Metamorphosed Archaean spherulitic felsic lavas on Mason Hill, Duketon, Eastern Goldfields

by R. L. Langford

Abstract

The metamorphosed porphyritic felsic lava at Mason Hill retains well-preserved primary volcanic features, including both relict spherulites and phenocrysts, that confirm the effusive nature of the protolith. There is a complete absence of broken or shardic crystals, and the population of phenocrysts is uniform in distribution and morphology. The metalava sequence at Mason Hill comprises several thin flows, each up to 3 m thick, and overlies a metasiltstone unit that is at least 2 m thick, indicating a relatively quiescent and intermittent phase of extrusive volcanism in the northern part of the Archaean granite–greenstones in the Duketon region of the Eastern Goldfields Province.

KEYWORDS: greenstone, Duketon, Eastern Goldfields, Archaean, spherulite, lavas.

The DUKETON* 1:100 000 sheet is located in the northern part of the Archaean granite–greenstones of the Eastern Goldfields Province. The sheet is located about 100 km north of Laverton, and is dominated geologically by a north to north-northwesterly trending Archaean greenstone belt. The centre of the belt is dominated by metamorphosed felsic volcanic and volcaniclastic rocks. Most of these felsic rocks are strongly deformed, but those at Mason Hill (Fig. 1), located 7.5 km west-northwest of the abandoned townsite of Duketon, retain well-preserved primary volcanic features.

Mason Hill (578 m Australian Height Datum; Australian Map Grid (AMG) 4223 69453) is a low ridge about 500 m long that stands 10–15 m above the surrounding plains. The hill has a debris-strewn northwest slope and a rocky southeast-facing scarp. The dominant lithology exposed on Mason Hill is a metamorphosed porphyritic felsic lava of rhyolitic or dacitic composition. Although the rocks are invariably slightly to moderately weathered and poorly preserved, the metalava has a petrographic character that confirms its effusive origin, including locally preserved relict spherulites.

* Capitalized names refer to standard map sheets.

Structural setting

The greenstones of the Duketon belt are, for the most part, strongly foliated on a north-northwest trend, with dips greater than 60° to the east or west, although deformation is markedly heterogeneous. The central part of this belt is complexly folded and is interpreted as having an overall synclinal form, referred to as the Erlistoun Syncline (Gower, 1974; Farrell and Langford, in prep.).

On Mason Hill there is a poorly developed primary planar structure defined by parting planes in the metamorphosed volcanic rocks and bedding in the metasedimentary rocks, which dip 20–30° to the north-west. These are cut by a well-developed axial-planar cleavage dipping about 60° to the west-southwest (Fig. 2). Structurally, the layering and sedimentary bedding define an open anticline, with bedding-cleavage intersections indicating an axis plunging 28° northwest.

Lithological character

The metalava unit probably comprises several thin flows each up to 3 m thick, and overlies a meta-siltstone unit that is at least 2 m thick. The top of the metalava cannot be seen on Mason Hill, and there are more exposures of this rock type, lying structurally above these exposures, on Ingijingi Hill about 400 m to the north. The area to the south of Mason Hill is dominated by poor exposures of very fine-grained, well-foliated felsic rocks, with no relict textures preserved, that are presumed to be volcaniclastic in origin.

The primary igneous layering comprises discrete parting planes 10–50 cm apart, with sedimentary units separating discrete flows at a much wider spacing. At the base of the southwestern end of the scarp there is a finely foliated meta-sedimentary unit, distinguished from the lava in part by the absence of quartz relicts. This unit, lying below the metalava, can be

