The Yilgarn Craton meets the Albany–Fraser Orogen: Mesoproterozoic reworking of the southern craton margin

by

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The Albany–Fraser Orogen comprises several Paleoproterozoic to Mesoproterozoic lithotectonic units, and the southern and southeastern margins of the Archean Yilgarn Craton. The orogen is interpreted to have formed during 1345–1260 Ma collision between the West Australian and Mawson Cratons (Stage I Albany–Fraser Orogeny; Myers et al., 1996; Clark et al., 2000), and to have undergone significant intracratonic reworking during Stage II of the Albany–Fraser Orogeny (1215–1140 Ma; Clark et al., 2000).

The recently discovered Tropicana gold deposit has sparked much interest in new greenfields mineral exploration within the orogen. The deposit is located within the deformed, southeastern margin of the Yilgarn Craton, adjacent to the Fraser Complex, and appears to be the result of Paleoproterozoic to Mesoproterozoic orogenic processes related to the Albany–Fraser Orogeny. This potentially makes other reworked parts of mineralized terranes along the craton margin a target for exploration (Fig. 1). The reworked parts of the Yilgarn Craton are being identified using new aeromagnetic data, combined with SHRIMP U–Pb zircon geochronology. The interpreted bedrock geology map shows revised tectonic boundaries and subdivisions, and can be used to speculate on the extent and significance of tectonic events.

From inboard to outboard, the lithotectonic units of the Albany–Fraser Orogen are: the Northern Foreland, the Paleoproterozoic-dominated Biranup Complex, and the Mesoproterozoic Fraser and Nornalup Complexes (Fig. 1; Beeson et al., 1988; Myers, 1990). These units mostly consist of strongly deformed amphibolite to granulite facies rocks intruded by various granitic plutons. The Northern Foreland represents reworked Yilgarn Craton and generally has a transitional boundary with the interior of the craton, where Archean, dominantly north- to northwest-trending structures are increasingly overprinted by Proterozoic, dominantly east- to northeast-trending structures. Where deformation intensity increases, and the rocks approach granulite facies, the affinities of their protolith provenance become problematic. For example, the Munglinup Gneiss (Fig. 1) was previously considered to be part of the Biranup Complex, allocthonous to the Yilgarn Craton (Myers, 1995). However, magnetic anomalies within the gneisses suggest the presence of remnant greenstones and, in some instances, these can be traced across the Northern Foreland boundary and into the craton interior. New SHRIMP U–Pb zircon dating has yielded felsic igneous protolith ages of 2681 ± 5, 2661 ± 15, and 2658 ± 21 Ma for the Munglinup Gneiss, which are similar to typical Yilgarn granite ages, and slightly older than those previously reported for the unit (Nelson et al., 1995). Some of these orthogneisses record thermal disturbances at c. 1190 Ma, consistent with reworking during Stage II of the Albany–Fraser Orogeny. We therefore interpret the Munglinup Gneiss to be part of the Northern Foreland, i.e. reworked Yilgarn Craton.

The Munglinup Gneiss shows at least four phases of deformation: 1) isoclinal folding of gneissic layering; 2) regional, mostly north-trending, open to tight folds; 3) regional northeast- to east-trending tight folds; and 4) magmatic shear zones. Large-scale fold interference patterns from phases 2 and 3 are prominent on aeromagnetic images, indicating multiple folding is the dominant structural feature of the Munglinup Gneiss. Phases 1 and 2 are possibly Late Archean in age, but phase 3 structures are oriented parallel to the cross-cutting regional trend of the Albany–Fraser Orogen. The gneissic layering is locally boudinaged, but it is not clear whether this occurred during deformation phase 2 or 3. Phase 2 is cut by major bounding faults to the south (e.g. Red Island), and all phases are cut by the Jerdacuttup Fault to the north.

In contrast to the Munglinup Gneiss, the Dalyup Gneiss of the Biranup Complex has igneous protolith ages of c. 1680 Ma, and probably represents part of an exotic terrane. The Dalyup Gneiss is dominated by granulite facies orthogneisses, extends from at least the Bremer Bay area in the west, to inboard of the Fraser Complex in the east (Nelson et al., 1995), and forms the main suture to the craton margin. In the Bremer Bay area the structure

