Tectonic setting and exploration potential of the northern Capricorn Orogen

by

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The Capricorn Orogen is a long-lived zone of accretionary, collisional and intracratonic tectonic activity that formed between c. 2215 and 570 Ma during assembly of the West Australian Craton. Assembly involved accretion of the Glenburgh Terrane to the southern margin of the Pilbara Craton during the Ophthalmia Orogeny, followed by collision of this combined cratonic block with the Yilgarn Craton during the Glenburgh Orogeny. All subsequent deformation was intracratonic. The central and southern Capricorn Orogen have been extensively studied in recent years, and have also been the subject of significant exploration activity leading most notably to the discovery of the Degrussa deposit. Although the northern margin of the orogen is host to vast Fe ore reserves in the Hamersley province, as well as two >1 Moz Au deposits (Paulsen's and Mount Olympus), it has received considerably less exploration interest for commodities other than Fe ore. This presentation re-examines the stratigraphy, structure and tectonic setting of the northern Capricorn Orogen and their implications for mineral prospectivity.

Revised stratigraphy

Recent mapping in the southern Hamersley province, combined with new geochronological data, has identified a number of stratigraphic revisions and important field relationships that have necessitated a re-examination of the geological evolution of this region. First, the contact between the Hamersley and Turee Creek Groups is demonstrably disconformable, with local erosion of up to 200 m of strata. The contact between the Woongarra Rhyolite and the Boolgeeda Iron Formation in the uppermost Hamersley Group is also likely disconformable, but confirmation requires more geochronological data. Existing data suggests that all dates currently reported for the Boolgeeda Iron Formation are maximum depositional ages that primarily reflect erosion of the underlying c. 2444 Ma Woongarra Rhyolite.

Four glacigenic diamictites have been named in the Turee Creek Group, and recent whole-rock and pyrite Re–Os dating of the Meteorite Bore Member (Fig. 1) allows for a much better constrained global correlation with equivalent units that record the Huronian Glaciation between c. 2.45 and 2.22 Ga. However, constraints on the maximum age of the Turee Creek Group suggest that three of the glacial units are younger than 2425 ± 9 Ma (Fig. 1), and that there could be a significant hiatus at the base of either the Kungarra Formation or the Boolgeeda Iron Formation. Formerly un-named units have been named, and the lower Wyloo Group has been formalized as the Shingle Creek Group (excluding the Wooly Formation). The Wooly Formation is a revised unconformity-bound unit consisting of both siliciclastic and carbonate rocks (formerly the Wooly Dolomite).

The relationship of angular unconformities to the recently named c. 2208 Ma Balgara Dolerite (Fig. 1) provides important constraints on the timing of Ophthalmian folding. Most importantly, intrusive relationships between the Balgara Dolerite and the Beasley River Quartzite show that all unconformities in the Shingle Creek and Turee Creek Groups are older than c. 2208 Ma. However, relationships between sills and individual unconformities, specifically at the base of the Anthiby Formation (Fig. 1), suggest that there may be an older component within the Balgara Dolerite. Nonetheless, mapped relationships imply that sill intrusion, folding and unconformity development all took place within a narrow timeframe at c. 2208 Ma.

Tectonic setting

The southern margin of the Pilbara Craton has long been interpreted to record a progression from continental rifting (Fortescue Group), to passive margin subsidence (lower Hamersley Group), followed by conversion to a convergent margin (upper Hamersley Group) involving northwards subduction beneath the Pilbara Craton during deposition of the Mount Bruce Megasequence Set (MBMS; Blake and Barley, 1992). In this interpretation, convergence was considered to have culminated in the formation of a retro-arc foreland basin during deposition of the Turee Creek Group, with the Beasley River Quartzite unconformity representing continent–continent collision and post-collisional uplift, although it was recognized that the Shingle Creek Group could also be part of the underlying MBMS. The latter interpretation has now been confirmed, with the Turee Creek Basin consisting of the Boolgeeda Iron Formation, and Turee Creek and Shingle Creek Groups, although incontrovertible evidence for northwards subduction to drive convergence is still lacking. The Wooly Formation is now interpreted to be as much as 172 Ma younger than the Shingle Creek Group and records extension of the southern Pilbara Craton margin accompanied by normal faulting and local mafic volcanism between c. 2031 and 2008 Ma.

