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Short communication

A possible buried Paleoproterozoic collisional orogen beneath central South China: Evidence from seismic-reflection profiling

S.W. Dong[a,*], Y.Q. Zhang[a], R. Gao[a], J.B. Su[a], M. Liu[b], J.H. Li[a]

[a] Institute of Geomechanics, Chinese Academy of Geological Sciences, Beijing 100081, China
[b] Department of Geological Sciences, University of Missouri, Columbia, MO 65211, USA

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ABSTRACT

The South China Craton consisting of the Yangtze and Cathaysia Blocks has figured importantly in the Neoproterozoic supercontinent of Rodinia. However, its lack of Grenville-age structures and metamorphism and the presence of Paleoproterozoic high-grade metamorphism and S-type magmatism raise questions about the timing and nature of the Yangtze–Cathaysia collision. Here we present results of a 400-km-long high-resolution seismic reflection profile across the purported suture between the Yangtze and Cathaysia Blocks. The seismic profile reveals folded and thrust-imbricated seismic reflectors which we interpret to represent the relics of the Yangtze–Cathaysia collisional orogen. The inferred orogen was extended in the Neoproterozoic, resulting in its burial by Neoproterozoic flysch strata. Geochronological data suggest that this buried orogen was formed in the Paleoproterozoic (∼2.0–1.9 Ga), likely associated with the assembling of the Columbia supercontinent. These results call for major revision of the models for the formation of the South China craton and its role in the assembling of the Rodinia and the Columbia supercontinents.

1. Introduction

The South China Craton is traditionally considered to have resulted from the amalgamation of the Yangtze and Cathaysia Blocks (Li et al., 2002, 2007), as part of the global Grenvillian continental collision that assembled the supercontinent Rodinia (e.g., Shu et al., 2011), which is expressed by the development of the >1200 km Xuefeng–Jiangnan fold-thrust belt in central South China (Fig. 1). The evidence for associating the formation of the South China Craton with the Neoproterozoic Grenvillian orogeny includes (1) the Neoproterozoic stratigraphic unconformity in the Xuefeng Mountain belt (Wang et al., 2007a,b), (2) the 1.0–0.9 Ga ophiolites and blue schists east of the Xuefeng Mountain belt (Chen et al., 1991), (3) the 1.3–1.0 Ga greenschist-facies metamorphism on both sides of the orogen (Li et al., 2002, 2007), and (4) Neoproterozoic foreland-basin deposits on the Yangtze side sourced from the Cathaysia Block (Li et al., 2002). This Neoproterozoic collision model, however, fails to explain several observations such as (1) the low-grade (green-schist facies) metamorphism along the proposed suture zone, contrasting to the high-grade metamorphism in typical Grenvillian orogenic belts (e.g., Johansson et al., 1991), (2) the lack of anatexis in the inferred collisional orogenic belt, (3) the young age (ca. 900–800 Ma, e.g., Wang and Li, 2003) of the angular unconformity thought to mark the time of the Yangtze–Cathaysia collision, which differs from the ∼1.3–1.0 Ga global Grenvillian orogeny (e.g., Hoffman, 1989).

Recent studies in South China have recognized Paleoproterozoic granulite- to amphibolite-facies metamorphism and S-type magmatic activity (e.g., Yu et al., 2012; Zhao et al., 2014a,b), raising the question of whether the formation of the coherent South China Craton was accomplished in the Paleoproterozoic, possibly during the assembling of the Columbia supercontinent. The question of whether the formation of the South China craton was associated with the assembling of the Rodinia supercontinent or the Columbia supercontinent is important to the reconstructions of Proterozoic continents, but testing these different models is hampered by the sparse exposure of Paleoproterozoic rocks in South China.

Subsurface geology can provide important insight into crustal architecture and tectonic history of collisional orogen (Lucas et al., 1993). Here we report results of a high-resolution seismic-reflection profile across a segment of the Xuefeng–Jiangnan fold-thrust belt (Fig. 1). The seismic images reveal a buried orogen in the middle crust possibly achieved by the Yangtze–Cathaysia collision. In conjunction with analysis of regional stratigraphy and

* Corresponding author. Tel.: +86 01068999606.
E-mail address: swdong@cags.ac.cn (S.W. Dong).

