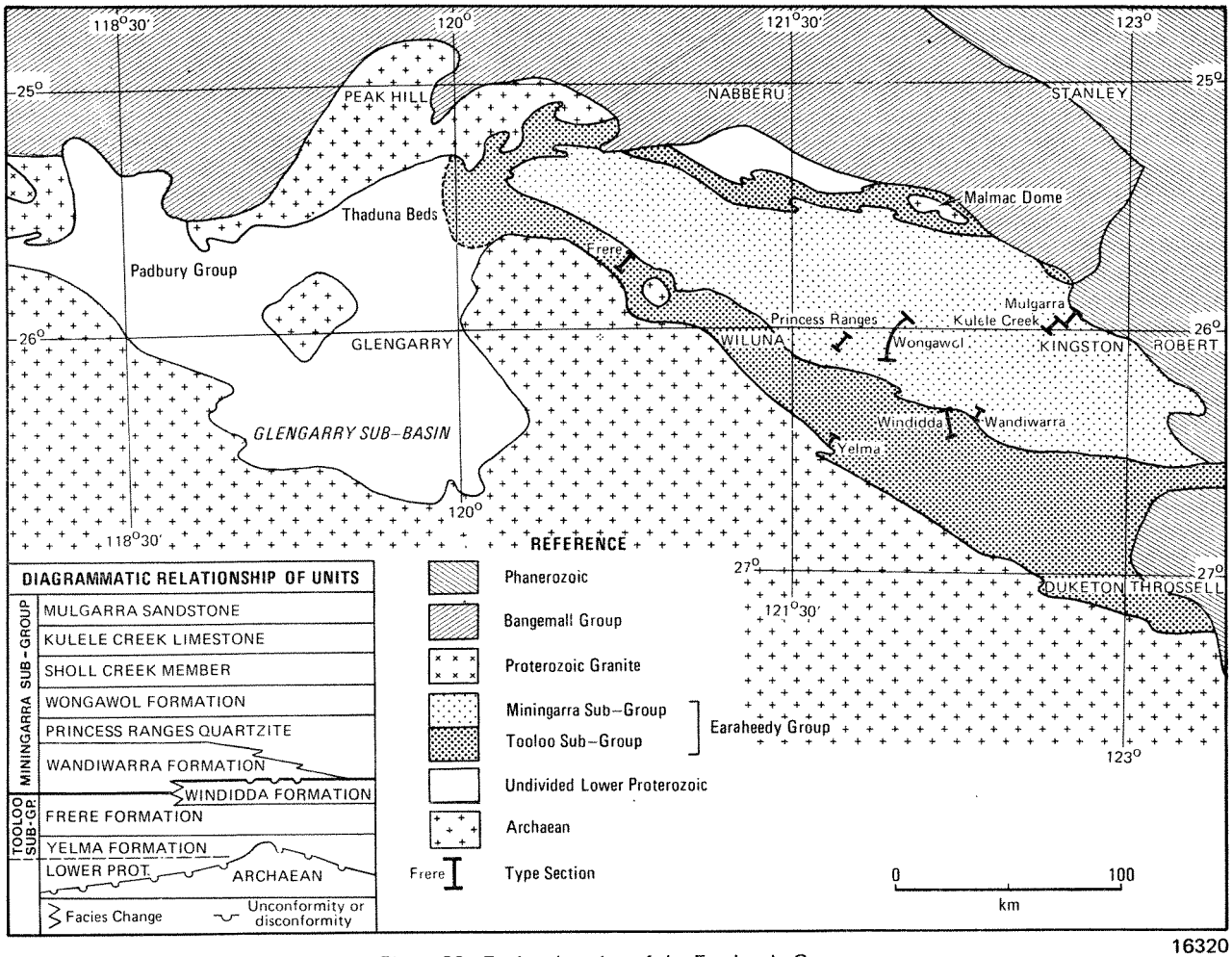

Figure 22. Regional setting of the Earaheedy Group.

The most conspicuous rock type is a clastic or pelletal-textured ferruginous chert in which rounded to angular grains of chert or ferruginous chert are set in a chert matrix. Locally this iron-formation is prominantly meso-banded, consisting of alternating layers of pelletal ferruginous chert and nonpelletal chert or hematitic shale. The ferruginous chert pellets are occasionally oolitic.

Clastic sequences up to 100 m thick form the bulk of the Frere Formation in the southeast part of the basin where the predominant rock type is buff, brown or maroon shaley siltstone with minor fine-grained sandy shale. The siltstone beds are finely laminated, with small-scale cross-bedding, and include thin chert bands in places.