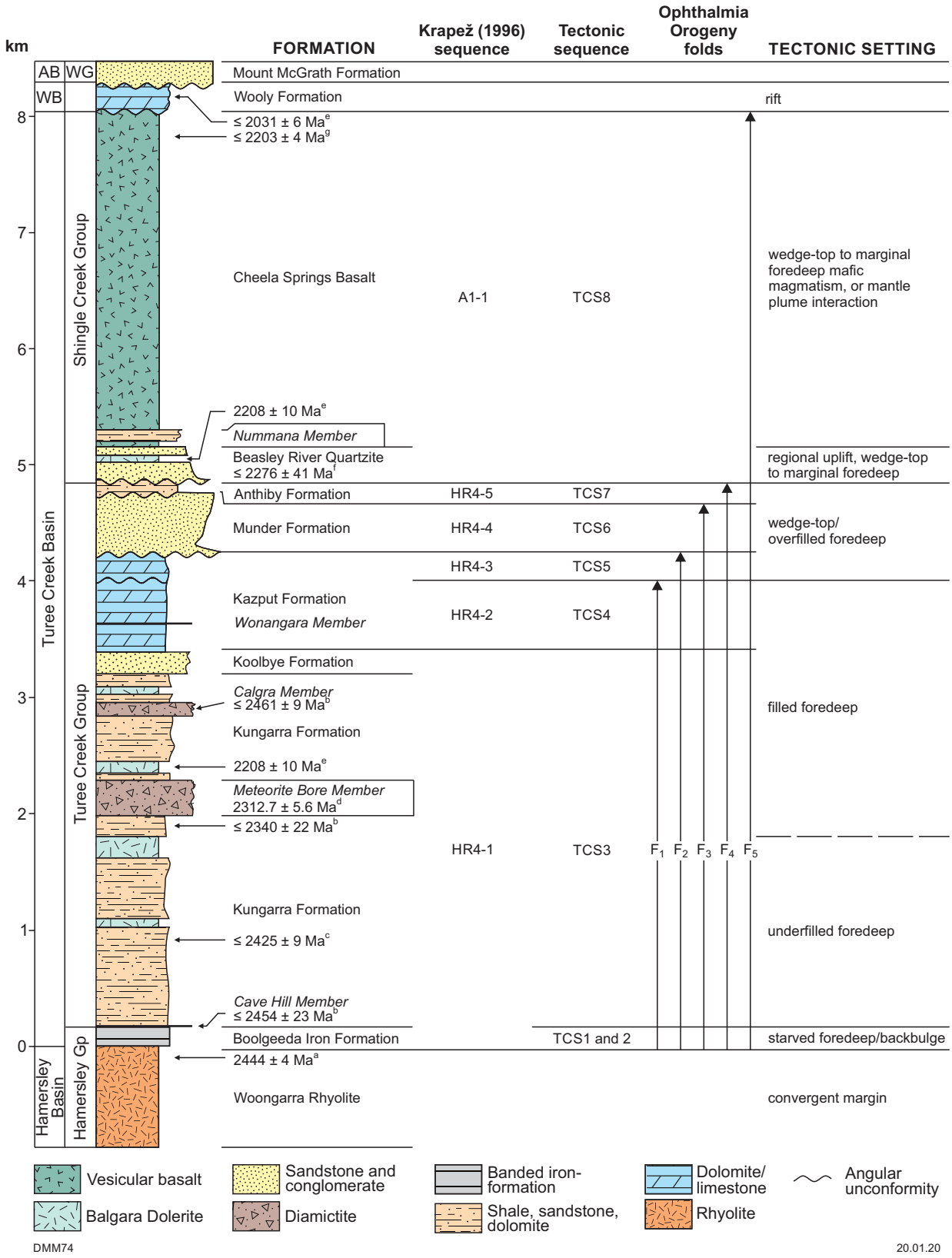

Figure 1. **Depositional and tectonic sequence nomenclature, tectonic setting of basin stages, and relationships to Ophthalmian fold events (labelled F_{1-5}) in the Turee Creek Basin. Modified after Martin and Morris (2010), and including new geochronology (with 95% uncertainties) from: a – Wingate et al. (2018a); b – Caquineau et al. (2018); c – Wingate et al. (2018b); d – Philippot et al. (2018); e – Müller et al. (2005); f – Krapež et al. (2017); g – Wingate et al. (2019). Only robust and geologically meaningful dates are shown. Abbreviations: AB, Ashburton Basin; WB, Wooly Basin; WG, Wyloo Group**

Exploration potential

In addition to the well-documented hypogene and supergene Fe ore deposits, the revised tectonic settings have important implications for mineral prospectivity of the southern Hamersley province. In particular, mapping of the wide regional distribution of the revised Wooly Formation shows that it hosts the Mount Olympus Au deposit, as well as some smaller Au and base metal prospects. The close spatial association of these mineral occurrences with regional-scale normal faults that may be related to deposition of the Wooly Formation and also display evidence of significant hydrothermal fluid flux (silica flooding), suggests enhanced prospectivity for a range of deposit styles including orogenic and Carlin-style Au, as well as sediment-hosted base metal deposits. Potential may also exist for flood basalt-hosted Ni – Cu – platinum group element deposits associated with the Balgara Dolerite and Cheela Springs Basalt.

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