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Reconstruction of an extensive Archaean dacitic submarine volcanic complex associated with the komatiite-hosted Mt Keith nickel deposit, Agnew-Wiluna Greenstone Belt, Yilgarn Craton, Western Australia

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Abstract

Felsic volcanic rock units characterise a large portion of the 2.7 Ga. Agnew-Wiluna Greenstone Belt (Western Australia) stratigraphy and form the hangingwall and footwall sequences to several komatiite-hosted nickel sulphide deposits in the region. The Mt Keith region of the Agnew-Wiluna Greenstone Belt (AWB) comprises a sequence of felsic, mafic and ultramafic extrusive and intrusive units. The felsic volcanic dominated footwall and hangingwall sequences to the Mt Keith nickel deposit comprise cyclical packages of coherent dacite lavas, with associated monomictic *in situ* to resedimented breccias. Clasts in the monomictic breccia facies are identical to the coherent dacite and the two facies are often in gradational contact. The dacites are interpreted as submarine lavas and the breccias as associated autoclastic facies (hyaloclastite, autobreccia). These dacite lavas are inferred to have been emplaced into a deep water environment which retarded volatile exsolution suppressing explosive fragmentation and increasing lava mobility, resulting in large tabular flow units. The AWB sequence has undergone multiple periods of deformation and metamorphism subsequent to emplacement resulting in strain and alteration in large sections of the coherent lava facies. A notable textural variant within the lavas is a set of pseudo-textures/structures resembling tuffaceous and brecciated dacitic units. The process of pseudo-clastic texture/structure generation is related to a combination of polyphase alteration, brecciation and development of a secondary structural/metamorphic layering. Understanding the origin of these pseudo-clastic textures/structures has allowed recognition of the lateral and vertical facies variation of the felsic sequence and reconstruction of the original volcanic architecture.

Keywords: Dacite complex; Archaean; Mt Keith; Submarine; Pseudo-textures

1. Introduction

Felsic volcanic rock units comprise a large proportion of the Archaean stratigraphy of the Agnew-Wiluna Greenstone Belt (AWB), Eastern Goldfields Province, Yilgarn Craton of Western Australia (Fig. 1). However, compared to the komatiite units within this sequence there has been little study of their facies architecture and mode of emplacement. Felsic sequences occur along the entire strike length of the AWB and are intimately associated with several major nickel deposits, including the world class Mt Keith Nickel sulphide deposit to which felsic rocks form the footwall and hangingwall sequences. This komatiitic–felsic association is well represented in the northern part of the Eastern Goldfields Province, and is in contrast to classical komatiite-hosted NiS sequences in the Kambalda area where the komatiite–basalt association is dominant with only minor felsic components present as distal facies tuffs preserved as interflow layers between komatiite units (Lesher et al., 1984; Squire et al., 1998; Beresford et al., 2002).

The volcanology and facies architecture of the felsic sequences have previously only been described locally within individual prospects, e.g. Shed Well (Heptinstall, 1991), Sarah's Find (Palich, 1994). Paucity of outcrop, discontinuous drill coverage and locally intense deformation and alteration makes correlation between these areas difficult and has hampered regional-scale reconstruction of facies relationships in the northern part of the AWB. However, expanded drilling by WMC

