Focusing on the Fortescue and Hamersley Basins

by

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An integrated geochemical, isotopic and geochronological study of igneous and sedimentary rocks is currently being undertaken in the Fortescue and Hamersley Basins of the southern Pilbara region (Fig. 1). The 2775–2629 Ma volcano-sedimentary Fortescue Group is conformably overlain by the 2629–2420 Ma Hamersley Group and the 2445–2208 Ma Turee Creek Group, all three of which constitute the Mount Bruce Supergroup (Fig. 2). The Mount Bruce Supergroup unconformably overlies the granite–greenstones of the Pilbara Craton in Western Australia.

A digital 1:250 000 scale interpreted bedrock geological map of the southern Pilbara Craton is planned for release in 2018. The digital map, combined with legacy data and up-to-date imagery, will form the basis of a regional dataset that will be updated as new data and insights into the geological evolution of the area arise.

Targeted field validation in support of the new geological map has identified a number of potential stratigraphic revisions. One of the most significant revisions is in the upper part of the Mount Bruce Supergroup, where a regional paraconformity to local low-angle unconformity has been recognized at the base of the Turee Creek Group. The regional lithostratigraphic relationships between the Woongarra Rhyolite and overlying Boolgeeda Iron Formation in the Hamersley Group, combined with a critical appraisal of the currently available geochronology, suggest that a similar paraconformable to unconformable relationship may also be present at the base of the Boolgeeda Iron Formation. These relationships suggest that the predominantly epiclastic sedimentary unit currently considered to be the uppermost division of the Woongarra Rhyolite should instead be included in the Boolgeeda Iron Formation, which calls into question the current definition of the upper limit of the Mount Bruce Supergroup.

The Turee Creek Group is an important stratigraphic unit that records the Great Oxidation Event and Huronian-age glaciations, but much of the stratigraphic nomenclature of the Turee Group has yet to be formalized. Recent fieldwork has identified new occurrences of known glacigenic horizons, as well as a potentially new horizon. In order to assist the description and correlation of this globally important succession, new formalized stratigraphic names have been introduced for all the previously unnamed units, as well as for each of the recognized glacigenic horizons.

Preliminary, high-precision geochemical and isotopic data, obtained from a detailed sampling traverse in the Paraburdoo area (Fig. 1), reveal significant geochemical variations in the mafic units of the Fortescue Group. In the southern Pilbara region, Thorne and Trendall (2001) proposed four tectonic packages in the Fortescue Group (Fig. 2), deposited in progressively deeper marine environments interpreted to reflect changing tectonic settings up stratigraphy, from rift to passive margin. However, geochemical data from Paraburdoo do not show progressively increasing or decreasing element trends through tectonic packages 1 to 3 in the lower part of the Fortescue Group. Rather, the Mount Roe Basalt and Boongal, Pyradie and Bunjinah Formations contain at least two (A and B) or three (A, B, and C) geochemical subgroups (Fig. 3), within which geochemical trends are evident. The geochemical subgroups display variations in Th/TiO_2 ratios (Fig. 3) akin to the high-, intermediate- or low-Th groups described by Barnes et al. (2012) in basalts of the Eastern Goldfields Superterrane. The geochemical variation evident in the lower part of the Fortescue Group can be explained by a komatiitic magma source modified by assimilation and fractional crystallization processes. Thorne and Trendall (2001) assigned deep-marine sedimentary rocks and basalt of the Jeerinah Formation to tectonic package 4, and suggested a passive margin setting. Geochemically the basalts of the Jeerinah Formation are more primitive than the lower parts of the volcanic succession and could not have been generated from the same komatiitic magma source.

Further outcrop and diamond drillcore sampling will be used to systematically and laterally assess the geochemical variation of magmatic units across the Fortescue Basin. The geochemical relationship between felsic and associated mafic and ultramafic igneous rocks will also be used to establish which of the mafic intrusive rocks of the region are related to the Fortescue and Hamersley Groups.