Along the northern limb of the synclinorium the shale units have a strong slaty cleavage.

Stromatolitic carbonate, which marks the boundary between the Yelma and Frere Formations at several localities along the southern limb of the synclinorium, also occurs within the Frere Formation. These carbonate units form lenticular bodies up to 20 m thick and several kilometres long.

Windidda Formation

The Windidda Formation is that unit of carbonate and fine-grained clastic sediments lying between the Frere Formation and the Wandiwarra Formation. The base is taken at the base of the first carbonate unit above the thick iron-formations of the Frere Formation, and the top is the top of the uppermost carbonate-clast conglomerate band on which the sandstone of the Wandiwarra Formation rests. The type section is between points 8 km south and 5 km north-northwest of Windidda homestead, between grid references 533714 and 530727. Here the formation is approximately 1 200 m thick.

In the type section a basal unit consisting of a few metres of brown ankeritic carbonate with chert and stromatolitic bands is overlain by grey to pink laminated limestone. The limstones are locally conglomeratic and are interbedded with calcareous shales. The shales become more common higher in the sequence. The top of the Windidda Formation is not exposed in the type section, but about 25 km to the west-northwest the top is marked by a prominent 1 to 2 m-thick band of intraformational limestone conglomerate.

The Windidda Formation is confined to the south-eastern limb of the synclinorium. In the Nabberu Sheet area, and along the northern limb, the stratigraphic position of the Windidda Formation is occupied by siltstone and fine-grained sandstone indistinguishable from similar rocks of the Wandiwarra Formation. This probably represents a deeper water facies in which carbonates were not deposited. A local disconformity occurs at the top of the formation where it is overlain by the transgressive Wandiwarra Formation.

MININGARRA SUBGROUP

The Miningarra Subgroup consists of the Wandiwarra Formation, Princess Ranges Quartzite, Wongawol Formation, Kulele Creek Limestone and Mulgarra Sandstone.

Wandiwarra Formation

The Wandiwarra Formation is named from Wandiwarra Well, 12 km east of Windidda homestead in the Kingston Sheet area, and is the unit of medium to fine-grained clastic sediments between the uppermost carbonate member of the Windidda Formation and the lowermost mature quartzite of the Princess Ranges Quartzite. In the type section (between grid references 547722 and 548724) it consists of

fine-grained, pink to grey, finely laminated, cross-bedded micaceous sandstone with occasional ripple marks and small mud pellets. Interbedded with the fine-grained sandstone are 1 to 2 m bands of grey-brown, impure micaceous quartz arenite, and finely laminated micaceous shale. Total thickness in the type section is 350 m.

Where the Wandiwarra Formation overlies carbonates of the Windidda Formation, the basal bed is a poorly sorted glauconitic sandstone, but where the carbonates are absent, in the northern and central parts of the synclinorium, the shale unit overlying the Frere Formation is taken as the base of the Wandiwarra Formation.

The contact between the Wandiwarra Formation and the overlying Princess Ranges Quartzite is diachronous: the mature quartzites marking the base of the Princess Ranges Quartzite rest directly on the Windidda Formation in the east; to the west the Wandiwarra Formation thickens and the first mature quartzite appears higher in the sequence.

Princess Ranges Quartzite

The Princess Ranges Quartzite is named from the Princess Ranges in the Kingston Sheet area. It is the unit of predominantly medium to coarse-grained, quartz-rich clastic rocks that lies conformably between the Wandiwarra and Wongawol Formations. The base and the top are respectively, the bottom of the first massive, pale, crystalline quartzite overlying the Wandiwarra Formation; and the last bed of similar quartzite beneath the Wongawol Formation. The type section is along the unnamed creek that crosses the Princess Ranges between grid references 479762 and 483764.

The Princess Ranges Quartzite is dominated by three main units of massive orthoquartzite interbedded with fine sandstone and sandy siltstone. The formation is about 200 m in thickness at the type section, but it thickens to the southeast due to the diachronous nature of the lower contact.

The diagnostic rock type is a medium to coarse-grained, supermature, quartz-cemented orthoquartzite. Glauconite is present in some units, and fine lamination, cross bedding, ripple marks and mud pellets are common. Ferruginous spots up to several centimetres across give the quartzite a speckled or blotchy appearance. The spots are probably weathered rhombs of carbonate cement.

Wongawol Formation

The Wongawol Formation ("Wongawol Sandstone" of Hall and Goode, 1975) is named from Wongawol homestead in the Kingston Sheet area, and is the unit of fine-grained sandstone, siltstone and minor carbonate rocks between the Princess Ranges Quartzite and the Kulele Creek Limestone. The type section is along the Wiluna-Carnegie road between grid references 504752 (Kingston Sheet) and 513777 (Stanley Sheet).

