Another Jillawarra-style sub-basin in the Bangemall Supergroup — implications for mineral prospectivity

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Abstract

Recent regional mapping and revisions to the stratigraphy of the Bangemall Supergroup suggest close similarities between the geology of the southwestern part of the EDMUND 1:250 000 sheet and the Jillawarra sub-basin. These similarities include lithofacies, structural setting, and intrusion of felsic rocks into the lower Bangemall Supergroup. The presence of the large Abra lead–copper–barium deposit and other base metal mineralization in the Jillawarra sub-basin implies enhanced mineral prospectivity for the EDMUND sheet area.

KEYWORDS: Bangemall Supergroup, Edmund Group, Collier Group, Abra, Mesoproterozoic, base metals

Introduction

The 1.64 – 1.00 Ga Bangemall Supergroup hosts several stratabound base metal occurrences (Cooper et al., 1998), the most significant of which are in the Jillawarra sub-basin (Fig. 1). Perhaps the best known of these is the large, low-grade polymetallic Abra deposit at the eastern end of the sub-basin. Abra was discovered in 1981 and is Western Australia's largest known lead–copper–barium deposit, containing minor silver and gold (Boddington, 1987; Vogt and Stumpfl, 1987; Collins and McDonald, 1994; Vogt, 1995). The best known base metal prospects, including Abra, are in the lower part of the Bangemall Supergroup, but variations in stratigraphic nomenclature have made it difficult to apply specific regional correlations. Rationalization of the stratigraphy of the Bangemall Supergroup (Copp, 1998; Martin et al., 1999) suggests that the dolomites and carbonaceous siltstones of the Irregully, Blue Billy, Kiangi Creek, and Discovery Formations on EDMUND* are the most prospective lithologies.

In this paper, the facies and stratigraphy of the Jillawarra sub-basin on MOUNT EGERTON and COLLIER are compared to those of the Irregully Formation on EDMUND, in order to assess regional prospectivity for Abra-style deposits.

Regional geology

There is strong evidence on EDMUND for a two-fold subdivision of the Bangemall Supergroup into an older Edmund Group and a younger, unconformably overlying Collier Group (Martin et al., 1999). The Edmund Group unconformably overlies Palaeoproterozoic rocks of the Ashburton and Capricorn Formations to the north, and the Gascoyne Complex to the south (Fig. 1). Within the Edmund Group, the basal Irregully Formation has been redefined (Chuck, 1984; Copp, 1998) to include only the lowermost major carbonate unit (Wongida Dolomite Member of Daniels, 1970). The thin, locally developed, basal siliciclastic unit, the 'Yilgatherra Member' of Daniels (1970), is here elevated to formational status, and may be equivalent to the Tringadee Formation of Chuck (1984) and Muhling and Brakel (1985).

Initial basin subsidence was controlled by extension and growth faulting (Chuck, 1984; Muhling and Brakel, 1985), which is reflected in the distribution and thickness of the basal units of the Bangemall Supergroup, as well as in the style of later deformation. Upright, open to tight folds in the Edmund Fold Belt are interpreted as the result of reverse reactivation of earlier horst and graben structures (Muhling and Brakel, 1981, 1985). The east–west trending Jillawarra sub-basin is one of these early grabens that has been filled with a mixed siliciclastic–carbonate succession (Vogt, 1995). No other grabens have been described from the region, although their presence is inferred in models for the tectonic evolution of the Bangemall Supergroup (e.g. Chuck, 1984).

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* Capitalized names refer to standard 1:250 000 map sheets

