A marine to fluvial transition in the Paleoproterozoic Koolbye ormation, Turee Creek Group, Western Australia

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Abstract

Although no unambiguous biogenic criteria exist to discriminate Precambrian shallow-marine successions from fluvial deposits, physical sedimentological evidence, including an association of primary sedimentary structures and textures, stratigraphic position, and comparison with Phanerozoic and Modern examples has been found useful in identifying these deposit types. Our high resolution sedimentary facies analysis coupled with new mapping clearly indicates shallow-marine to beach-aeolian to fluvial sedimentation in the Paleoproterozoic Koolbye Formation of the Turee Creek Group, Western Australia. A falling stage systems tract within the Koolbye Formation has been documented. Our sedimentary facies analysis in combination with sedimentological analysis of the underlying Kungarra Formation indicates development of at least three falling stage systems tracts within the Turee Creek Group across the rise of atmospheric oxygen (the Great oxidation event).

Key words: *Paleoproterozoic, tidal flat, beach, fluvial, Koolbye Formation, Turee Creek Group, Western Australia*

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1. Introduction

The distinction between Precambrian shallow-marine and fluvial deposits is problematic (Collinson, 1986; Fedo and Cooper, 1990; McCormick and Grotzinger, 1993; Bose and Chakraborty, 1994; Eriksson et al., 1998, Bose et al., 2012). In phanerozoic successions, body fossils and trace fossils are in many cases the definitive criterion. Almost no biogenic criteria exist for early Precambrian successions (McCormick and Grotzinger, 1993; Eriksson et al., 1998; Bose et al., 2012). The resulting confusion is apparent in paleogeographic reconstruction of many early Precambrian unfossiliferous, texturally mature, tabular quartzite bodies (Long, 1978; Bose and Chakraborty 1994; Martin et al., 2000; Bose et al., 2012 and references therein). Precambrian shallow-marine successions typically comprise either metre-thick**,** upward-coarsening units, commonly interpreted as parasequences (Eriksson and Simpson, 1990; Jackson et al., 1990; Tirsgaard, 1996; Eriksson et al., 1998; Catuneanu, 2006), or they form successions of homogeneous sandstone hundreds to thousands of metres thick, generally showing an apparent lack of cyclic or sequential development and lacking mudstones (Long, 1978, 2006; Cant and Hein, 1986; Chandler, 1988; Tirsgaard, 1993; Eriksson et al., 1995, 1998). No unambiguous biogenic criteria exist to discriminate Precambrian shallow-marine succession from fluvial deposits. However, physical sedimentological evidence, stratigraphic position, and comparison with Phanerozoic and Modern examples have been found useful in identifying these deposit types (Harris and Eriksson, 1990; Fedo and Cooper, 1990; McCormick and Grotzinger, 1993; Chakraborty et al., 2009).

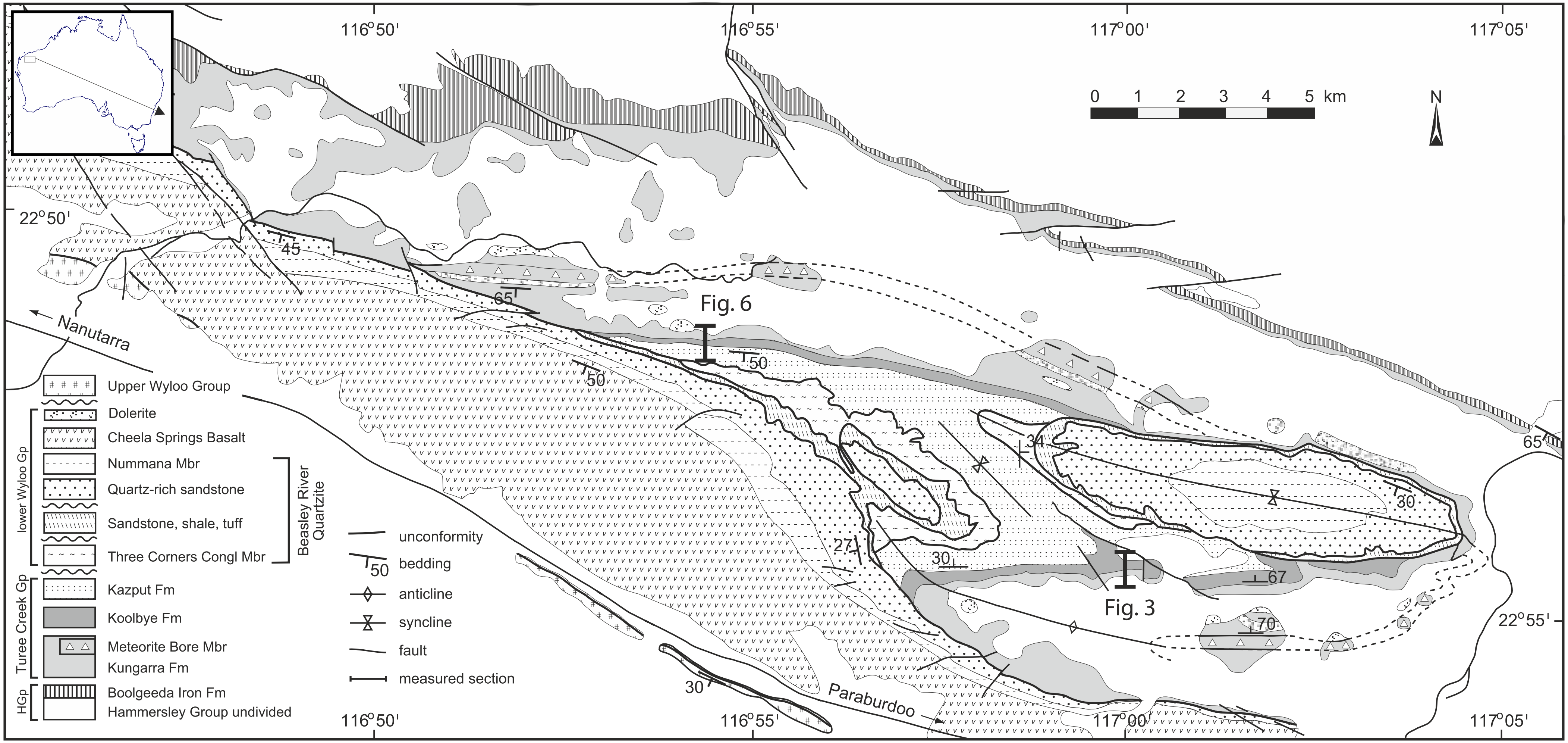
The terrestrial to marine Fortescue Group (2.78-2.63 Ga), the marine Hamersley (2.63-2.45 Ga), and the deep to shallow-marine Turee Creek (<2.45 to >2.22 Ga) **G**roups record almost continuous deposition for nearly 600 m.y. across the rise of atmospheric oxygen (Thorne and Trendall, 2001; Van Kranendonk, 2010; Williford et al., 2011; Van Kranendonk and Mazumder, 2015). The lower part of the Turee Creek Group, represented by the Kungarra Formation, is characterized by fine- to medium-grained siliciclastic rocks, together with minor carbonate rocks and glacio-marine sedimentation and shows an overall shallowing upward trend, implying relative sea level fall (Martin, 1999; Martin et al., 2000; Van Kranendonk and Mazumder, 2015*;* Van Kranendonk et al., 2015). However, the sedimentological inventory of the overlying Koolbye Formation remains to be documented in detail (Fig. 1). Thorne and Tyler (1996) inferred the Koolbye sandstones as coastal to shallow marine, whereas Martin et al. (2000) interpreted the Koolbye Formation as a fluvial deposit. This contradictory inferred depositional environment stems from a lack of sedimentary facies and stratigraphic analysis.

