Geology and mineral systems of the Paleoproterozoic basins of the eastern Capricorn Orogen

by

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The Paleoproterozoic Yerrida, Bryah, Padbury, and Earaheedy Basins form a belt extending for about 700 km along the northern margin of the Archean Yilgarn Craton, cover a total area of approximately 70 000 km^2, and are part of the eastern portion of the Capricorn Orogen (Fig. 1; Cawood and Tyler, 2004). The development of these four basins began at about 2.2 Ga and continued for nearly 400 million years, to about 1.8 Ga, recording periods of sedimentation, volcanism, and associated hydrothermal mineral systems (Pirajno et al., 2004; Pirajno, 2004). The Yerrida (c. 2.1 and 1.8 Ga), Bryah, Padbury (c. 1.9 Ga), and Earaheedy (c. 1.8 Ga) Basins contain the Windplain and Mooloogool, Bryah, Padbury, and Earaheedy Groups, respectively, with further subdivision into subgroups for the Earaheedy Group. The present-day geometry of these basins is the combined result of tectonic movements during the c. 2.0–1.96 Ga Glenburgh Orogeny and 1.83–1.78 Ga Capricorn Orogeny, and to a lesser extent the c. 1.79–1.76 Ga Yapungku Orogeny and perhaps again at c. 1.65 Ga during the Mangaroon Orogeny.

Yerrida Basin

The Yerrida Basin volcano-sedimentary succession contains the c. 2.1 Ga Windplain Group and the c. 1.8 Ga Mooloogool Group. The former, divided into the Juderina and Johnson Cairn Formations, is essentially an intracratonic sag-basin sedimentary succession deposited in a stable, shallow coastal marine environment, grading to intertidal–supratidal sabkha lagoons. The Mooloogool Group overlies the Windplain Group and contains the Thaduna, Doolgunna, Killara, and Maraloou Formations. The deposition of the Mooloogool Group marked a younger stage in the geodynamic evolution of the Yerrida Basin. The depositional systems of the high-energy clastic sedimentary rocks of the Doolgunna and Thaduna Formations can be linked to a compressional event, during which the Bryah and Padbury Groups (see below) were thrust over the Windplain Group. Post-compressional relaxation led to extension and the onset of continental mafic magmatism (Killara Formation), followed by the deposition of sulfidic black shales (Johnson Cairn Formation).

Bryah and Padbury Basins

The Bryah Group contains the Karalundi, Narracoota, Ravelstone, and Horseshoe Formations, all deformed and metamorphosed to greenschist facies. The Karalundi Formation forms the base of the Bryah Group and is in fault contact with the Doolgunna Formation in the southeast and east of the basin, and is locally intercalated with basaltic hyaloclastites of the Narracoota Formation, which forms the bulk of the group. In addition to basaltic hyaloclastites, the Narracoota Formation includes metamorphosed and deformed komatiitic basalt, peridotite, gabbro, pyroxenite, and minor felsic and volcaniclastic rocks. The layered mafic–ultramafic Trillbar Complex may be part of this formation. The Ravelstone Formation is a turbiditic succession and the conformably overlying Horseshoe Formation primarily comprises beds of ferruginous shale and banded iron-formation, marking the cessation of detrital influx with deposition of chemical sedimentary rocks in a starved basin. The Narracoota Formation is interpreted as a remnant of an oceanic plateau that was tectonically emplaced on the northwestern margin of the Yilgarn Craton at about 1.9 Ga.

The Padbury Group is subdivided into the Labouchere, Wilthorpe, Robinson Range, and Millidie Creek Formations. The age of the group is constrained by the underlying c. 1.9 Ga Bryah Group and the overlying Bangemall Supergroup (younger than 1.63 Ga). The Labouchere and Wilthorpe Formations are upward-coarsening, deep-water turbidite successions, with the overlying shales and banded iron-formations of the Robinson Range and Millidie Creek Formations heralding a change to shallow-water deposition in a lacustrine or marine-platform environment. The Padbury Group is interpreted as a foreland basin sequence built on top of the Bryah Basin, as a result of the Capricorn Orogeny.