The lower part of the Wongawol Formation is a monotonous sequence of grey to pinkish brown, finely laminated, very fine sandstone and siltstone. Abundant sedimentary structures include small-scale festoon cross-bedding, ripple marks, small scour channels, load casts, slump rolls and rare mud cracks.

Thin carbonate beds and carbonate breccia beds are interbedded with the sandstone in the upper part of the Wongawol Formation. The *Sholl Creek Member* (equivalent to "Sholl Creek Formation" of Hall and Goode, 1975) is taken from the lowermost carbonate bed to the top of the Wongawol Formation, and is well exposed along Sholl Creek between grid references 531779 and 528786 (Stanley Sheet). The base of the member marks a transition towards carbonate sedimentation, but the basal carbonates are lenticular. The Sholl Creek section supplements the Wongawol Formation type section, the corresponding part of which is poorly exposed. The most abundant rock type in the Sholl Creek Member is a fine-grained, arkosic micaceous sandstone similar to that in the lower part of the Wongawol Formation. In addition to the carbonate interbeds, micaceous maroon and chocolate shales are also interbedded and these become abundant towards the top of the Sholl Creek Member.

Total thickness of the Wongawol Formation is estimated at 2 000 m, of which the upper 600 m constitute the Sholl Creek Member. However, the shallow dips and gentle folds make calculations difficult, and these figures may be over-estimates. The formation represents a transition from shallow water clastic to carbonate sedimentation.

Kulele Creek Limestone

The Kulele Creek Limestone, which is named from Kulele Creek in the Stanley Sheet area, is the formation of carbonate and minor clastic sediments lying between the Wongawol Foramtion and the overlying Mulgarra Sandstone. The formation is about 300 m thick at the type section, which is in the vicinity of Mount Throssell between grid references 581767 (Kingston Sheet) and 586770 (Stanley Sheet). The base of the Kulele Creek Limestone is taken at the appearance of metre-thick stromatolitic carbonate and cross-bedded calcarenite beds, a horizon which approximately corresponds to the predominance of carbonate beds over shale beds, as distinct from the reverse in the upper part of the Wongawol Formation. The top is taken at the top of a thick carbonate band beneath the arenite of the Mulgarra Sandstone.

The Kulele Creek Limestone consists of bands of calcarenite, carbonate conglomerate, stromatolitic limestone, oolitic limestone and purple shale, commonly forming cyclic sequences 5 to 10 m thick. The stromatolites form domal structures several metres across, commonly with carbonate clasts and ooliths in the interdomal areas. These are particularly well preserved in an outlier of the lower part of the sequence, 60 km west of the type section, at grid reference 516777 (Stanley Sheet). Several prominent sandstone bands occur in the Kulele Creek Limestone between 150 and 200 m above the base.

The Kulele Creek Limestone conformably overlies the Sholl Creek Member of the Wongawol Formation, and the top is marked by the sudden incoming of a transgressive arenite sequence.

Mulgarra Sandstone

The Mulgarra Sandstone is named from Mulgarra Pool in the northeast corner of the Kingston Sheet area. Its type section is in the Timperley Range area between grid references 589767 (Kingston Sheet) and 594776 (Stanley Sheet), where it is only poorly exposed. Total thickness is probably greater than 100 m. At the base, a thick quartz arenite rests with a sharp, probably disconformable, contact on the underlying Kulele Creek Limestone.

The dominant lithology is a medium-grained grey to brown ferruginous quartz arenite with minor glauconite. The middle part of the exposed sequence contains minor shale and carbonate bands. Sedimentary structures include shale pellets, small slump rolls, small cross beds and rare load casts.

The Mulgarra Sandstone is the youngest known unit of the Earaheedy Group. It is exposed only in the extreme eastern part of the Nabberu Basin where it occupies the centre of the synclinorium.

AGE AND REGIONAL CORELATIONS

The Earaheedy Group is considered to be Lower Proterozoic in age for several reasons. The group unconformably overlies Archaean rocks and is unconformably overlain by the Bangemall Group which has been dated at about 1 100 m.y. The thick pelletal iron-formations of the Frere Formation are of the Lake Superior type which is generally considered characteristic of the Lower Proterozoic. Microfossils from the Frere Formation are identical to those from the Lower Proterozoic Gunflint and Biwabik Iron Formations of the Lake Superior district (Walter and others, 1976).