In order to fill this gap and better constrain the depositional environment of the Koolbye Formation, we present high resolution sedimentary facies analysis for the first time and discuss its sequence stratigraphic implications with respect to the developing Turee Creek basin.

2. Geological setting

The most complete and best exposures of the Turee Creek Group lie in the Hardey Syncline (Fig. 1: Trendall, 1979; Martin et al., 2000). The Turee Creek Group conformably overlies the <2.45 Ga Boolgeda Iron Formation of the Hamersley Group and is unconformably overlain by the lower Wyloo Group (Trendall, 1979; Martin et al., 2000; Van Kranendonk, 2010; Mazumder and Van Kranendonk, 2013; Van Kranendonk and Mazumder, 2015; Van Kranendonk et al., 2015).

Figure 1 Geological map of the study area showing the disposition of the Koolbye Formation and bounding litho-units; position of sections presented in Figs. 3 and 6 are marked. Map of Australia in inset.



Thorne and Tyler (1996) defined the clastic sedimentary rock succession of the c. 3.9 km thick Turee Creek Group as comprising the lower Kungarra, middle Koolbye, and upper Kazput formations (Fig. 1). Diamictite of the Meteorite Bore Member (MBM) of the Kungarra Formation was identified as glaciogenic on the basis of outsize clasts and striated faces (Trendall, 1979). Martin (1999) interpreted the diamictites as deposited from a floating ice sheet over a marine basin, and this was confirmed by Van Kranendonk and Mazumder (in prep. b), although they recognised two separate diamictite horizons.

The sedimentological inventory of the Koolbye Formation is largely unknown, including its relations to underlying rocks of the Kungarra Formation. The Koolbye Formation is conformably overlain by the Kazput Formation. The sedimentological inventory of the Kazput Formation is also very poor and the depositional environment is largely unknown (Martin et al., 2000), but research into this unit is also underway.

3. Sedimentary facies analysis

A detailed 105m thick section through the quartz-rich sandstones of the Koolbye Formation (Figs. 2, 3) was measured on the southern limb of the Hardey Syncline (Fig. 1). Here, the Koolbye Formation conformably overlies the Kungarra Formation with apparent conformity and is conformably overlain by the Kazput Formation (Fig. 1).

The Koolbye Formation at this locality is predominantly composed of medium- to fine-grained quartz-rich sandstone (Fig. 4 A-F) interbedded with fine-grained sandstone and siltstone. Four main horizons of quartz-rich sandstone are clearly evident from field exposures (Fig. 2). Whereas the lower two sandstone units are shallow marine (tidal flat deposits), the third unit represents beach deposit with aeolian reworking. The topmost sandstone unit is of fluvial origin (see Section 3.1-3.3 for detailed sedimentary facies

Figure 2 Field photograph showing the litho units of the Koolbye Formation, southern limb of the Hardy syncline (501993N, 7465956E). Medium to fine-grained sandstones (ridges) dip towards north (see Fig. 3 for details).

Figure 3 A detailed measured section through the Koolbye Formation on the southern limb of the Hardey Syncline (see Fig. 1 for location of the section and Fig. 2 for mode of occurrence).