Earaheedy Basin

The Earaheedy Basin comprises the Earaheedy Group, is divided into the Tooloo and Miningarra Subgroups, and lies at the easternmost end of the Capricorn Orogen.

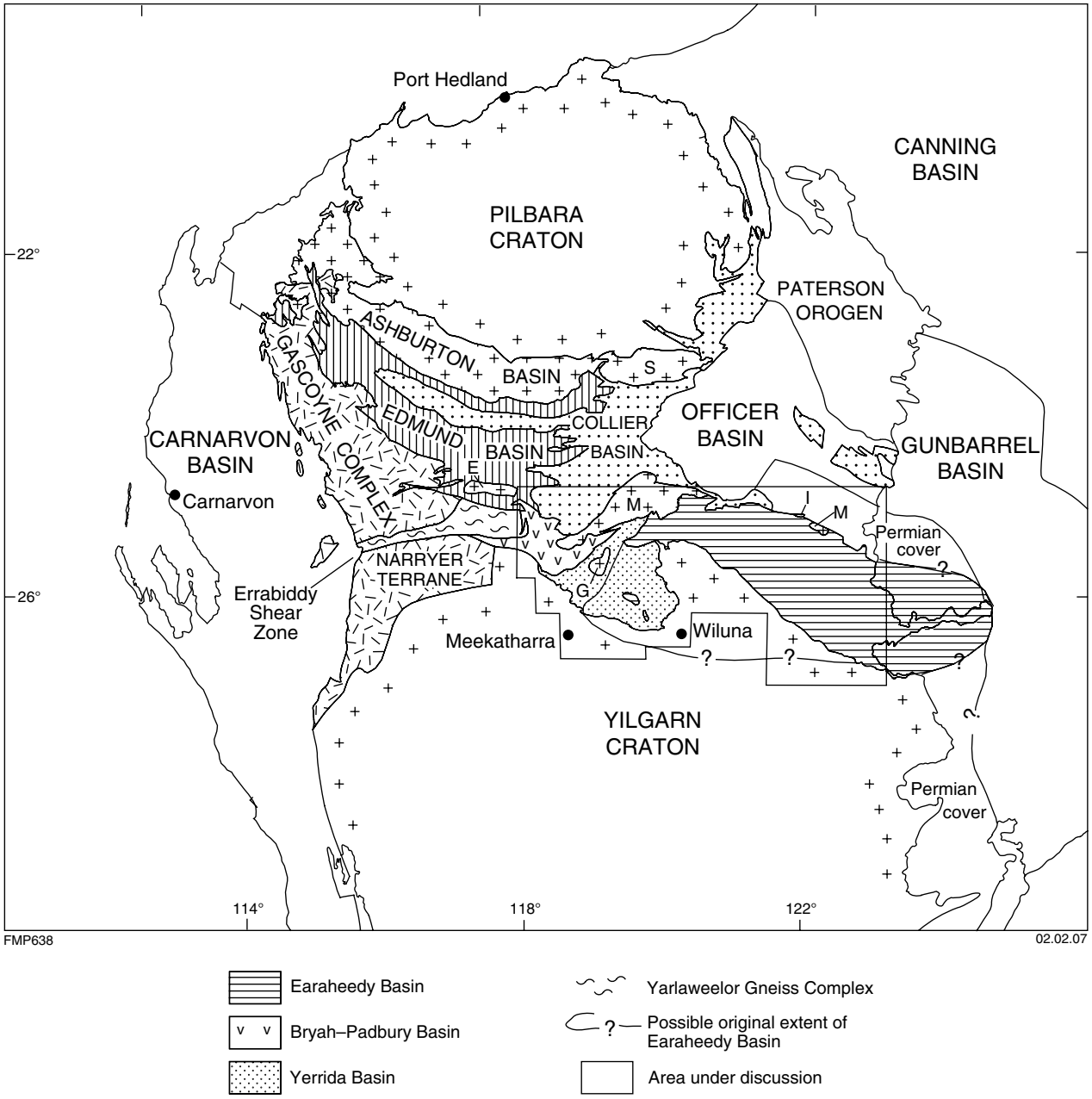

Figure 1. Tectonic units of the Capricorn Orogen and position of the Yerrida, Bryah, Padbury, and Earaheedy Basins. E — Egerton Inlier; G — Goodin Inlier; M — Marymia Inlier; S — Sylvania Inlier

Basement to the exposed Earaheedy Basin is the Archean Yilgarn Craton in the south, and to the west the Yerrida Basin. The regional structure is an asymmetric east-plunging syncline, with a vertical to locally overturned northern limb, due to compressive movements from the northeast, which created a zone of intense deformation along the exposed northern margin of the basin. This zone of deformation, named the Stanley Fold Belt, is characterized by reverse faults and shear zones that consistently dip steeply to the north, the development of slaty cleavage and phyllitic rocks, and the appearance of metamorphic minerals with Ar–Ar ages of c. 1650 Ma. The Earaheedy Group is a 5 km-thick succession of shallow marine clastic (Yelma Formation) with minor carbonate (Sweetwater Well Member) and chemical sedimentary rocks (Frere Formation), probably deposited in a trailing passive margin developed along the rifted northern margin of the Yilgarn Craton. The depositional age of the Tooloo Subgroup is poorly constrained, but Pb–Pb isochron ages on galena suggest a minimum age of 1.77 Ga. The succession of the Miningarra Subgroup comprises the dominantly clastic and glauconitic Chiall and Wongawol Formations, the stromatolitic Kulele Limestone, and finally the Mulgarra Sandstone.

Mineral systems

Mineral systems of the eastern Capricorn Orogen basins include: 1) volcanic-hosted massive sulfide (VHMS) related to submarine hydrothermal venting; 2) orogenic to post-orogenic lode deposits related to compressional stages of deformation; 3) syngenetic deposits related to passive continental margins; 4) deposits related to fluid movements during convergence and deformation.