A review of the geochronology of the southern Pilbara Craton suggests that there is scope for significant improvement in coverage and accuracy. Most notably, the majority of ages available for the region are external to GSWA, and pre-date the use of modern analytical techniques such as stable isotope analyses of zircon, which provide valuable additional information regarding tectonic setting. A suite of over 17 new samples has already been collected for zircon geochronology, including a number of samples from previously undated stratigraphic horizons. These results should significantly improve the geochronological framework and understanding of the tectonic setting and evolution of the region.

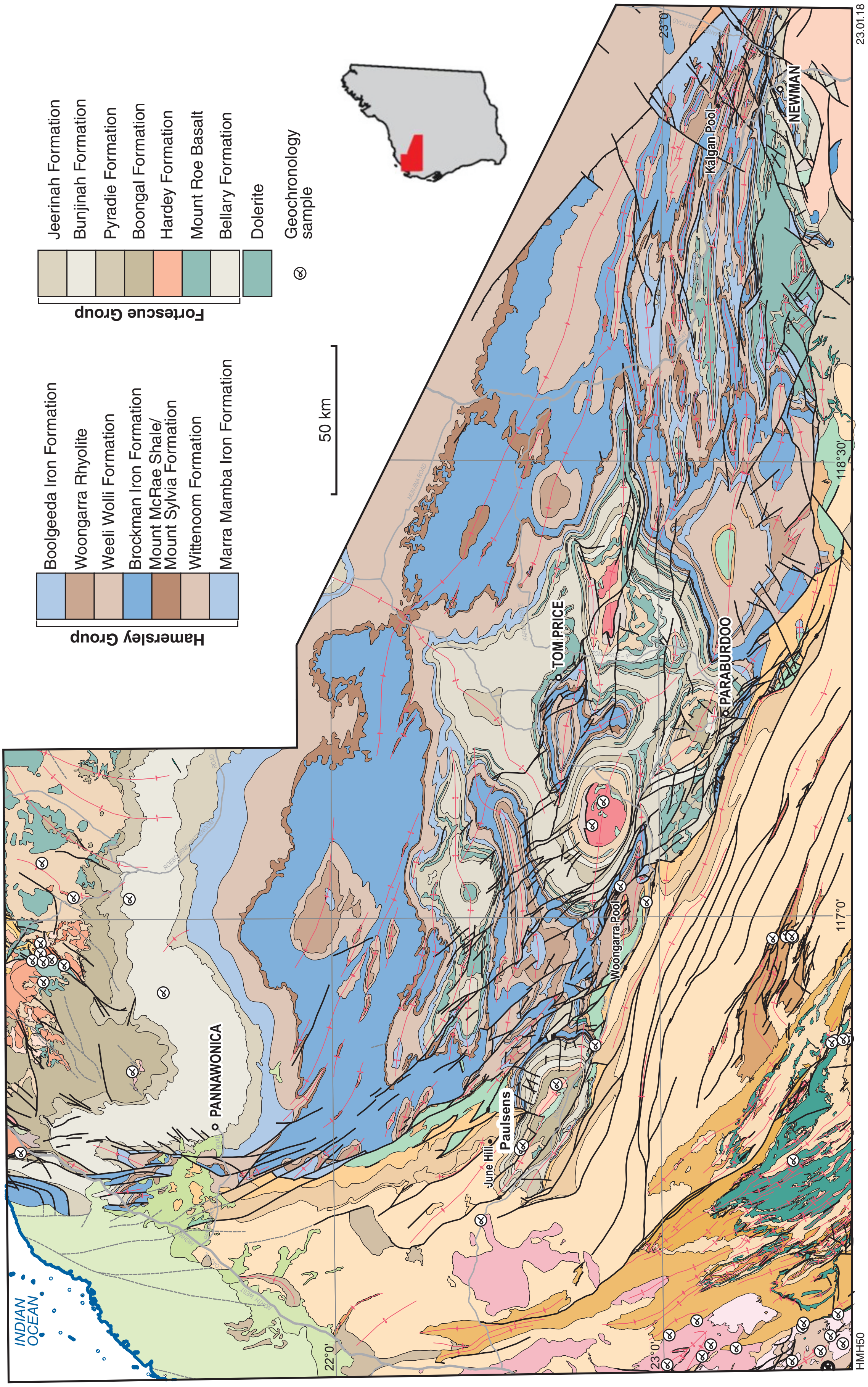

Figure 1. Geological map of the Fortescue and Hamersley Basins in the southern Pilbara