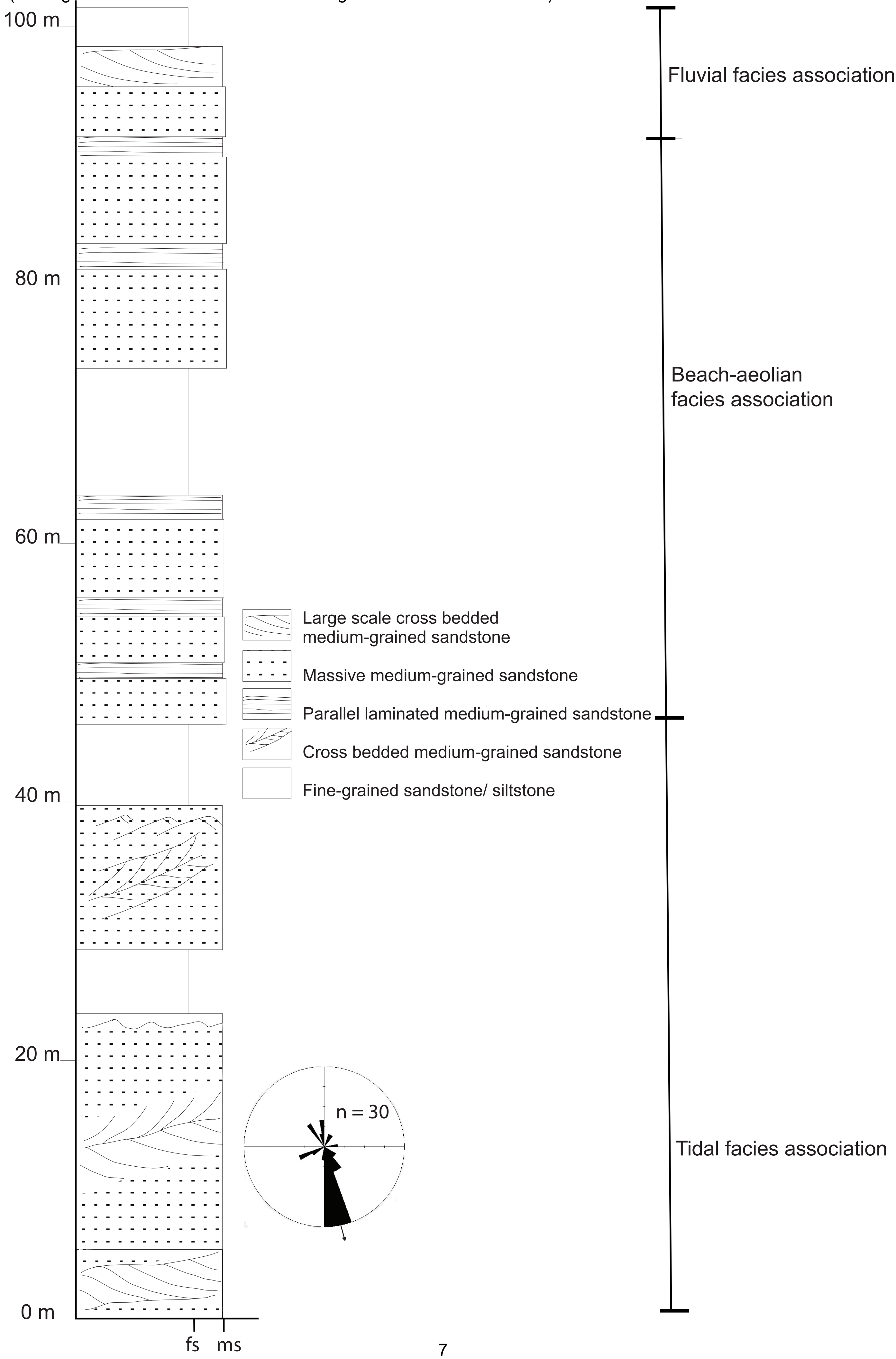
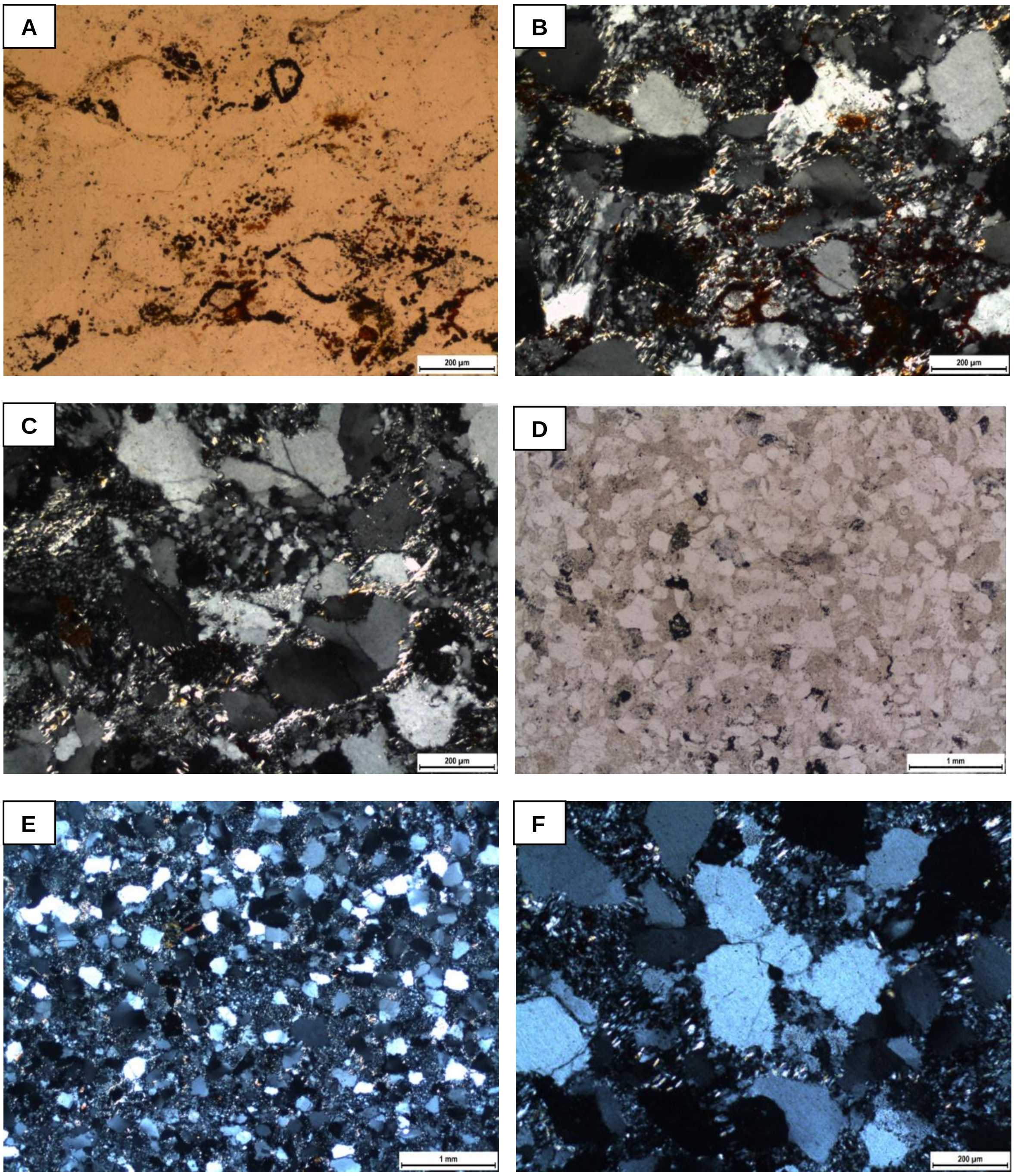


Figure 4 Photomicrographs of Koolbye sandstones. **(A)** quartz rich sandstone from the tidal facies association (see Fig. 3). Quartz grains have disseminated hematite inclusions along the contact of the primary grain boundaries and silica overgrowth, indicating that the grain roundness is primary, under plane polarised light. **(B)** Same photomicrograph under cross polars. **(C)** Lithic fragment and feldspar within the sandstone of the tidal facies association. **(D**) Compositionally mature, with some well sorted sub rounded to rounded quartz grains within the beach sandstone (see Fig. 3) under plane polarised light. **(E)** Same photomicrograph under cross polars. **(F)** Medium-grained sandstone from the fluvial facies association (see Fig. 3) with angular quartz grains and occasional volcanic rock f**ragments.**