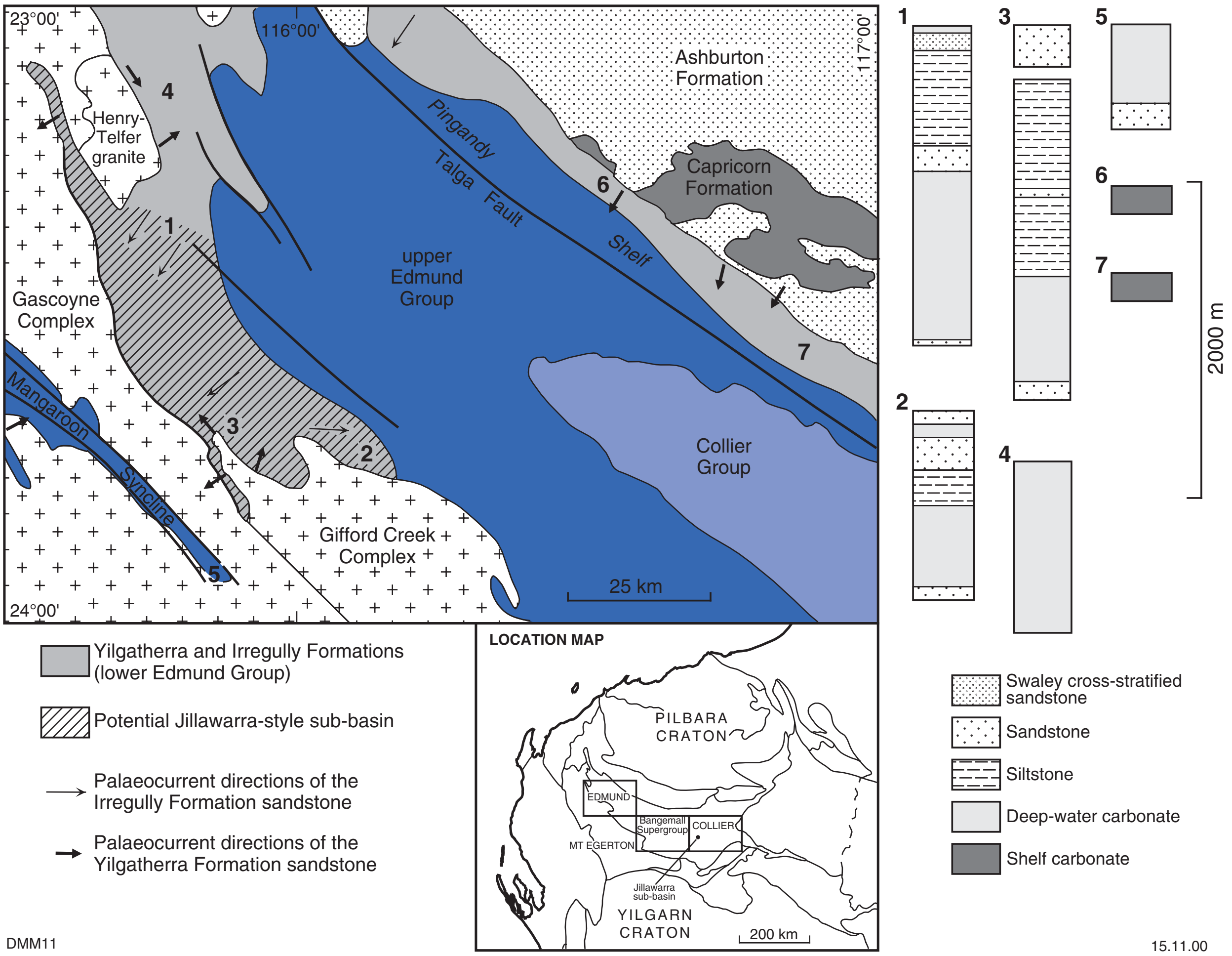

Figure 1. Sketch map showing the simplified geology of EDMUND *and the thickness, facies distribution, and palaeocurrent directions in the Yilgatherra and Irregully Formations of the lower Edmund Group. The distribution of the Bangemall Supergroup in Western Australia, and location of the Abra lead–copper–barium deposit in the Jillawarra sub-basin are also shown*

Facies distribution and thickness in the basal Bangemall Supergroup on EDMUND are strongly controlled by the synsedimentary Talga Fault (Fig. 1). North of the Talga Fault, on the Pingandy Shelf, the Yilgatherra Formation commonly consists of a few metres of fluvial sandstone and conglomerate, with palaeocurrents directed toward the south. The Irregully Formation unconformably overlies basement where the Yilgatherra Formation is absent. These basal siliciclastic rocks are considerably thicker (tens of metres) south of the Talga Fault, where they are either overlain by, or interbedded with, a unit of planar-laminated siltstone. Palaeocurrent directions in this area are highly variable and suggest that, in addition to a northerly source area, a few of the basement inliers were topographic highs at the time of deposition (Fig. 1). These highs are represented by the Henry–Telfer granite (Daniels, 1966) and the Gifford Creek Complex (Pearson et al., 1996). Rapid erosion of these highs produced immature arenaceous and rudaceous successions in adjacent grabens.

