AUSTRALIAN JOURNAL OF EARTH SCIENCES
https://doi.org/10.1080/08120099.2020.1755364

Unravelling the D_1 event: evidence for early granite-up, greenstone-down tectonics in the Eastern Goldfields, Western Australia

S. A. Jones[a], K. F. Cassidy[b] and B. K. Davis[c]

[a]SJGeology Ltd, Cromwell, New Zealand; [b]Bare Rock Geological Services Pty Ltd, Freemantle, Australia; [c]Olinda Gold Pty Ltd, Frenchville, Australia

ABSTRACT

The early tectonic history of the Eastern Goldfields Terrane (EGT) is poorly understood, but in places *ca* 2800 Ma mafic–ultramafic sequences are conformably overlain by *ca* 2720–2670 Ma sequences (*e.g.* Leonora and Laverton districts), suggesting minimal early deformation. The first significant angular unconformities occur at the base of the *ca* 2670–2655 Ma late basins and indicate that deformation was contemporaneous with deposition of the late basins. These basins mark the end of the volcano-sedimentary record in the EGT and typically grade upwards from polymictic mafic-dominated conglomerates to more siliciclastic compositions with abundant granitic clasts. The clastic sequences record the uplift and exhumation of granite-cored domes. There is a distinct lack of clasts with internal deformation fabrics (*e.g.* schist or gneiss). The timing of late basin formation overlaps with the *ca* 2672–2660 Ma D_1 event, which has been variously described as extensional or compressional. D_1 structures comprise a bedding-parallel S_1 that is axial planar to F_1 folds. The late basins and early D_1 fabrics are overprinted by upright north-trending F_2 folds and a sub-vertical S_2. A period of crustal thickening was achieved by autochthonous processes with deposition of greenstone sequences into local basins between *ca* 2720 and 2670 Ma. Partial convective overturn (or granite-up, greenstone-down tectonics) developed as a result of gravitational instability. As the large granite–gneiss bodies rose, solid-state extensional D_1 shears developed around the granites with a radial pattern of L_1 extension lineations. Areas of compression developed within the sinking greenstone sequences. A final phase of subsidence in the central parts of the greenstone belts produced depocentres (late basins). A shift from dominantly vertical tectonics to horizontal tectonics at *ca* 2655–2650 Ma is marked by the onset of east–west D_2 compression and the change in granite compositions from high-Ca to low-Ca granites.

KEY POINTS

1. Older *ca* 2800 Ma mafic–ultramafic sequences are conformably overlain by *ca* 2720–2670 Ma sequences suggesting minimal early deformation in the EGT. The first significant angular unconformities are at the base of the *ca* 2665 Ma late basin sequences.
2. Late basin sequences record the uplift and exhumation of granite-cored domes and sedimentation is contemporaneous with the regional *ca* 2672–2660 Ma D_1 event.
3. The D_1 event represents granite-up, greenstone-down tectonics (D_1 event) that developed as a result of gravitational instability arising from autochthonous crustal thickening from *ca* 2720–2670 Ma.
4. Granite-up, greenstone-down tectonics precludes an accretionary model for the development of the EGT.

ARTICLE HISTORY
Received 5 November 2019
Accepted 30 March 2020

KEYWORDS
D_1; Eastern Goldfields; deformation; granite-up; greenstone-down; extension

Introduction

The pronounced north-northwest structural grain of the Eastern Goldfields Superterrane (EGT) is made up of north-northwest-trending greenstone belts and granite ('*senso lato*') domes separated by an anastomosing network of major shears (Figure 1). The regional tectonic history has been described and interpreted by numerous authors (Archibald *et al.*, 1981; Barley *et al.*, 2003; Blewett *et al.*, 2010; Champion & Sheraton, 1997; Campbell & Hill, 1988; Cassidy *et al.*, 2006; Czarnota *et al.*, 2010; Hammond & Nisbet, 1992; Kositcin *et al.*, 2008; Krapez *et al.*, 2008; Ridley, 1993; Williams & Whitaker, 1993; Pawley *et al.*, 2012; Squire *et al.*, 2010; Swager, 1997; Weinberg & van der Borgh, 2008; Wyche *et al.*, 2012), the schemes of which are shown in Figure 2.

The regional structural architecture is typically attributed to intense east–west compression during D_2 and D_3 events

CONTACT S. Jones sarah.jones@sjgeology.co.nz SJGeology Ltd, 29 Ray Street, Cromwell, 9310, New Zealand
Editorial handling: Chris Fergusson