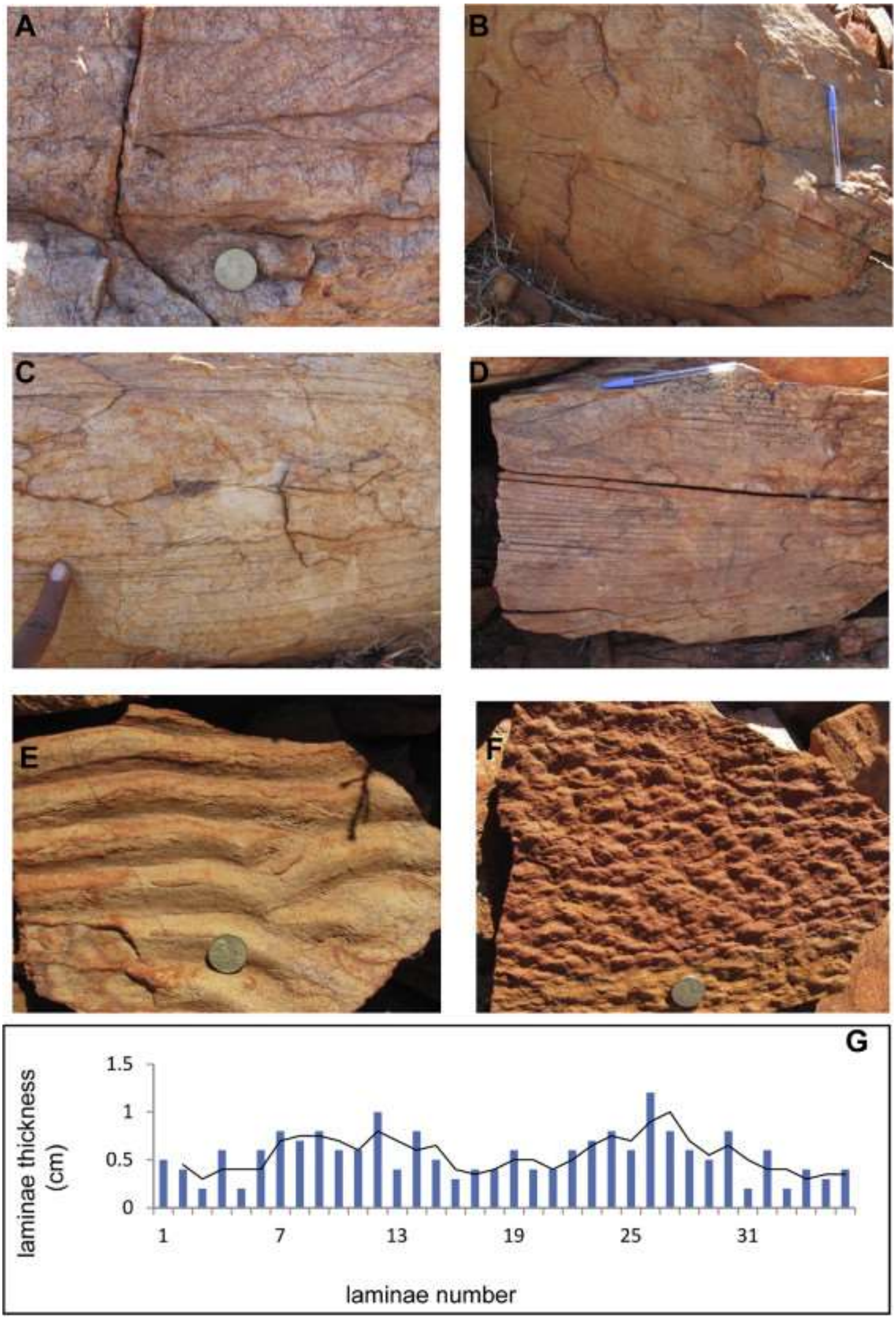


description and interpretation). The sandstone units become progressively younger from left to right (Fig. 2)**.** The two lower sandstone units (Figs. 2-3) are dominated by quartz grains (Figs. 4A, B), with subordinate lithic fragments and feldspars (up to 5%, Fig. 4C). The matrix content is 10-12%. Quartz grains have disseminated diagenetic hematite inclusions along the contacts of the primary grain boundaries and silica overgrowths, which helps to show that the grain roundness is primary (Fig. 4A). The third sandstone unit (Figs. 2-3) has angular and cuspate as well as some subrounded to rounded quartz grains (Figs. 4D, E). On the contrary, the topmost sandstone unit (Fig. 3) is medium grained and contains abundant angular quartz (Fig. 4F) and occasional volcanic rock fragments. The topmost sandstone unit (fluvial) is compositionally as well as texturally immature than the tidal flat and beach deposits.

In the measured section on the southern limb of the Hardey Syncline, three facies associations are identified (Figs. 1, 3). These facies associations include a tidal flat association (Fig. 5), a coastal (beach and aeolian) association (Figs. 7, 8) and a braided fluvial facies association (Fig. 3).On the northern limb of the Hardy syncline (Fig. 1), however, the tidal facies association is lacking whereas the beach and aeolian and the fluvial facies associations of the Koolbye Formation conformably overlies shallow marine Kungarra Formation (Figs. 6 and 9).

Paleocurrent data has been collected from three-dimensional bedding plane exposures with spectacular trough cross-beds. Paleocurrent analysis has been done following the methodology prescribed by Dott (1974) and High and Picard (1974). As the dip of bedding is $>25^{o}$, tilt correction has been done following the methodology prescribed by Ramsay (1961). The three facies associations are described and interpreted below.

Figure 5 Field photographs of Koolbye sandstone (two lower sandstone units; see Figs. 2-3). **(A)** Herringbone cross bedding. **(B)** Laterally accreted tidal rhythmite; note mud drapes along the foreset planes. **(C)** Parallel and ripple lamination within the tidal sandstone; note thin mud drapes along the ripple foreset planes. **(D)** Reactivation surfaces truncating the foreset planes; note mud drapes along the foreset planes. **(E)** Nearly straight crested ripples with tuning fork like bifurcation formed on tidal flat. **(F)** Interference ripples. **(G)** Plot of successively younger foreset laminae thickness showing sinusoidal pattern; this indicates periodic rise and fall of current strength, compatible with tidal current (see De Boer et al. 1989, and Mazumder, 2004 for details).



3.1. Tidal facies association

The tidal facies association, constituting ~45% of the measured section (Fig. 3), conformably overlies tidal current and wave activated shallow marine sandstone of the Kungarra Formation (Martin, 1999; Martin et al., 2000; Van Kranendonk and Mazumder, *in prep. a*). Two facies constitute the tidal facies association.

