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The 1320 Ma intracontinental Wongawobbin Basin, Pilbara, Western Australia: A far-field response to Albany–Fraser–Musgrave tectonics

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ABSTRACT

The Eel Creek Formation, which crops out along the northeastern edge of the Archean Pilbara Craton in Western Australia, is a formerly undated, siliciclastic succession with a preserved thickness of at least 500 m. Only a small portion of the basin is exposed at surface; the bulk of it is buried beneath Neoproterozoic and Phanerozoic basins. Two tuff samples from near the base of the succession have SHRIMP U–Pb zircon ages of 1318 ± 7 Ma and 1310 ± 8 Ma, which are interpreted to be igneous crystallization ages. These depositional ages are indistinguishable from a SHRIMP U–Pb zircon date of 1317 ± 11 Ma previously obtained for a tuff about 80 km to the south-southeast at Ripon Hills. The three dates indicate that sedimentation and minor felsic volcanism at c. 1320 Ma extended over a minimum distance of 110 km along the eastern margin of the Pilbara Craton. The succession at Ripon Hills has been interpreted as an outlier of the Manganese Group, but current evidence is consistent with partial correlation between the c. 1070 Ma Collier Group and the Manganese Group. Therefore, correlation of the succession at Ripon Hills with the c. 1320 Ma Eel Creek Formation is more likely. We propose that both sequences are components of the newly named Wongawobbin Basin, an intracontinental basin that formed in response to far-field stress associated with the Albany–Fraser Orogen of southeast Western Australia and the Musgrave Orogen of central Australia. The Eel Creek Formation was sourced mainly from the Pilbara Craton, but with a minor contribution from the Archean Gregory Range Inlier and the Paleoproterozoic Rudall Province to the southeast.

1. Introduction

The southern margin of the combined West Australian and North Australian Cratons from about 1350 Ma onwards recorded voluminous granitic magmatism and high-grade metamorphism in both the Albany–Fraser Orogen and the Musgrave Orogen. Well-documented tectonothermal events include Stage I (1330–1260 Ma) and Stage II (1225–1140 Ma) in the Albany–Fraser Orogen, and the Mount West Orogeny (1345–1290 Ma) and Musgrave Orogeny (1220–1150 Ma) in the Musgrave Orogen (Howard et al., 2015; Spaggiari et al., 2015). This tectonothermal activity has been interpreted to be the result of convergent margin processes, including continental-arc magmatism (Howard et al., 2015), accretion of an oceanic arc, back-arc magmatism and northwest-directed subduction beneath the southeastern to southern margin of the Australian continent (Spaggiari et al., 2015). Magmatism was accompanied by high-T, low-P granulite facies metamorphism (Clark et al., 2014; Howard et al., 2015; Spaggiari et al., 2015), as well as uplift and deposition of foreland basin sediments (e.g., Snowys Dam Formation; Spaggiari et al., 2015).

Despite the tumultuous upheaval along this margin, few possible responses of the West Australian Craton (Fig. 1) to this intense tectonothermal activity have been identified. The only known coeval events within the craton interior being 1310 ± 4 Ma and 1291 ± 10 Ma foliated granite and pegmatite from the Rudall Province (Bagas, 2004) more than 600 km to the north of the margin, and a tuffaceous horizon dated at 1317 ± 11 Ma, in what were interpreted to be fine-grained sedimentary rocks of the Manganese Group by Blake et al. (2011) nearly 1000 km north of the margin. More recently, it has been suggested that the Rudall Province underwent medium- to high-pressure metamorphism between c. 1380 and c. 1275 Ma (Anderson et al., 2016). The apparent lack of responses in the craton to Stage I in the Albany–Fraser Orogen and the Mount West Orogeny in the Musgrave Orogen is surprising given both the extensive record of Paleoproterozoic to Neoproterozoic sedimentary basins on the Australian continent related to distal convergent margin processes (e.g., Giles et al., 2002; Scott et al.,