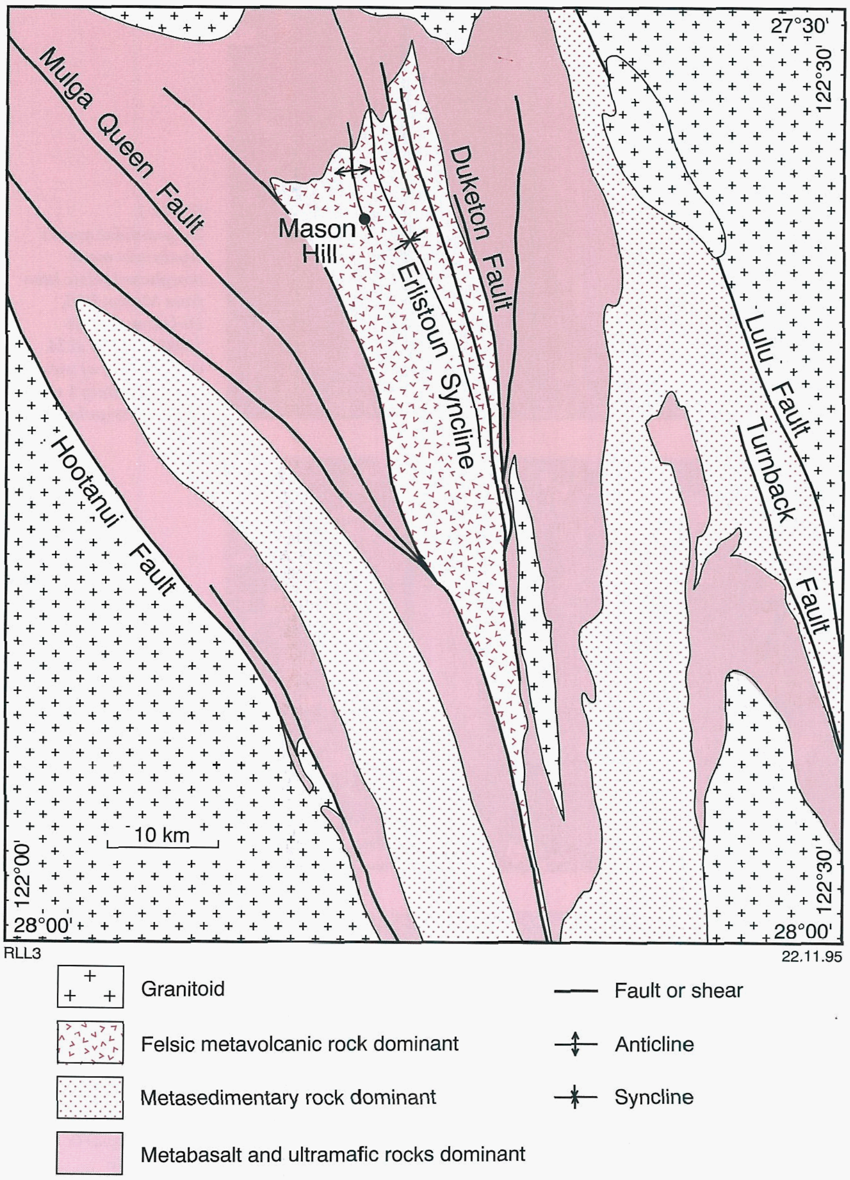

Figure 1. Simplified geology of DUKETON *showing the location of the metamorphosed spherulitic felsic lavas on Mason Hill*

traced for at least 150 m to the northeast.

About 4 m to the southeast of the survey post on Mason Hill (Mines Department DUK 10) there are exposures of metamorphosed spherulitic felsic lava with thin metasedimentary rock interbeds. The spherulitic unit is about 20 cm thick, and contains spherulites ranging in size from 5–20 mm. A further 80 m to the northeast there are more exposures with a relict spherulitic texture that are probably part of the same unit as that near the survey post. Here the unit has at its base a crystal-rich pebbly horizon about 5 cm wide, containing well-rounded pebbles up to 4 cm across. The matrix to the pebbles is well foliated, probably indicating an originally silty or clayey nature. Below the pebbly horizon, interpreted as a volcanic conglomerate, is a metasiltstone.

Petrography

In thin section the metalava contains small relict quartz crystals as phenocrysts, glomeroporphyritic aggregates, and bipyramidal pairs up to 2 mm across (Fig. 3). Some of the small bipyramidal pairs have reaction haloes (Fig. 4). The phenocrysts are typically less than 1 mm across, and have subhedral and embayed forms. There are also very scarce occurrences of trains of tiny quartz crystals that have formed parallel to the primary igneous layering (Fig. 5). The matrix to the metalava is very fine-grained secondary quartz and white mica.

Relict phenocrysts other than quartz are present, with only indistinct shapes giving any sense of the original nature. Pseudomorphs presumed to be after feldspar are not common, and do not possess any diagnostic characteristics. Therefore, the proportions of plagioclase and alkali feldspar, and hence the composition of the protolith, cannot be determined precisely. Evidence in thin section of a mafic mineral phase is almost non-existent, with only one noted occurrence of a euhedral pseudomorph about 0.4 mm across with the distinctive shape of an amphibole (GSWA 120908, AMG 4224 69454).

Origin and composition

Deformed granites in the Duketon area vary from syenogranite to monzogranite, with quartz syenite also present (Farrell and Langford, in prep.). There is no field evidence of a link between plutonism and volcanic activity, although it seems likely that a subvolcanic granite or felsic dyke complex should exist.

SHRIMP U–Pb zircon dates from the southern part of the Eastern Goldfields (Nelson et al., in prep.) show an age overlap between the felsic volcanic rocks and granitoids that seems to confirm a genetic link in that area. A genetic relationship between some of the granitoids and the felsic volcanic rocks of central DUKETON is therefore likely.

