Geology and physical volcanology of the Bentley Supergroup, Musgrave Province

by

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The Bentley Supergroup is well-exposed in the west Musgrave Province of central Australia and consists of supracrustal volcano-sedimentary rocks of latest Mesoproterozoic age, with U–Pb geochronology indicating deposition between about 1080 and 1025 Ma (Smithies et al., 2008). This depositional age range brackets the age of emplacement of the mafic–ultramafic Giles intrusions, which form part of the Warakurna large igneous province (Wingate et al., 2004), a magmatic expression of the Giles Event (Evins et al., in press).

The Bentley Supergroup is primarily composed of bimodal volcanogenic rocks comprising voluminous and widespread extrusive felsic and mafic igneous rocks such as rhyolitic to dacitic lava flows and ignimbrite sheets, as well as basaltic to andesitic lavas and mafic volcaniclastic rocks. Interlayered with the volcanogenic rocks are continental siliciclastic and minor lacustrine calcareous rocks (Daniels, 1974). The extrusive igneous rocks of the Bentley Supergroup are also part — together with coeval intrusive igneous rocks — of the Warakurna Supersuite (Howard et al., 2007).

Outcrops of the Bentley Supergroup are confined to the west Musgrave Province, where they unconformably overlie older Mesoproterozoic metamorphic basement (Daniels, 1974). The supergroup was deposited within an extensive, probably intracontinental, rift basin much larger than its present outcrop extent. In the Blackstone area, the Bentley Supergroup is represented by the Kunmarnara and Tollu Groups, consisting of a succession of coarse siliciclastic rocks and amygdaloidal basalts unconformably overlain by felsic and then basic to intermediate lavas, and the Skirmish Hill Volcanics (Smithies et al., 2008). In the Warburton–Jameson area, Daniels (1974) suggested the existence of three structural domains separated by inferred caldera faults. The southwestern part of the west Musgrave Province is characterized by the south-dipping and -younging volcano-sedimentary Pussy Cat, Cassidy, and Mission Groups (Fig. 1). This succession has a cumulative thickness of several kilometres and forms an arcuate, southeast- to east-trending belt. The southern margin of this succession is unconformably overlain by the Townsend Quartzite, the basal unit of the Officer Basin succession. To the north and east lie the Scamp and Palgrave areas, which were originally interpreted by Daniels (1974) as volcanogenic caldera subsidence areas.

Recent field mapping has focused on the northern half of the MOUNT EVELINE* 1:100 000 map sheet (Fig. 1). In this area, the Pussy Cat Group is represented by the Glyde Formation and the intercalated Kathleen Ignimbrite. The lower Glyde Formation is dominated by dark-coloured, mafic volcaniclastic sedimentary rocks, and the upper part is dominated by amygdaloidal mafic lavas. The lower volcaniclastic rocks comprise mainly laminated to massive mudstones, plane-bedded and trough cross-bedded arkosic sandstones, and poorly sorted, matrix-supported mud- and debris-flow deposits (lahars; Fig. 2a). Some finely laminated mudstones may represent subaqueous ash-fall tuffs. Minor components — important for paleoenvironmental reconstruction — include evaporitic horizons and stromatolites. The Glyde Formation was deposited in a volcanically active fluvio-lacustrine environment with mafic volcanic source components commonly dominating over felsic components in the volcaniclastic deposits. Moderate-temperature, low-pressure regional metamorphism overprinted Glyde Formation volcaniclastic rocks to biotite- and epidote-rich, commonly hornblende-porphyroblastic hornfels and micro-granofels, whereas mafic volcanic rocks were transformed into epidotitic amphibolites.

The Kathleen Ignimbrite has a maximum thickness of over 500 m and forms a mappable unit within the Glyde Formation. It is mainly composed of rhyolitic flow-banded lava-like deposits, which Daniels (1974) interpreted as densely welded and rheomorphic pyroclastic rocks. Observations supporting a pyroclastic origin include the irregular and patchy distribution of quartz and feldspar phenocrysts and crystal fragments, the presence of cognate rhyolite-porphyry and mafic-volcanic pyroclasts, alternating felsic and mafic layers in its basal part, relicts of glass shards (Fig. 2b) and pumice breccias in its higher part, and fiamme textures and stratified crystal-tuffs near the top. The Kathleen Ignimbrite also contains upwardly intruded clastic dykes of Glyde Formation material, indicating that the ignimbrite was deposited rapidly onto semi-consolidated, water-bearing volcaniclastic sediments.

