Forum

Orogen-parallel flow during continental convergence: Numerical experiments and Archean field examples: COMMENT and REPLY

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Duclaux et al. (2007) use the Eyre Peninsula region of the eastern Gawler Craton (South Australia) as their primary field example of Archean-aged orogen-parallel flow as envisaged from the perspectives of numerical models. While we would like to make it clear that we do not contest the notion of orogen-parallel flow and its potential structural evolution as presented in the model of Duclaux et al., we have serious concerns about the application of the model to the development of the N-S–trending structural fabrics in the eastern Gawler Craton.

Duclaux et al. suggest that the approximately N-S–trending fabrics and shallow plunging mineral stretching lineations developed in the eastern Gawler Craton (their Fig. 4) are attributed to the late stages of the early Paleoproterozoic (2460–2420 Ma) Sleafordian Orogeny, which they loosely describe as an Archean-aged tectonic system. However, there are a number of structural and geochronological studies that suggest this is not the case, and that the deformation in the eastern Gawler Craton records the effects of the late Paleoproterozoic 1730–1690 Ma Kimban Orogeny.

Vassallo and Wilson (2001, 2002) and Tong et al. (2004) presented detailed structural and metamorphic analyses of the late Archean (2550–2450 Ma) Sleaford Complex, the overlying Palaeoproterozoic (2000–1740 Ma) Hutchison Group metasediments (Daly et al., 1998; Fanning et al., 2007), and the 1850 Ma Donington magmatic suite, which comprise the major rock systems in the eastern Gawler Craton. Importantly, the Hutchison Group occupies most of the region Duclaux et al. indicate contains Archean-aged structures (gray region in Figure 4 of Duclaux et al.). Kimban-aged (1730–1690 Ma) deformation produced a pervasive layer-parallel fabric at grades between granulite and amphibolite. Metamorphism was associated with the development of non-cylindrical and sheath folds together with high strain zones that developed during dextral top-to-the-north shearing and dominantly N-S stretching followed by E-W–oriented flattening. This N-S–oriented deformational fabric (seen in outcrop and aeromagnetic data) is present in the 1850 Ma Donnington Suite, the 2000–1740 Ma Hutchison Group, and the underlying Sleaford Complex, and it represents the Kimban Orogen structural grain (Vassallo and Wilson, 2001, 2002).

Geochronological data from the eastern Gawler Craton also suggest that the N-S structures developed during the Kimban Orogeny. At Refuge Rocks (~15 km east of location A in Figure 4 of Duclaux et al.), migmatitic granitic gneiss from a region of pervasive N-S fabric development has a protolith emplacement age of 1740 ± 4 Ma (Fanning et al., 2007). This indicates that the pervasive N-S fabric in that region is younger than 1740 Ma. In southern Eyre Peninsula, we have analyzed monazite from metapelitic granulite (Tong et al., 2004) in the Sleaford Complex at Fishery Bay (location B, Figure 4 of Duclaux et al.). These outcrops contain an intense N-S–oriented shallow plunging linear fabric. Using electron probe microanalysis (EPMA), monazite grains located within the foliation give an age of 1702 ± 12 Ma (n = 71; MSWD = 1.3). The EPMA monazite age of 2479 ± 20 Ma obtained by Duclaux et al. from inclusions within garnet probably reflects early Palaeoproterozoic metamorphism. However, we contend that the N-S–trending foliation is ca. 1700 Ma in age and not early Paleoproterozoic (Archean of Duclaux et al.). This is consistent with Reid et al. (2007) who showed that SHRIMP zircon ages from leucosomes developed in N-S–oriented high-grade fabrics in the 1850 Ma Donnington Suite range between 1710 and 1701 Ma. West of these regions of N-S–trending granulite-grade structures lies the isoclinally folded 1767 ± 16 Ma Price Metasediments (Oliver and Fanning, 1997), which are defined in regional TMI data sets as a prominent N-S–trending magnetic high.

Duclaux et al. provide an EPMA monazite age of 1827 ± 10 Ma for an interpreted post-tectonic cordierite-bearing dike from southern Eyre Peninsula, and used this to constrain the age of regional deformation in the eastern Gawler Craton (including sequences deposited between 2000 and 1730 Ma; Oliver and Fanning, 1997; Fanning et al., 2007) to an approximately late Archean timeframe. While it is difficult to comment on the veracity of the age data of Duclaux et al. given the brevity of their presentation, the bulk of available data from the eastern Gawler Craton suggests deformation occurred at around 1700 Ma.

We find it regrettable that the application of the transpressional strain model of Duclaux et al. implies that the eastern Gawler Craton contains regionally developed Archean-aged or early Paleoproterozoic structures. Further, we see no compelling reason as to why an Archean time frame is even important to the model presented by Duclaux et al. We suggest that the strain model may be appropriate to the development of the ca. 1700 Ma transpressional Kimban Orogen structures that dominate the eastern Gawler Craton. This implies that the strain model of Duclaux et al. does not necessarily require the involvement of soft buoyant Archean continental lithosphere. Rather, such transpressional evolutions may develop at any time in Earth history given appropriate boundary conditions.

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