Late Archaean volcanism and sedimentation in the central Yilgarn Craton

by

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In the central part of the Southern Cross granite–greenstones, felsic volcanic rocks of the Marda Complex and clastic sedimentary rocks of the Diemals Formation were deposited at c. 2.7 Ga. They unconformably overlie an older (c. 3.0 Ga) greenstone succession containing metamorphosed mafic–ultramafic and sedimentary rocks with prominent chert and banded iron-formation.

The Marda Complex (Hallberg et al., 1976) occupies a roughly elliptical area of about 600 km^2 (Fig. 1) surrounded by units of banded iron-formation of the older greenstone succession, which dip moderately to steeply towards the complex. Small outlying areas of felsic volcanic rocks are attributed to the Marda Complex. To the north-northwest, the Diemals Formation (Walker and Blight, 1983) fills a roughly triangular synformal structure largely bounded by faults, but locally unconformable on the older greenstone succession. Metamorphism in these sequences is typically low greenschist facies, with higher grades observed only in contact aureoles.

Rhyolitic ignimbrite of the Marda Complex has a SHRIMP (sensitive high-resolution ion microprobe) age of 2732 ± 3 Ma (Nelson, in prep.). Metasedimentary rocks that unconformably overlie the lower greenstone succession and interfinger with the Marda Complex volcanics have been regarded as equivalent to the Diemals Formation lithologies (Chin and Smith, 1983), suggesting that the Diemals Formation and the Marda Complex were contemporaneous. However, sedimentary rocks of the Diemals Formation differ from those in the Marda Complex in that they do not have a distinct volcaniclastic component.

The Diemals Formation is a sequence of clastic metasedimentary rocks which have been folded into a regional-scale syncline with a moderate northerly plunge. In the western limb, silty argillite at the base is overlain by sandstone and pebbly sandstone. In the east, the lowermost exposed part of the formation consists of conglomerate and pebbly sandstone lenses interbedded with siltstone, which are in turn overlain by sandstone. The total thickness of the formation is uncertain, due to poor exposure and medium-scale folding.

The basal unconformity of the Diemals Formation is best exposed southwest of Diemals Homestead (Fig. 1), where a foliated, poorly sorted conglomerate contains clasts of black shale and deeply weathered mafic rocks derived from the underlying greenstones. At this locality, the basal conglomerate and the overlying sandstones dip moderately to the south-southwest, whereas the underlying greenstones dip steeply to the west.

The lowermost portion of the Diemals Formation consists of fawn to yellow–brown and grey (typically purple-weathered) silty argillite, with chloritic schist and graphitic shale horizons near the base. Minor, structurally controlled gold mineralization is hosted by these fine-grained sedimentary rocks. In the eastern limb of the syncline, the silty argillite is interbedded with lenses of polymictic conglomerate and pebbly sandstone. The conglomerate contains variably flattened clasts, up to 50 cm in size, which consist mainly of reworked sandstone and argillite, banded iron-formation, banded chert, and weathered mafic rocks, with granitoid and other felsic clasts present locally. Chert and banded iron-formation clasts commonly contain tight to isoclinal folding, indicating deformation prior to deposition of the Diemals Formation.

Sandstones and pebbly sandstones in the upper portion of the Diemals Formation vary from clean quartz arenite (locally quartzite) to much more immature quartz and lithic greywacke, and ferruginous sandstone, indicating variable conditions of transport and deposition. Graded bedding, cross-bedding and scour troughs are locally preserved.

Field characteristics and facies relationships suggest that the Diemals Formation represents a fluviatile sequence deposited over a deformed greenstone basement, with some contribution from granitoid sources. A predominant transport direction from east to west is indicated by clast lithology and the asymmetric distribution of facies in the lower parts of the formation. The presence of intraformational and mafic clasts within the conglomerate lenses indicates a relatively active tectonic environment, with uplift and erosion of the greenstone