Volcanogenic Cu–Au–Ag mineralization is present in felsic components of the Narracoota Formation at Horseshoe Lights. This mineral system was probably originally formed on the sea floor during eruption of dacitic rocks in an oceanic-plateau setting. The Horseshoe Lights mineralization was subsequently deformed and later enriched by supergene processes.

Orogenic to post-orogenic Au-only lode deposits, present in both the Bryah and Padbury Groups and in parts of the Stanley Fold Belt, were formed during the late stages of compressional deformation and subsequent stress relaxation. They are structurally controlled and associated with retrograde regional metamorphism, probably relating to influx of meteoric fluids into open structures.

Syngenetic deposits are mainly represented by banded and granular iron-formations of the Robinson Range Formation (Bryah Basin) and Frere Formation (Earaheedy Basin). Both are Lake Superior-type iron formations. The Frere Formation is very extensive with a strike length of more than 250 km, constituting a major resource of iron ore. Local supergene enrichment gives grades of up to 66% Fe.

Mineral systems related to fluid movements are of at least two types, both are in the Earaheedy Basin. The Sweetwater Well occurrences, west of the Shoemaker Impact Structure, are classic Mississippi Valley-type Zn–Pb–Cu–Ba hosted in carbonate rocks of the Yelma Formation. The other is the world-class Magellan lead deposit, consisting of lead carbonates and oxides, located in outliers of the Yelma Formation in the Yerrida Basin along the unconformity with the underlying Windplain Group. The Magellan mineralization, termed a 'nonsulfide' ore system, originated by the action of low-temperature basinal fluid migration and paleoweathering processes.

References

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