3.1.1 Facies A: Medium-grained, cross-bedded sandstone facies

Description: These are medium-grained cross-bedded sandstone (Figs. 5A-C) with planar tabular, concave-up or sigmoidal foreset geometry with occasional horizontal lamination. Sets of large-scale cross-bedding range from 10 to 55cm in height, with a lateral extent varying from 1-5m. Sets often form co-sets, which may constitute an entire sand sheet. Well-developed herringbone cross-stratification is found at places within the co-sets (Fig. 5A). Mud drapes (Figs. 5C-D) are common along the foresets and also along the reactivation surfaces. Lower set boundaries are slightly erosive (Fig. 5B-C). Foreset dip directions are either weakly bipolar, with the dominant paleocurrent towards the south and a subordinate paleocurrent direction towards the north-northwest (Fig. 3). A plot of successive laminae thickness reveals thick-thin alternation that is characteristic of tidal deposits (Fig. 5G; De Boer et al., 1989; Mazumder, 2004).

Interpretation: The sedimentary structures (5A-D) associated with the large-scale cross-bedding are typical, although not individually diagnostic of, tidal action (Eriksson and Simpson, 2004). Characteristic features of a tidal deposit include: mud drapes along foresets (Figs. 5A-D), numerous reactivation surfaces (Fig. 5D), widespread herringbone cross-stratification (Fig. 5A), and broadly undulatory lower set boundaries associated with successive foreset bundles (Fig. 5A). The bipolar foreset-dip directions (Fig. 3) are common throughout the two lower sandstone units (Fig. 3). This observation, coupled with thick-thin alternation of the cross-stratification foreset thicknesses (Fig. 5G), clearly indicate that the facies represents a tidal channel deposit (Visser, 1980; Boersma and Terwindt, 1981; De Boer et al., 1989; Trisgaard, 1993; Bose et al., 1997; Eriksson P.G. et al., 1998; Eriksson and Simpson, 2004, 2012; Mazumder, 2004, 2005; Eriksson, K.A. et al., 2006; Köykkä and Lamminen, 2011； Longhitano et al., 2012). Thus, this facies (which constitutes ~80 % of the tidal facies association) represents sand sheet elements interpreted to be deposits in tidal channels (cf. Tirsgaard, 1993).

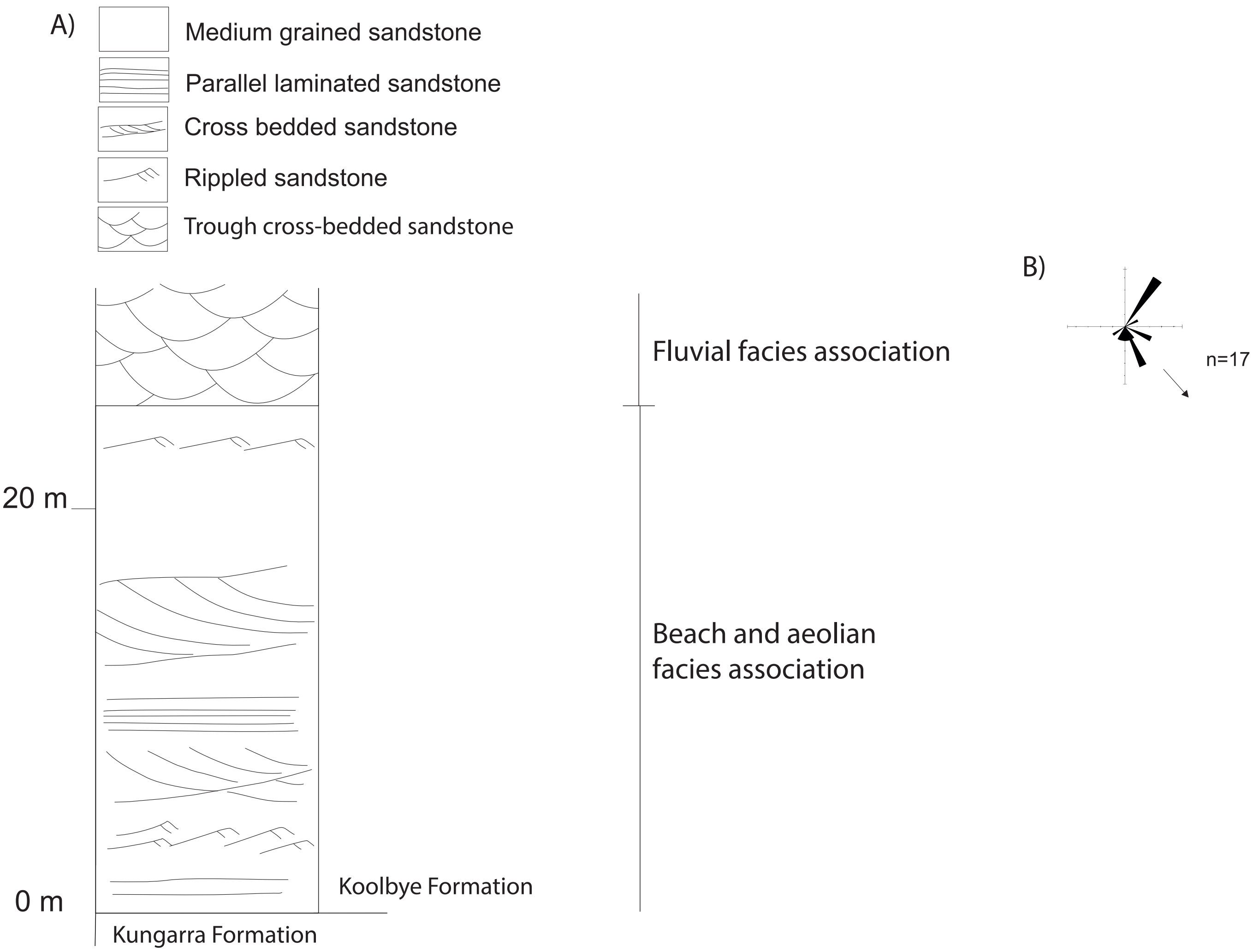
3.1.2 Facies B: Very fine-grained rippled sandstone facies

Description: This facies is characterized by thinly bedded, very fine sandstone/silty sandstone with thickness up to 2m. These are laterally extensive and are invariably overlain and underlain by the sand sheet elements of Facies A (Figs. 5A-D). Whereas the lower contacts of this facies with Facies A are non-erosive, the upper contacts are erosional. There is no vertical change in grain-size. Straight to sinuous crested, near symmetric ripples on bedding planes (Fig. 5E), often with tuning fork-like bifurcation are the most common sedimentary structures together with multi-directional, interference ripples (Fig. 5F). Desiccation cracks are preserved at places.