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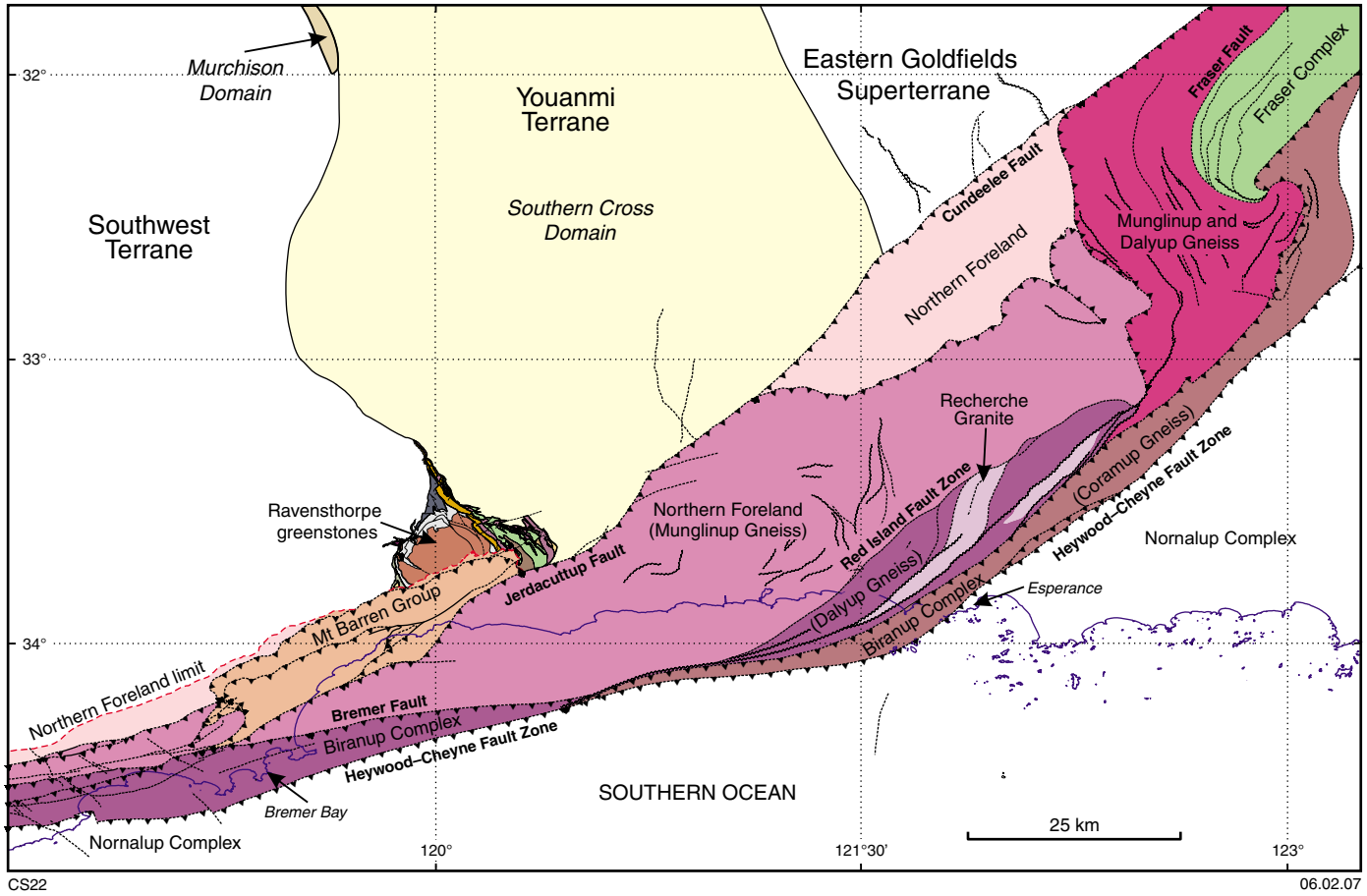

Figure 1. Simplified map of the Albany–Fraser Orogen and southern Yilgarn Craton extracted from the new interpreted bedrock geology map (GSWA, in prep.), based on GSWA's regional geological mapping over the map area between 1970 and the present

is complex but is dominated by large-scale boudinage, indicative of at least one extensional event within the orogen. Boudinaged Dalyup Gneiss samples have yielded protolith igneous crystallization ages of 1680 ± 7 and 1689 ± 11 Ma, and the latter underwent new metamorphic zircon growth at 1197 ± 12 Ma. Crystallized melts within the boudin necks yielded crystallization ages of 1178 ± 4 and 1187 ± 5 Ma, and the latter preserves evidence of subsequent metamorphism at 1167 ± 15 Ma. In the Esperance area, the Dalyup Gneiss is dominated by tight to isoclinal folding, shear zones, and mylonite zones, and is in fault contact with the strongly deformed Coramup Gneiss (also part of the Biranup Complex, Fig. 1), which contains both para- and orthogneisses. New SHRIMP U–Pb zircon dates show that garnet-bearing granodioritic gneiss has an igneous crystallization age of 1688 ± 12 Ma (indistinguishable from the Dalyup Gneiss), and underwent metamorphism at 1231 ± 9 Ma. Metamorphosed quartz sandstone (in the Coramup Gneiss) from the same area has a maximum depositional age of c. 1750 Ma, was metamorphosed at 1215 ± 5 Ma, and preserves evidence for post-metamorphic resetting at 1184 ± 7 Ma.

The structural complexity of the Biranup Complex rocks is evident on aeromagnetic images, which show that most of the Dalyup and Coramup Gneisses are contained within major shear zones that wrap around the craton margin. These are interpreted to represent the remnants of terrane amalgamation, possibly during Stage I of the Albany–Fraser Orogeny (1345–1260 Ma), as the main regional structures close to the craton margin are cross-cut by mafic dykes belonging to the c. 1210 Ma Gnowangerup Dyke Suite. Metamorphic ages recorded in both the Munglinup Gneiss and Biranup Complex rocks between c. 1210 and 1140 Ma represent reworking during Stage II.

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