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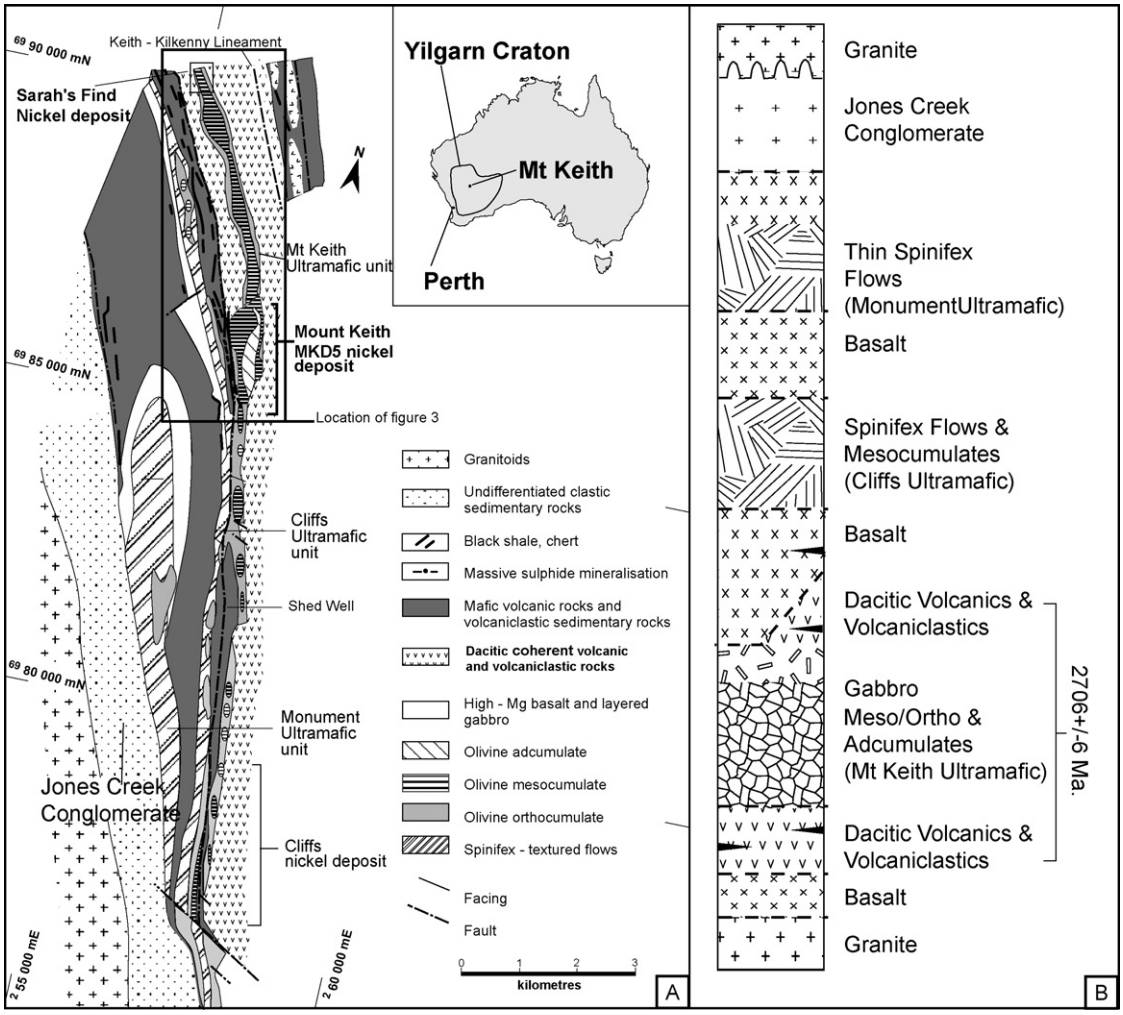

Fig. 1. (A) Regional geology of the Mt Keith region illustrating distribution of felsic, mafic and ultramafic units, modified from Dowling and Hill (1990), unpublished report for CSIRO. (B) Stratigraphy of the Agnew-Wiluna Belt in the Mt Keith Region. Sedimentary units such as black shale and chert are indicated by black wedges within dacite and basalt sequence.

Resources Ltd. within the vicinity of the Mt Keith nickel deposit has provided new facies information within the felsic succession, assisting in the reconstruction of the vertical and lateral facies variations of the felsic sequence. Information from three key localities in the Mt Keith region is presented in this paper with the aim of: (1) documenting original textures of these rocks where preserved, (2) documenting the effect of strain and alteration on original textures, (3) reconstructing the volcanic facies architecture, and (4) reconstructing the emplacement origins of the felsic units.

1.1. Regional geology

The Mt Keith region is part of the Agnew-Wiluna Greenstone Belt (AWB), which is located within the Eastern Goldfields Province (EGP) in the eastern part of the Archaean Yilgarn Craton of Western Australia. The AWB comprises the northern portion of the Norseman-Wiluna Greenstone Belt which extends for a strike length of approximately 650 km. The AWB trends in a NNW/SSE direction and is bounded by large- to terrane-scale faults and voluminous Archaean granitoid bodies (Fig. 1). The Mt Keith/Cliffs/Sarah's Find area is located in the thinnest portion of the AWB, approximately 80 km south of Wiluna, where it has a maximum thickness of approximately 6 km.

The greenstone sequence in the Mt Keith area comprises a variably deformed and metamorphosed sequence of 2.7 Ga. felsic, mafic and ultramafic volcanic rocks. The ultramafic rocks in the Agnew-Wiluna region are highly endowed with nickel mineralisation, including two world class nickel deposits, the Mt Keith and Perseverance deposits. Both of these deposits are hosted in komatiitic-dunite lenses, which are underlain and overlain by felsic rock sequences.

The Mt Keith region comprises three separate ultramafic horizons which are separated by a variably deformed sequence of mafic and felsic rock units. The stratigraphy of the Mt Keith region has been assessed in several studies (e.g. Dowling and Hill, 1990; Hill et al., 1990; Bongers, 1994; Palich, 1994; Langworthy and Hronsky, 1995; Rosengren, 2004). In the Mt Keith region (Fig. 1) the lowest unit is the Mc Farlanes Basalt, a highly deformed unit which is in faulted contact at its base with the Mt Keith Granodiorite. The Mc Farlanes Basalt is overlain by