Interpretation: The presence of straight to sinuous crested near-symmetric ripples with tuning fork-like bifurcation and interference ripples clearly indicate that this facies formed in a wave influenced, low energy tidal flat environment (Tirsgaard, 1993; Johnson and Baldwin, 1996; Eriksson et al., 1998; Eriksson et al., 2006; Longhitano et al., 2012). The gradual transition to the underlying sand sheet and the erosive upper contact with the overlying sand sheet (both Facies A), in combination with the occurrence of local desiccation cracks, imply an intertidal depositional environment (Tirsgaard, 1993; Eriksson et al., 1998; Mazumder, 2005).

3.2. Beach and aeolian facies association

Figure 6 (A) A measured section through the Koolbye Formation on the northern limb of the Hardey Syncline (see Fig. 1 for location of the section). **(B)** Rose diagram showing paleocurrent pattern of the fluvial sandstone, northern limb of the Hardy syncline (493894E, 7471452N).



The beach and aeolian facies association constitute ~45% of the measured section on the southern limb of the Hardy syncline (Fig. 3). This facies association directly overlies the shallow marine Kungarra Formation on the northern limb of the Hardy syncline (Fig. 6). In both sections, this facies association is overlain by the fluvial facies association (Figs. 3, 6). Four facies constitute this facies association.

3.2.1 Facies C: Medium-grained, well sorted sandstone facies

Description: This facies is composed of medium-grained, well-sorted sandstone with subrounded to rounded grains (Fig. 4D-E) and characteristic heavy mineral layering (Fig. 7A-B). Small-scale trough cross-lamination is present at places, as are very low amplitude ripples on bedding planes (Fig. 8A). The foreset planes are defined by alternate dark and light coloured layers (Fig. 7A).

Interpretation: The relatively well sorted nature of this sandstone, in combination with the sub-rounded to rounded nature of the grains, indicate repeated reworking by water current or air, either in a shallow marine, or near coastal setting (Eriksson, 1979, his fig. 11; Kocurek, 1996; Eriksson et al., 1998). The characteristic parallel heavy mineral layering (Fig. 7B) is very common in modern (Fig. 7C) and ancient beach deposits and are indicative of a higher flow regime (Allen, 1984; Mazumder, 2000). This observation, coupled with the absence of mud draped ripples, reactivation surfaces and thick-thin alternation of foreset laminae indicate that this facies represents a beach deposit (Reading and Collinson, 1996; Eriksson et al., 1998). The low amplitude ripples are aeolian ripple indicating aeolian reworking of the beach sediments (described and interpreted below).

3.2.2 Facies D: Rippled sandstone facies

Description: This facies is characterized by medium-grained, well sorted sandstone with very low amplitude (up to 0.5cm) and nearly straight crested ripples on bedding plane (Fig. 8A).

Figure 7 (A) and **(B) F**ield photographs of the beach facies, southern limb on the Hardy syncline (Fig. 1). Note heavy mineral layering defining the foreset planes **(A)** and parallel lamination **(B). (C)** Heavy mineral zonation in recent beach sediments, Chandipur, Bay of Bengal, India.