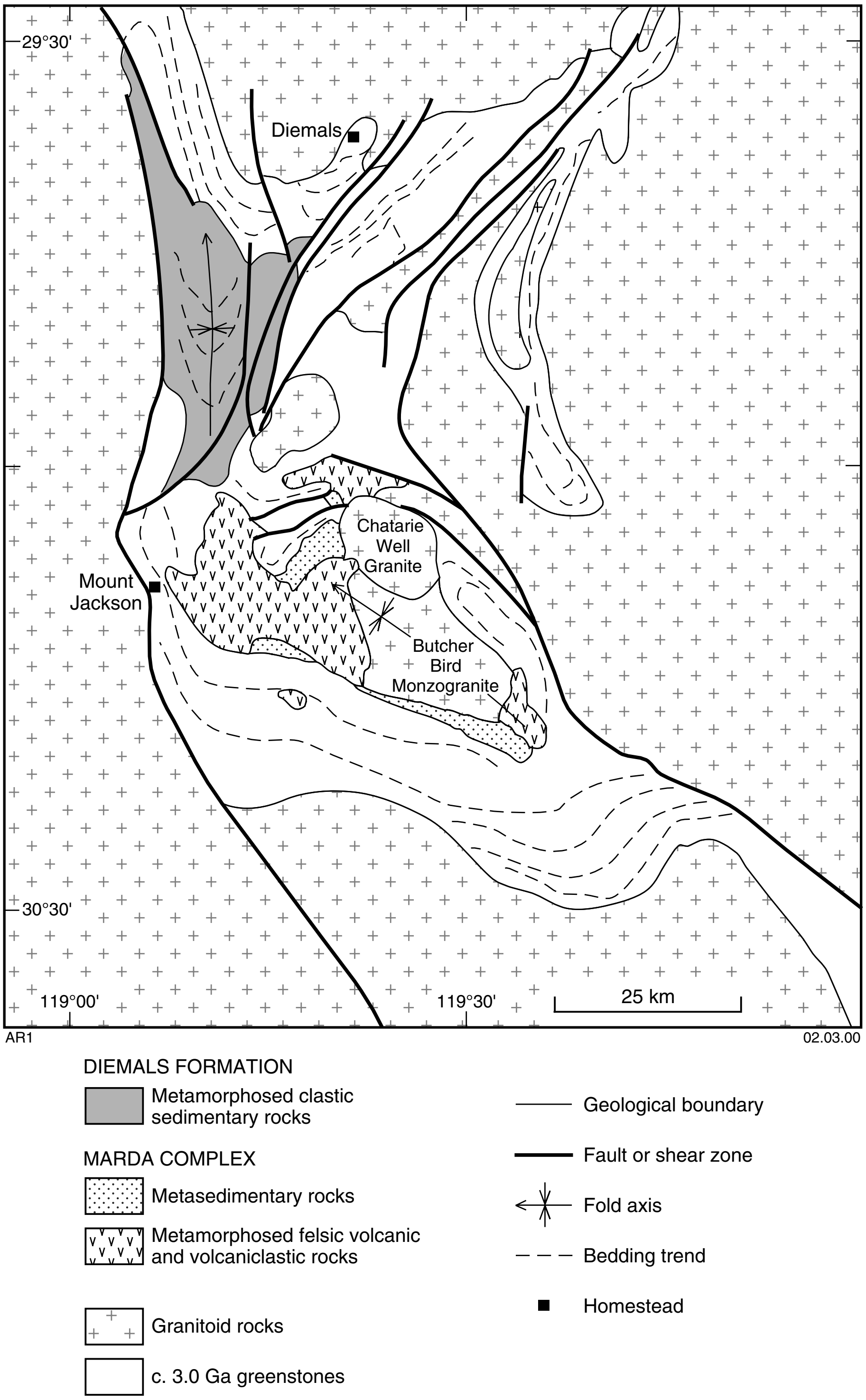

Figure 1. Simplified interpreted late Archaean geology of the central Southern Cross Province, showing the distribution and main structural features of the Diemals Formation and Marda Complex

basement and local reworking of the Diemals Formation sediments.

The Marda Complex comprises interfingering lava flows, pyroclastic rocks and minor volcaniclastic sediments, which were erupted in a largely subaerial environment onto a sequence of clastic sediments derived from the underlying greenstones. The whole succession has been folded at various scales.

The lower part of the Marda Complex is dominated by thick sequences of dark-grey andesitic and subordinate dacitic flows that are generally porphyritic and very commonly amygdaloidal. Overlying the andesites are thick sheets of rhyolitic ignimbrites and subordinate rhyolite flows, with textures indicative of subaerial deposition. Pyroclastic rocks include rheomorphic ignimbrites in which eutaxitic banding is defined by alternating layers of quartz and feldspar that wrap around altered plagioclase phenocrysts and lithic fragments. Fragmental ignimbrites include crystal and lithic lapilli tuffs, as well as minor ash tuffs and agglomerates. Lapilli include rhyolite and devitrified glass, as well as minor dacite, andesite and chert, set in a crystal-rich, welded and devitrified groundmass. In the crystal tuffs, plagioclase and resorbed quartz crystals are commonly surrounded by a matrix of welded shards. Rhyolitic flows are massive to quartz- and plagioclase-phyric, with an aphanitic groundmass of devitrified glass; sericitization is common and locally pronounced.

The sedimentary rocks of the Marda Complex include pebble conglomerate, sandstone and siltstone, commonly with a volcaniclastic component. The clast composition and immaturity of these sedimentary rocks suggests proximal deposition.

The Marda Complex is intruded to the east by the Butcher Bird Monzogranite (Fig. 1). The ubiquitous granophyric texture of this granitoid and its chemical similarity to the Marda Complex rhyolite suggest that it represents the high-level intrusion of the magma which was the source of the Marda volcanic rocks.

Geochemical investigation of the Marda Complex has confirmed that the Marda Complex volcanics form a broadly continuous geochemical series with a distinctive calc-alkaline trend (cf. Hallberg et al., 1976). Differences in the rare-earth element (REE) geochemistry of andesites and rhyolites preclude a simple derivation of the more acid rocks from the andesites by a process of crystal fractionation (Taylor and Hallberg, 1977). A crustal source for both lithotypes is indicated by the lack of significant heavy REE depletion, and is supported by high contents of Th and U.

The mineral potential for volcanogenic massive sulfide deposits (VHMS) in the felsic rocks of the Marda Complex is considerably limited by their largely subaerial nature. Although most Marda Complex andesites show chemical similarities to those hosting the Selbaie mineralization in the Abitibi Subprovince, Canada (Barrie et al., 1993), the Marda Complex lacks the bimodal character typical of volcanic rocks that host significant VHMS deposits. Potential exists in the Marda Complex for structurally controlled gold mineralization. Most of the gold in the Marda area is concentrated in quartz–sulfide vein systems that crosscut the banded iron-formation units around the Marda Complex, but some gold is reported from similar vein systems at the base of the Marda volcanic pile.

Evidence for the tectonic setting of the Marda volcanic rocks is not conclusive. The Marda Complex has the high potassium, calc-alkaline chemistry of Andean-type modern subduction settings, broadly similar to that of some felsic complexes of the Eastern Goldfields for which a subduction-related environment has been postulated (Morris, 1998, and references therein). However, the isolated nature of the Marda Complex within the Southern Cross Province, the lack of rock associations typical of continental subduction, and the inferred crustal derivation for the Marda lavas, preclude a straightforward analogy.

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