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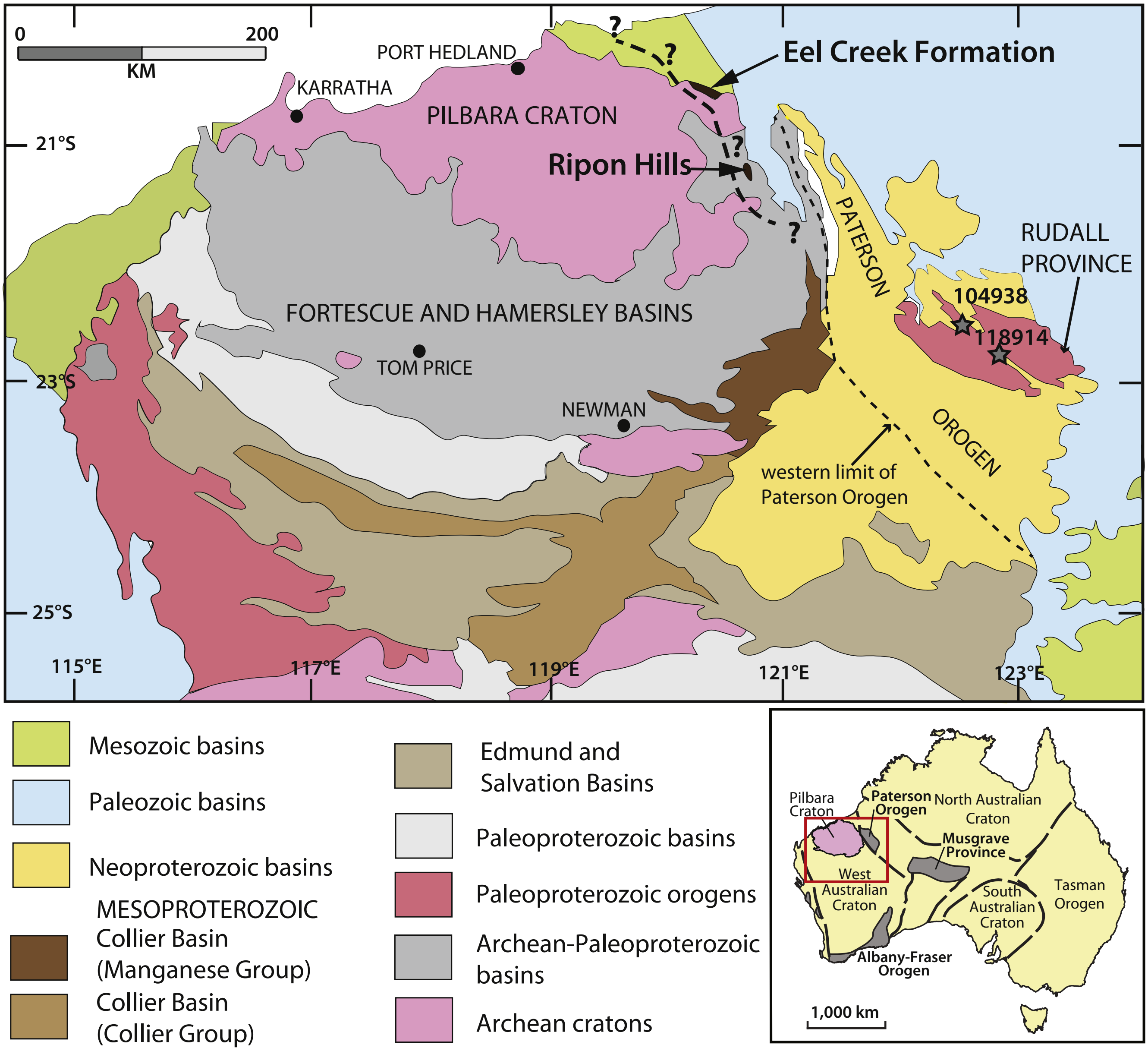

Fig. 1. Distribution of the Eel Creek Formation, and the Manganese and Collier Groups. The location of the succession at Ripon Hills studied by Blake et al. (2011) is also shown. Possible western limit of the Wongawobbin Basin indicated by bold dashed line with question marks. Green stars mark locations of 1310–1290 Ma granite samples from Bagas (2004) in the Rudall Province. Modified from the Geological Survey of Western Australia's 1:500,000 Tectonic Units, 2015 GIS layer (http://geodownloads.dmp.wa.gov.au/datacentre/datacentreDb.asp). Inset figure modified from Spaggiari et al. (2015).

2000), and the long-term weakness of the Australian lithosphere (e.g., Hand and Sandiford, 1999; McLaren et al., 2005). Furthermore, in modern-day settings there are records of intra-craton shortening and craton-margin basins (e.g., the Qaidam Basin; Yin et al., 2008).

In this paper, we provide sensitive high-resolution ion microprobe (SHRIMP) dates of c. 1320 Ma for two tuff samples from near the base of the Eel Creek Formation, a previously undated Precambrian sedimentary succession on the northeastern edge of the Archean Pilbara Craton in Western Australia (Fig. 1). The formation crops out over about 200 km^2, although the formation was inferred by Williams (2003) to extend over more than 1,000 km^2 to the east in the subsurface. Deposition of the Eel Creek Formation in the newly named Wongawobbin Basin coincided in time with Stage I of the Albany–Fraser Orogeny and the Mount West Orogeny in the Musgrave Orogen. We also present detrital zircon provenance ages from four samples of siliciclastic sandstones within the formation. We use these new data to assess the chronostratigraphic relationship between the Eel Creek Formation and other Proterozoic-aged successions in northwestern Australia, and the tectonostratigraphic significance of the formation.

2. Regional geology

The Eel Creek Formation is a sequence of unmetamorphosed siliciclastic sedimentary rocks more than 500 m thick, located along the northeastern edge of the Pilbara Craton (Hickman, 1983; Hickman and Chin, 1977; Williams, 1999, 2003). The succession dips to the northeast and unconformably overlies Archean metasedimentary and metavolcanic sequences (greenstone belts), and is itself overlain by glacial deposits of the Permian Paterson