* Capitalized names refer to standard 1:100 000 map sheets.

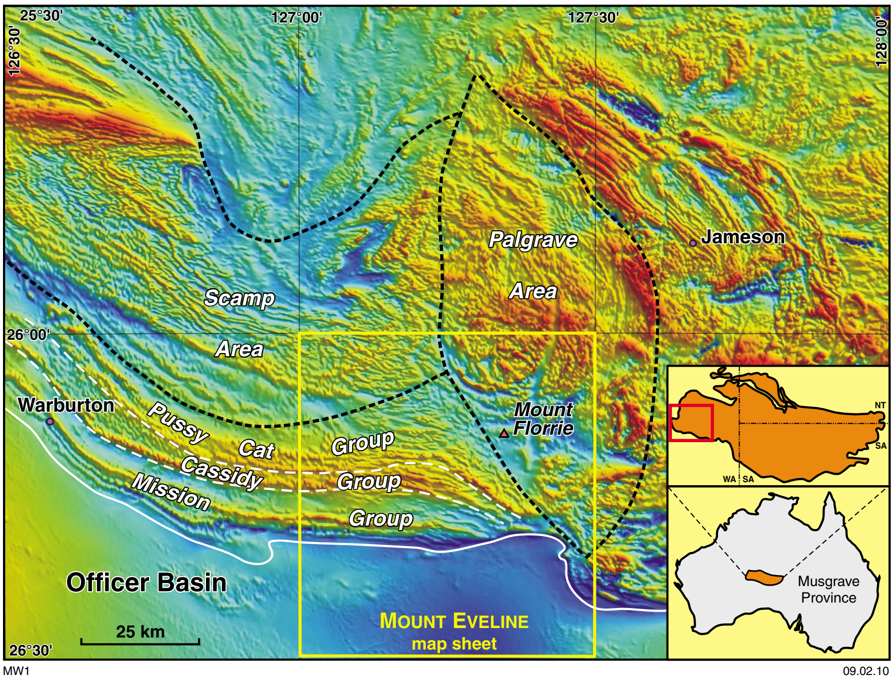

Figure 1. Aeromagnetic image showing the area in which the Bentley Supergroup is exposed in the Warburton–Jameson area of the west Musgrave Province. The dashed black lines mark the approximate positions of caldera faults and structural domains as postulated by Daniels (1974). However, the aeromagnetic data as well as our own lithological and structural observations cannot be fully reconciled with Daniels' interpretation. The red frame in the upper inset indicates the position of the area shown in the aeromagnetic image.