Mechanisms of formation

Spherulites, which consist of radiating arrays of crystal fibres, are a characteristic product of the high-temperature devitrification of natural glass, and can occur in welded ignimbrites as well as lavas

Figure 2. Bedding–cleavage intersection in metamorphosed felsic lava on the southwest end of Mason Hill, Duketon, looking northwest (AMG 4222 69452)

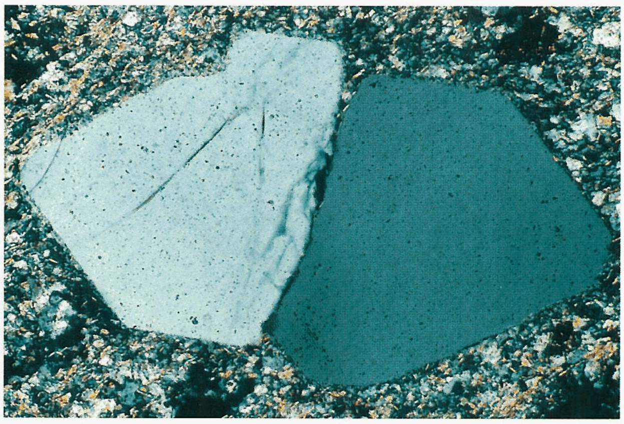

Figure 3. Bipyramidal quartz crystals in metamorphosed felsic lava from Mason Hill, Duketon. GSWA 120907 (AMG 4224 69454). Field of view approximately 1 mm wide; cross-polars

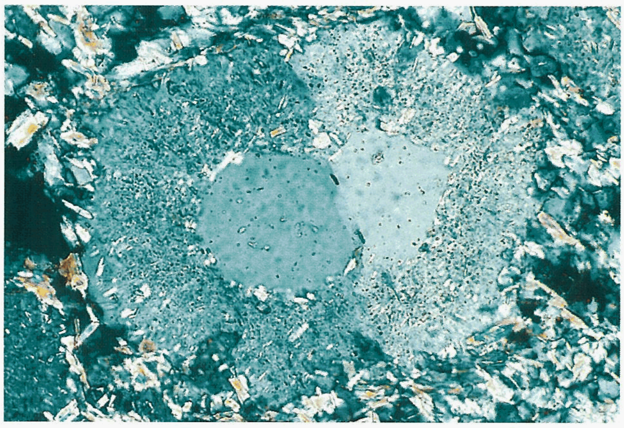

Figure 4. Reaction halo around bipyramidal quartz in metamorphosed felsic lava from Mason Hill, Duketon. GSWA 120906 (AMG 4222 69452). Field of view approximately 0.5 mm wide; cross-polars

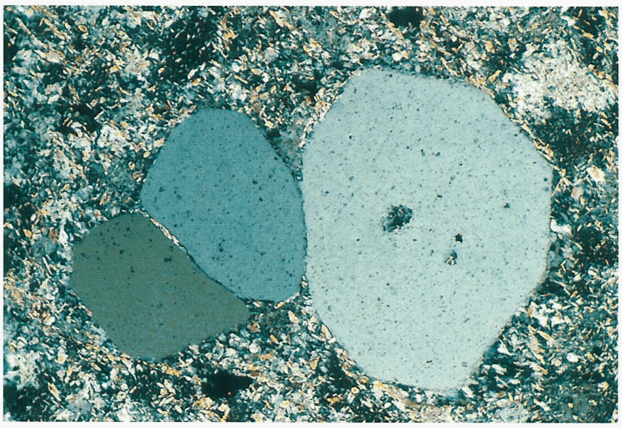

Figure 5. Train of quartz crystals in metamorphosed felsic lava from Mason Hill, Duketon. GSWA 120908 (AMG 4224 69454). Field of view approximately 1 mm wide; cross-polars

(McPhie et al., 1993). Phenocrysts usually form in lavas, but can form in 'tufolavas' (Fischer and Schmincke, 1984) or rheomorphosed ignimbrites (Branney and Kokelaar, 1992). However, rocks of pyroclastic origin should have many broken or shardic crystals preserved. Even with rheomorphism producing late-stage euhedral crystal growth in the matrix, pyroclastic rocks would typically contain only very small euhedral crystals, contrasting with the coarser relict degraded or broken phenocrysts in the larger and more abundant typical pyroclast population.

Post-extrusive rheomorphism of a tuff matrix or crystallization in a magma may account for some of the small bipyramidal pairs with reaction haloes. However, the majority of the euhedral crystals and crystal aggregates are more likely to have formed at or before eruption in a coherent volcanic fluid. The subhedral and embayed phenocrysts indicate some disequilibrium with the surrounding magma.

The metalava on Mason Hill contains both relict spherulites and phenocrysts that, taken in isolation, may not be seen as conclusive evidence of an effusive origin, but together are most likely to indicate that the rock was a lava. In addition, there is a complete absence of broken or shardic crystals, and the population of phenocrysts is uniform in distribution and morphology. Overall the sequence on Mason Hill comprises a number of thin porphyritic lava flows separated by volcaniclastic or sedimentary units, indicating a relatively quiescent and intermittent phase of extrusive volcanism.

Acknowledgement

The author is grateful for the advice of T. J. Griffin, who first identified the spherulitic textures on Mason Hill.

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