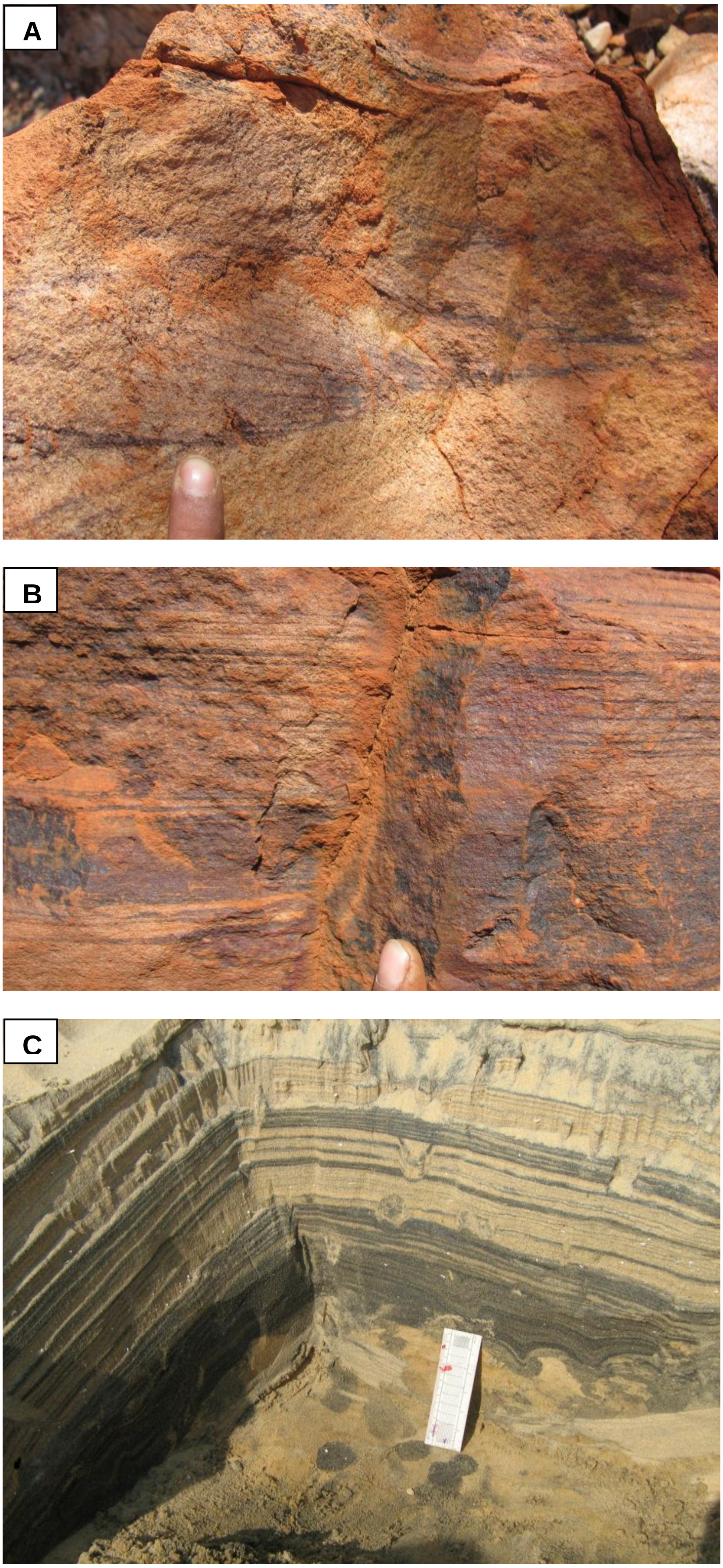
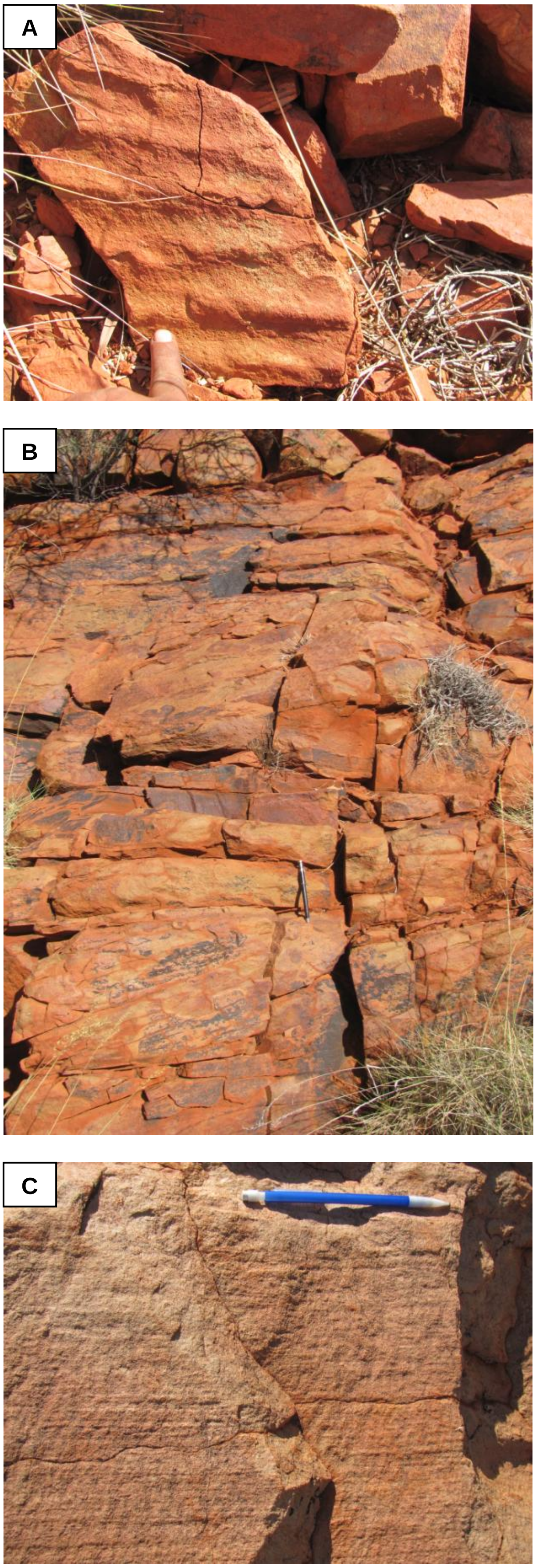


Figure 8 Field photographs of the aeolian facies association**. (A)** Very low amplitude aeolian ripple (southern limb on the Hardy syncline). **(B)** Aeolian dune and **(C)** Pinstripe lamination (northern limb on the Hardy syncline).



This facies occurs invariably on top of the medium-grained, well sorted sandstone with heavy mineral layering (Facies C) (Fig. 7A-B).

Interpretation: These low amplitude ripples are typical of aeolian ripples (cf. Steidtmann, (1974, his figs. 6 and 7); Kocurek, 1991, 1996; Grotzinger et al., 2005) and their association with medium-grained well sorted sandstone with heavy mineral layering (Facies C) indicate their generation in a coastal environment (Eriksson et al., 1998, 2013).

3.2.3 Facies E: Tabular cross-stratified sandstone facies

Description: This facies is characterized by large-scale, planar and tabular cross-stratified fine-grained sandstone (Fig. 8B) containing cross-sets of variable thickness, the maximum being 3 m. Foresets are downslope-wedging. No mud drapes along the foresets were observed. This facies vertically grades either into parallel and/or very low angle laminated sandstone (Facies F) (Figs. 8B-C).

Interpretation: These cross-stratified sandstones are either the product of migration of aeolian dunes (Boothroyd and Nummedal, 1978; Bose and Chakraborty, 1994; Kocurek, 1996; Eriksson and Simpson, 1998; Simpson et al., 2004) or the products of lateral accretion of linguoid bars in fluvial systems (Cant, 1978; Cant and Walker, 1978; Miall, 1988, 1996; Collinson, 1996). However, the well sorted nature of the sands (Fig. 4D-E) and their association with units containing pin-stripe lamination (Fig. 8C; see below) clearly support an aeolian origin of this facies (Kocurek, 1991, 1996; Simpson et al., 2004; Mazumder and Van Kranendonk, 2013).

3.2.4 Facies F: Pin-stripe laminated, well sorted, medium-grained sandstone facies

Description: This facies is characterized by well sorted, almost horizontal sheet like sandstones with rounded to sub-rounded grains and planar, to very low angle, pin-stripe stratification (Fig. 8C). Relatively fine-grained sand forms the bases of each stratum, as evident from distinct colour variations. At places, sediments with the coarsest grain size are concentrated on top of each layer, giving rise to inverse grading locally. Internal cross-lamination is preserved in places (Fig. 8C). Individual facies units have an average thickness of 30 cm.

Interpretation: The planar stratified to low-angle inclined stratifications in this facies are very similar to the pin-stripe lamination attributed to aeolian action (Hunter, 1981; Hunter and Rubin, 1983; Fryberger and Schenk, 1988; Kocurek, 1991, 1996; Mazumder and Van Kranendonk, 2013), specifically aeolian inter dune deposits (Kocurek, 1991, 1996; Eriksson and Simpson, 1998; Simpson et al., 2012; Mazumder and Van Kranendonk, 2013). The colour contrast (Fig. 8C) defining the pin-stripe lamination is a consequence of differential permeability caused by differential diagenesis due to the sediments accumulating in wind-ripple troughs and being relatively less sorted than the wind ripple deposits (Fryberger and Schenk, 1988; Simpson et al., 2012; Mazumder and Van Kranendonk, 2013).