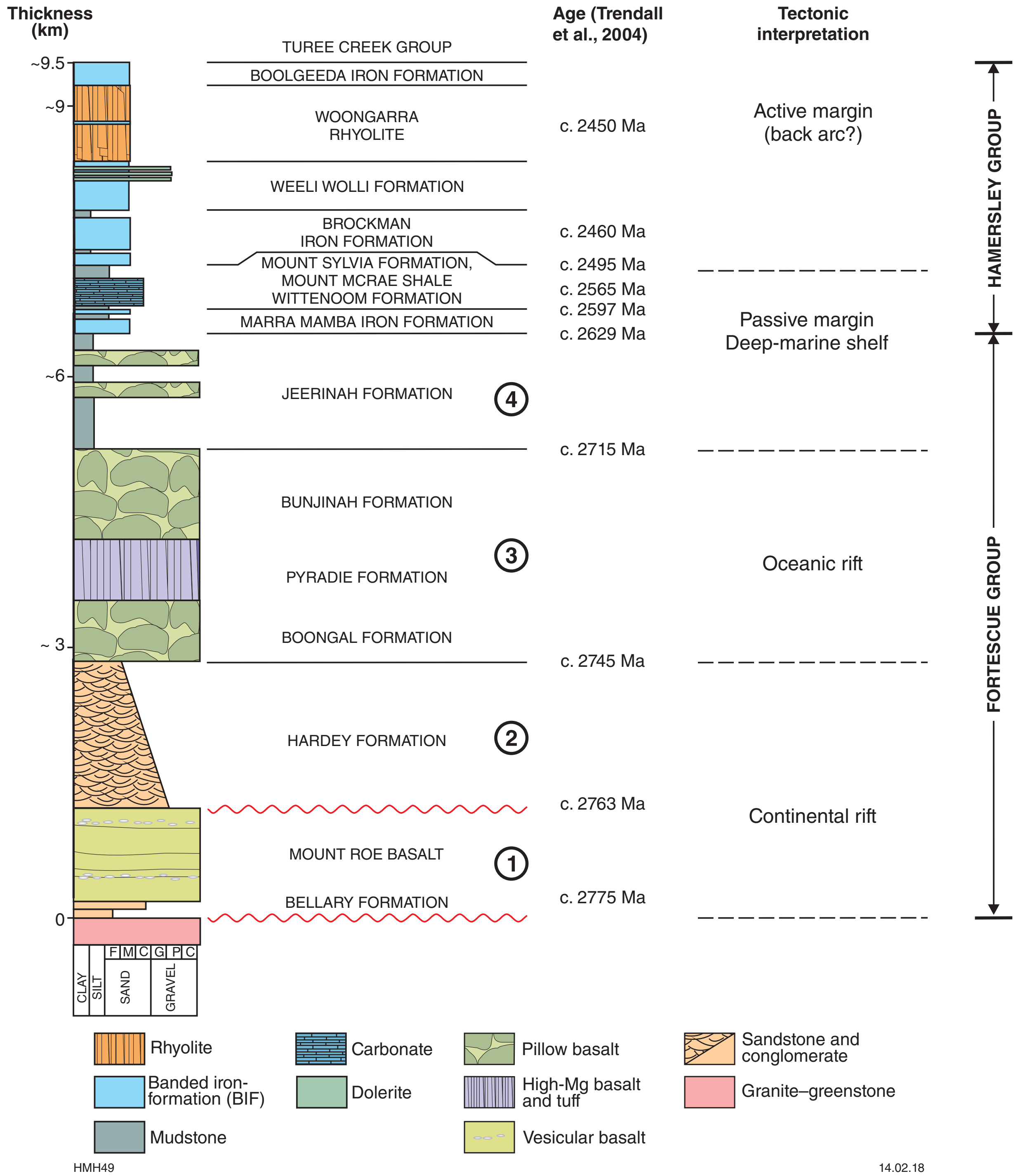

Figure 2. The stratigraphy of the Fortescue and Hamersley Groups in the southern Pilbara. Tectonic interpretations from Martin and Morris (2010) and Thorne et al. (2011); ages after Trendall et al. (2004). Tectonic packages of the Fortescue Group are numbered 1–4