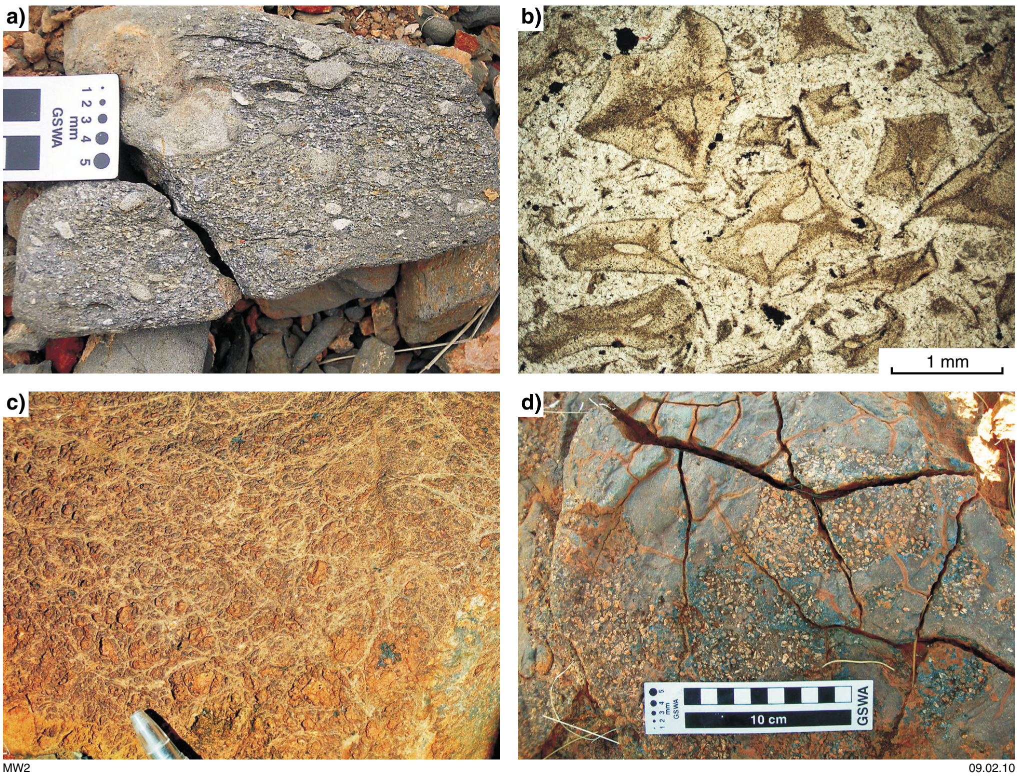

Figure 2. (a) Coarse-grained mafic volcaniclastic rocks of the Glyde Formation; (b) relict glass shards in the upper part of the Kathleen Ignimbrite (photomicrograph in plane-polarized light); (c) relict perlitic cracks in formerly glassy felsic volcanic rock of the Palgrave area; (d) intrusive phenocryst-rich rhyolite porphyry forming peperites within fine-grained, semi-consolidated volcaniclastic rocks of the Glyde Formation.

The Scamp area lies north of the Pussy Cat Group outcrop belt. Daniels (1974) inferred that a major east-trending caldera fault separates the two areas. Our recent mapping of the southeastern Scamp area instead indicates that the Scamp volcanics and the Pussy Cat Group are part of the same south-dipping succession, with the Scamp volcanics representing a deeper stratigraphic level. The Scamp area north of the Kathleen Ignimbrite is dominated by extrusive rhyolitic volcanic rocks, including both lava flows and ignimbrites. In its eastern part, mafic volcanic and volcaniclastic rocks form significant intercalations in the rhyolitic portions and are strikingly similar to Glyde Formation rocks.

The Palgrave area, a northerly trending oval area of outcrop, was again interpreted by Daniels (1974) as a caldera. However, our lithological and structural data do not support this interpretation. The succession comprises roughly north-trending, west-dipping and -younging felsic volcanic and pyroclastic rocks with minor mafic volcaniclastic intercalations. Formerly vitric volcanic rocks are typically strongly spherulitic or perlitic (Fig. 2c). These rocks are similar to those of the Bentley Supergroup further west, although here they represent a more proximal lithofacies. The Palgrave succession partially wraps around a large synvolcanic dome (Winburn Granite). Brittle deformation and hydrothermal alteration associated with doming and formation of a large west-northwesterly plunging fold is conspicuous in the Mount Florrie region (Fig. 1), which has recently been the site of a significant gold discovery (Handpump prospect; Beadell Resources, 2009).

On MOUNT EVELINE the intrusion of synvolcanic felsic magmas — like those of the Winburn Suite — into the Bentley Supergroup was very common. Typical rocks are rhyolite porphyries and microgranites, which form sills up to 250 m thick, dykes up to 150 m wide, and stocks such as the 4 × 6 km Mount Eveline intrusion. Some of these magmas mixed and mingled with unconsolidated or semiconsolidated volcaniclastic sediments and pyroclastics to form peperites (Fig. 2d). In the central Palgrave area, a large-wavelength magnetic and gravity anomaly suggests the presence of a large mafic intrusive body (probably Giles Suite) at depth.

References

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