3.3 Braided fluvial facies association

This facies association occurs on top of the beach and aeolian facies association in the sections on both the limbs of the Hardy syncline (Figs. 3 and 6) and is characterised by very well preserved, large channels (Fig. 9A-B). The fluvial facies are developed in meter-scale, fining-upward successions and lacks finer facies constituents (i.e. fine sandstone/siltstone/mudstone) (Fig. 9A). In contrast to the facies constituents of the underlying beach and aeolian facies association (Figs. 4D-E), angular quartz is the dominant constituent, with feldspar and lithic fragments comprising less than 10% of the framework grains (Fig. 4F). Two facies constitute this facies association.

Figure 9 Field photograph of fluvial facies association, northern limb on the Hardy syncline (Figs. 1 and 3). **(A)** Large fluvial channel; note lenticular beds**. (B)** Trough cross-bedded sandstone.

3.3.1. Facies G: Medium-grained large-scale trough cross-stratified sandstone

Description: This facies is characterized by medium grained large scale trough cross-stratified sandstone (Fig. 9A). Bed geometry is mostly tabular but lenticular beds are also common (Fig. 9A). The facies units are up to 4m thick. The thickness of the trough cross-bed sets decreases upwards in cosets (Fig. 9B). This facies invariably occurs on major erosion surfaces. Sediment dispersal patterns show a wide spread from northeast to south west and a vector mean direction towards the southeast (Fig. 6B).

Interpretation: This facies is attributed to dune migration along the channel floor under hydrodynamic conditions of the upper part of the lower flow regime (Miall, 1985; Mazumder and Sarkar, 2004; Sambrook Smith et al., 2006; Mazumder and Van Kranendonk, 2013).

3.3.2. Facies H: Massive to plane laminated medium-grained sandstone

Description: This facies is characterized by massive to plane laminated medium-grained sandstone. It occurs on top of trough cross-bedded sandstones (Fig. 9A) and has a sheet-like geometry. At places, the massive sandstone units have wedge-shaped geometry (Fig. 9B). The parallel laminated unit is more common towards the top of the succession (Fig. 9A). The measured thickness of this facies is much less than the trough cross-stratified sandstone facies.

Interpretation: This facies may represent deposition from highly suspended flow during floods (overbank deposits: Miall, 1985; Mazumder and Sarkar, 2004; Mazumder and Van Kranendonk, 2013), or may have formed within the river channel during the lowering of current velocity (Collinson, 1996). The parallel laminated sandstones may represent decreasing water depth during waning flow. Confinement of this facies invariably on top of the trough cross-stratified sandstone facies, together with a lack of fine-grained facies (i.e., fine sandstone/siltstone/mudstone) indicate that this facies probably formed within the channel.

4. Discussion

Sedimentary facies analysis of sections on the southern and northern limb of the Hardy syncline reveals deposition across a marginal marine to fluvial-aeolian transition (Figs. 3 and 6). The lower part of the Koolbye Formation on the southern limb of the syncline represents a shallow-marine intertidal deposit, in which two distinct architectural elements have been recognized: a tidal channel, showing a bipolar, unimodal paleocurrent pattern (Figs. 3, 5A-D); and a tidal flat (Figs. 5E-F). This is followed upsection by beach (Fig. 7A-B) and coastal aeolian sediments (Figs. 8A-C), and then by braided fluvial deposits (Figs. 3, 6) with spectacular channel morphology and large-scale trough cross beds (Figs. 9A-B).

The transition from deep to shallow marine deposits of the underlying Kungarra Formation, to marginal marine (intertidal-beach) and fluvial sandstones of the Koolbye Formation indicates deposition during overall relative sea level fall throughout the lower part of the Turee Creek Group (Posamentier et al., 1988; Posamentier and James, 1993; Catuneanu, 2006; Fig. 3). Sedimentary facies analysis of the Kungarra Formation reveals two distinct glacial cycles (Van Kranendonk and Mazumder, 2015; Van Kranendonk et al. 2015). Each glacial cycle sharply commenced with a falling stage systems tract and terminated with a transgressive systems tract, consistent with drawdown and subsequent release of large volumes of seawater from, and into, waxing and waning ice sheets, respectively (Van Kranendonk and Mazumder, 2015). The transition from tidal flat to beach-aeolian to fluvial depositional environment within the Koolbye Formation clearly indicates another falling stage systems tract (see Catuneanu, 2006; Catuneanu et al., 2009).

Our data in combination with that of Van Kranendonk and Mazumder (2015) document at least three falling stage systems tracts within the Turee Creek Group.

Of interest in this regard, is the change in the nature of the Koolbye Formation on either limb of the Hardey syncline, specifically the absence of a tidal flat component on the northern limb. Importantly, however, tidal flat deposits have been observed immediately beneath Koolbye Formation sandstones on the northern limb of the syncline, characterised by tuning fork-like, bifurcating ripples and a wide variety of ripple crest directions in fine grained sandstone (Van Kranendonk and Mazumder, 2015). This observation suggests that the Kungarra-Koolbye stratigraphic contact is conformable with the finer-grained facies (Kungarra Formation) of the broadly similar depositional environment in the north and west relative to the relatively coarser-grained equivalent in the south and east (Koolbye Formation). The appearance of a beach-aeolian association on both limbs of the syncline reflects the progressive shallowing upwards nature of the basin over this depositional interval (Figs. 1, 3).

5. Conclusions

High resolution sedimentary facies analysis and new mapping indicates shallow-marine to fluvial sedimentation in the Paleoproterozoic Koolbye Formation of the Turee Creek Group, Western Australia. We have documented a falling stage systems tract within the Koolbye Formation. Our sedimentary facies analysis in combination with sedimentological analysis of the Kungarra Formation indicates development of at least three falling stage systems tracts within the Turee Creek Group across the rise of atmospheric oxygen (the Great oxidation event).

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Graphical Abstract

RESEARCH HIGHLIGHT

- High resolution sedimentary facies analysis of the Paleoproterozoic Koolbye Formation for the first time and new mapping
- A marine to fluvial transition across the Great Oxidation Event is documented in the Koolbye Formation
- We have identified previously unrecognised falling stage systems tract within the Koolbye Formation
- Our sedimentological analysis confirms development of at least three falling stage systems tract within the Turee Creek Group across the rise of atmospheric oxygen.