The Irregully Formation on EDMUND

North of the Talga Fault, the Irregully Formation consists primarily of peritidal dolostone and sandstone with minor siltstone (Copp, 1998). Stromatolites have been recorded from several horizons and although they have not been studied in detail, they act as useful stratigraphic markers (Grey, 1985; pers. comm.). Two thin peritidal sandstone horizons are present in the lower Irregully Formation, which also contains the stromatolite *Conophyton garganicum australe* Walter 1972, and local evaporite pseudomorphs. The peritidal facies consists mainly of thin upward-shoaling cycles of intraclast breccia overlain by stromatolitic dolomite (mainly containing *Paniscollenia* Koroljuk 1960). Towards the top of the Irregully Formation there is a horizon of club-shaped stromatolites — *Colonella* Komar 1964. The upper Irregully Formation is characterized by the branching columnar stromatolite *Baicalia capricornia* Walter 1972. Immediately south of the Talga Fault, the Irregully Formation thickens considerably (Fig. 1), and is dominated by thick subtidal cycles of intraclast breccia and dololutite, with rare stromatolites and siliciclastic facies.

The siliciclastic component of the Irregully Formation increases progressively towards the southeastern corner of EDMUND. In this area, the Irregully Formation is dominated by interbedded dololutite, dolomitic siltstone, siltstone, and sandstone. Sandstone units within the Irregully Formation in the southeastern part of EDMUND are characterized by large-scale trough cross-stratification and palaeocurrent directions predominantly towards the south-southeast. Terrestrial to shallow-marine siliciclastic facies, comprising trough cross-stratified sandstone and interbedded planar- and ripple-laminated siltstone, dominate the Irregully Formation around the western margin of the Gifford Creek Complex, where cross-bed sets are up to 2 m thick. In the southeastern part of EDMUND, a distinctive marker horizon in the upper Irregully Formation is characterized by swaley cross-stratified, shallow-marine sandstone interbedded with stromatolitic dolomite (*B. capricornia*). This horizon is interpreted to correlate with similar occurrences of *B. capricornia* in the upper Irregully Formation north of the Talga Fault.

Abra and the Jillawarra sub-basin

To date, the Jillawarra sub-basin is the only area where significant base metal mineralization has been found in the Bangemall Supergroup (Cooper et al., 1998). The sub-basin is bounded to the north and south by the Quartzite Well Fault and West Creek Fault respectively, and lies between the granitic inliers of the Coobarra Dome to the east and Woodlands Dome to the west (Vogt, 1995). The Abra deposit is hosted within dolomitic siltstone and shale of the upper Gap Well Formation, which forms the lower part of the Bangemall Supergroup in this area. Although stromatolites are present in the succession, they have not been formally identified (Grey, K., pers. comm.).

The polymetallic mineralization at Abra consists of a lower funnel-shaped stringer zone and an upper stratiform zone, and is disconformably overlain by conglomerate, sandstone, and siltstone of the West Creek Formation (Boddington, 1990; Vogt, 1995). The ore minerals are mainly galena, chalcopyrite, and barite, with an alteration halo of chlorite and hematite. Previous workers have interpreted Abra as a syngenetic hydrothermal deposit, related to elevated heat flow during the development of the Jillawarra graben and nearby, possibly coeval, felsic volcanism (Boddington, 1990; Collins and McDonald, 1994; Vogt, 1995).

Igneous activity

Elevated heat flow in the Jillawarra sub-basin has been interpreted as the result of intrusion of high-level granitoids in the Coobarra and Woodlands Domes (Boddington, 1990; Vogt, 1995). Granodiorite in the Coobarra Dome has been dated at 1797 ± 8 Ma and forms part of the Gascoyne Complex basement. However, local high-K rhyolite lava flows and plugs in the basal Bangemall Supergroup have been dated at 1638 ± 14 Ma (Nelson, 1995). Igneous activity is also known from the EDMUND area. Pearson et al. (1996) documented high-level dykes and sills of carbonatitic affinity intruding the basal Bangemall Supergroup southeast of the Edmund Homestead. A small granophyric plug intrudes the Yilgatherra Formation about 2 km north of Horse Well (MGA 354100E 7431200N)*, on the western flank of the Henry–Telfer granite. The wider distribution of igneous activity in the basal Bangemall Supergroup has important implications for regional mineral prospectivity.