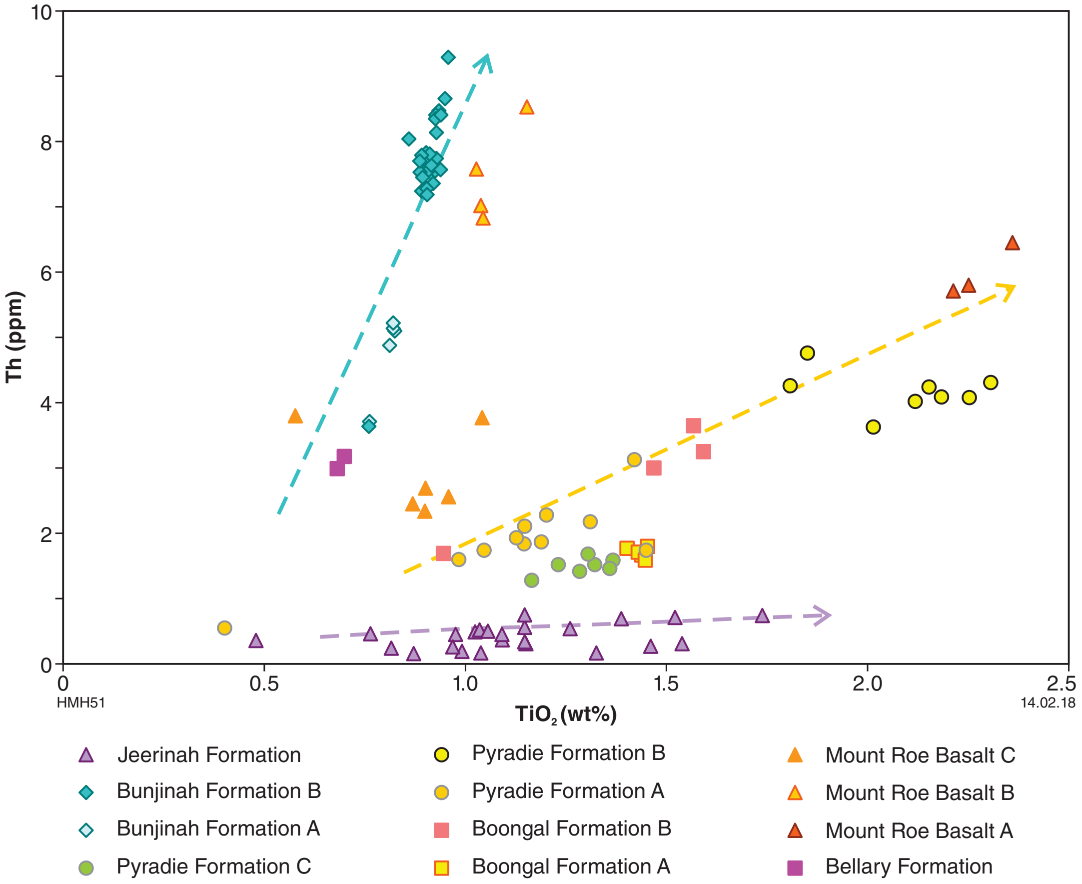

Figure 3. **Th vs TiO_2 plot showing high-, intermediate- and low-Th groups within the Fortescue Group (after Barnes et al., 2012)**

Another important aspect of this project is to better understand the structural and tectonic framework of the region. The extent and timing of various fold events that constitute the northern margin of the Capricorn Orogen are poorly constrained. Furthermore, fault architecture and kinematics have not previously been systematically mapped across the southern Pilbara Craton. With the benefit of recent geophysical imagery, preliminary work has already identified a number of new regional faults, and aided systematic mapping of previously known fault systems. Future work will focus on discriminating the effects of the Ophthalmia (2215–2145 Ma) and Capricorn (1817–1772 Ma) Orogenies on the southern Pilbara Craton margin, recognizing that deformation was driven by events in the central and southern Capricorn Orogen.

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