Glauconite from the Yelma Formation in the Duketon Sheet area (southeast Nabberu Basin) gave K-Ar ages of around 1 700 m.y. and Rb-Sr ages of between 1 590 and 1 710 m.y. (Preiss and others, 1975). Horwitz (1975) reports a K-Ar age of 1 685 m.y. for glauconite which, using his coordinates, comes from the base of the Wandiwarra Formation in the northwest corner of the Kingston Sheet area. Because of the possibility of argon loss these must be regarded as minimum ages.

Relationships between the Earaheedy Group and the Lower Proterozoic Padbury Group (Barnett, 1975) to the west are uncertain. Pelletal iron-formations are present in the Padbury Group, although they are a minor constituent, and a correlation of at least the upper part of the Padbury Group with the Frere Formation is possible. The bulk of the Earaheedy Group may therefore be younger than the Padbury Group.

The Glengarry Sub-basin (Fig. 22) contains a basal quartz arenite unit overlain by a mixed unit of shale, marl, carbonate, greywacke and arenite. This mixed unit is probably a facies variant of the Thaduna Beds. It is not clear at present whether the basal arenite is a diachronous shore facies of the mixed unit and continuous with the Yelma Formation, or whether the Yelma Formation is unconformably above the entire sequence in the Glengarry Sub-basin.

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PRELIMINARY SYNTHESIS OF LOWER PROTEROZOIC STRATIGRAPHY AND STRUCTURE ADJACENT TO THE NORTHERN MARGIN OF THE YILGARN BLOCK

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ABSTRACT

An east-west elongated synclinorium, filled with Lower Proterozoic sediments, unconformably overlies the northern margin of the Yilgarn Block and is unconformably overlain by the Middle Proterozoic Bangemall Group. Two sub-basins are described. The western, Glengarry Sub-basin, contains the oldest sediments, which are a basal sandstone followed in the southeast by a shelf sequence of shales, marls and carbonates and in the northwest by an axial sequence of shale, arkose, greywacke and interbedded basalt. The youngest sediments in the sub-basin are the thick coarse-grained clastics, iron-rich shales and banded iron-formation of the Padbury Group. The Earaheedy Group occupies the eastern (Earaheedy) sub-basin and unconformably overlies part of the older sequence in the Glengarry Sub-basin. The basal pelletal iron-formations and iron-rich shales are possible equivalents of the upper part of the Padbury Group. The succeeding quartzites, fine sandstones and limestones are the youngest rocks in the basin.

The Lower Proterozoic rocks are located on an east-west trending junction between Archaean granite-greenstone and gneissic terrains, marking the transition from cratonic to mobile basement, and the basin structure is related to this underlying major crustal suture. On the southern margin of the present extent of the Lower Proterozoic rocks, the sediments are relatively flat lying on the Kingston Platform. The Stanley Fold Belt lies to the north of the Kingston Platform and is an arcuate zone of tight folding. In the centre the north-northwest trending Wiluna Arch narrows the present basin extent, and the sediments there are faulted by the Celia Lineament. In the extreme west, sediments have been involved in the dynamothermal metamorphism associated with the Proterozoic Gascoyne Province, forming banana-shaped synclinal zones truncated by the basement highs of the Yarlarweelor Gneiss Belt, and the Marymia Dome. Within the fold belt narrow zones occur where tectonically active basement has controlled sedimentation and extrusion of basic volcanics. The Goodin Dome is associated with such zones. In the east, tight folds are oriented east-west and are overturned to the south. Granite basement comes to the surface in the Malmac Dome.

Correlation between these Lower Proterozoic rocks and the Hamersley Basin has been suggested by several previous authors, but is considered to be unlikely due to differences in lithology and radiometric ages.

INTRODUCTION

A complex arcuate belt of Lower Proterozoic sedimentary rocks lies with marked angular unconformity on the Archaean Yilgarn Block along its northern margin, and is unconformably overlain by Middle Proterozoic rocks of the Bangemall Basin. Hall and Goode (1976) introduced the term "Nabberu Basin" to include all these lower Proterozoic rocks, and this term has been subsequently used in a number of publications. However, in view of the uncertainties over relationships between the two sub-basins (described below) we feel that it is premature to say whether the sub-basins have sufficient stratigraphic and structural unity to justify inclusion within a single named (Nabberu) basin; it may be that when better evidence is available concerning their relative ages it will be more appropriate for each to be raised to basin status. We nevertheless find the term Nabberu Basin convenient in describing these rocks, and use it in this paper in the sense of Hall and Goode, with the proviso that further work is required to prove its validity.

Systematic mapping by the Geological Survey of Western Australia has previously skirted around this basin (Bunting and Chin, 1975; Barnett, 1975), and only recently have programmes been directed to the basin itself. Although much of this current work is incomplete, and previously