Mineralization potential of the EDMUND area

Regional mapping and resultant stratigraphic revisions to the Bangemall Supergroup on EDMUND indicate that a re-evaluation of the economic potential of this area is warranted. In particular, the common similarities in stratigraphy (source and host rocks), structure (fluid pathways), and regional geology (heat flow) between the Jillawarra sub-basin and the southwestern part of EDMUND (Table 1 and Fig. 2) suggest that the latter area has potential for Abra-style deposits. Facies and thickness changes within the Irregully Formation in this area

* Locations mentioned in the text are referenced using Map Grid of Australia coordinates, Zone 51. All locations are quoted to the nearest 100 m.

Table 1. Comparison of ore controls in the Jillawarra sub-basin and the southwestern part of EDMUND

Geological feature	*Jillawarra sub-basin*	*Southwestern EDMUND*
Lithostratigraphic units	Gap Well and West Creek Formations	Irregully Formation
Lithology	Mixed siliciclastic–carbonate succession	Mixed siliciclastic–carbonate succession
Faulting	East–west graben	Talga Fault and northwest–southeast graben
Associated basement highs	Woodlands and Coobarra Domes	Henry–Telfer dome, Gifford Creek Complex
Syndepositional magmatism	Tangadee Rhyolite	Granophyre plugs and alkaline intrusives
Potential source rock	Arkose (Tringadee Formation)	Immature sandstone (Yilgatherra Formation)
Alteration	Chlorite–siderite	–
Ore minerals	Galena, chalcopyrite, barite, tetrahedrite, sphalerite	–
Gangue minerals	Hematite, magnetite, carbonate, pyrite, quartz, jaspilite	Quartz veins, hematitic sandstone, pyritic siltstone

JILLAWARRA SUB-BASIN (VOGT, 1995)	
FORMATION	**LITHOLOGY**
Discovery Chert	Massive to laminated chert
Jillawarra	Silica and iron-rich shale Dolomite, dolomitic shale, shale, sandstone
West Creek	Coarse-grained sandstone, conglomerate lenses Siltstone, dolomitic siltstone, minor sandstone Shale, conglomerate, minor rhyolite Siltstone, sandstone, conglomerate
Gap Well	Siltstone, dolomitic shale, stromatolitic dolomite Siltstone and sandstone, stromatolitic dolomite Coarse-grained sandstone (Woodlands Arenite) Siltstone and sandstone Dolomite, dolomitic shale, minor sandstone Siltstone, sandstone, minor dolomitic siltstone
Tringadee	Arkose

EDMUND AREA (THIS STUDY)	
LITHOLOGY	**FORMATION**
Laminated chert	Discovery
Sandstone, lesser siltstone	Kiangi
Sandstone, siltstone	Gooragoora, Blue Billy
Stromatolitic dolomite Interbedded coarse-grained sandstone, siltstone, minor dolomite Dolomite and / or siltstone Coarse-grained sandstone, siltstone, dolomitic siltstone, dolomite, dolomite breccia	Irregully
Coarse-grained sandstone, siltstone, minor conglomerate	Yilgatherra

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Figure 2. Comparative lithostratigraphy of the basal Bangemall Supergroup on EDMUND *and in the Jillawarra sub-basin*

suggest the presence of a fault-bounded basin north of the Mangaroon Syncline and south of the Talga Fault (Fig. 1) in the basal Bangemall Supergroup. Filling of this sub-basin was strongly controlled by uplift of the adjacent basement domes, which appears to have coincided with felsic and alkaline magmatism.

Previous exploration activity in the southwestern part of EDMUND focused heavily on uranium and diamonds, and the potential for base metal deposits has not been thoroughly tested. Base metal exploration programs have commonly been more regional in nature, and target generation for stratabound deposits has relied heavily on an outdated stratigraphic framework. Although the potential of this area was recognized by Alcoa (Shackleton, 1982), Chuck (1984), and BHP who recorded a pyrite-cemented fault breccia and anomalous zinc, nickel, and cobalt in the Yilgatherra Formation (Surman, 1985), there is scope for further exploration. A detailed assessment of the similarity of the southwestern part of EDMUND to the Jillawarra sub-basin will rely on continued systematic mapping and application of the revised Bangemall Supergroup stratigraphy.

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