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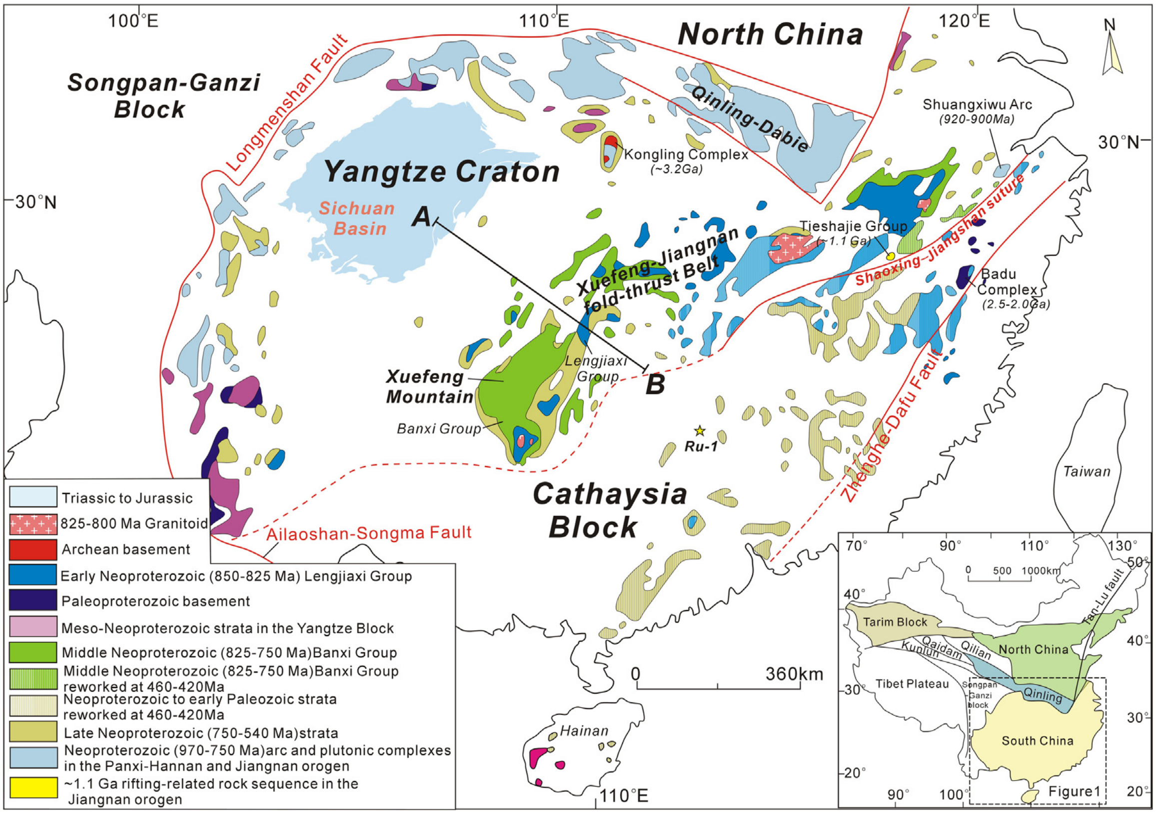

Fig. 1. Simplified geological map showing the Precambrian geology of South China (modified after Zhao and Cawood, 2012) and the location of the seismic reflection profile A–B. Inset shows the major Precambrian blocks in China.

geochronology, we propose that the South China craton was formed by Paleoproterozoic continental collision and modified by Neoproterozoic rifting.

2. Regional geology

The South China Craton consists of the Yangtze Block in the northwest and the Cathaysia block in the southeast (Fig. 1). The Yangtze Block is an ancient terrane bearing Archean continental nucleus that underwent Paleoproterozoic and Neoproterozoic reworking, as evidenced by abundant 3.8–3.2 Ga TTG rocks (Zhang et al., 2006a), 2.0–1.9 Ga high-grade metamorphism and migmatization in the Kongling complex (Zhang et al., 2006b), and widespread 820–750 Ma magmatism (Zhang and Zheng, 2013). The nature of the Cathaysia block is hotly debated, with controversies existing over whether this so-called block is a Precambrian “old land” (Grabau, 1924; Shui, 1987), or a Paleozoic “orogenic belt” (Guo et al., 1989). This block underwent episodic metamorphism and rifting in the Proterozoic, as evidenced by the development of ~1.9 Ga amphibolite facies metamorphic rocks (Yu et al., 2012; Wan et al., 2007), ~1.8 Ga post-orogenic A-type granitoids (Yu et al., 2009a,b), and ~860–800 Ma mafic gabbroic intrusions (Shu et al., 2011). The Xuefeng–Jiangnan fold-thrust belt is traditionally considered the collisional orogen marking the formation of the South China craton from the collision between the Yangtze and Cathaysia Blocks (e.g., Charvet et al., 1996; Cawood et al., 2013). This event is marked by the angular unconformity separating two low-grade metamorphic sequences (Wang et al., 2008). Above this unconformity is the Banxi or Danzhou Group, composed of Neoproterozoic (820–750 Ma) sandstone, conglomerate, pelite, slate and lesser volcano-clastic rocks (Wang and Li, 2003). Below the unconformity is the Lengjiaxi or Fangjingshan Group, composed of 860–820 Ma (e.g., Wang and Li, 2003) schist, sandstone, siltstone interbedded with minor tuff, spilite and mafic-ultramafic sills, and shows depositional features of flysch turbidites (Wang et al., 2007a,b). This sequence is characterized by tight linear, isoclinal and overturned folds, contrasting to the open folds in the Banxi Group above the unconformity (e.g., Wang et al., 2007a,b). Coeval with deposition of the Lengjiaxi and Banxi Groups was magmatism that generated 860–700 Ma granitoids, gabbros, bimodal volcanic rocks and lesser komatiitic basalts in the Xuefeng–Jiangnan fold-thrust belt (e.g., Wang et al., 2007a). The magmatism is considered anorogenic in an intra-continental rifting setting, related to mantle plume activity causing breakup of Rodinia (Li et al., 1999), continental-margin arc development (Zhou et al., 2002), or melting of a juvenile arc during orogenic collapse and lithospheric extension (Zheng et al., 2008). Notably, the Neoproterozoic flysch turbidites, together with the anorogenic magmatic rocks, constitute a huge rift basin termed as the Nanhua Rift. The rift initiated coevally with the deposition of the Banxi Group (at ca. 820 Ma) that developed upon a folded basement composed of the Lengjiaxi Group and its equivalents, which underwent several episodes of rifting events during the period 820–690 Ma (Wang and Li, 2003). This rift was evolved into a foreland basin during the Paleozoic intra-continental orogeny and eventually closed by the end of this orogeny, as indicated by a regional angular unconformity at the base of Upper Devonian (e.g., Shu et al., 2008; Li et al., 2010; Charvet et al., 2010). And in turn, the newly created Paleozoic intra-continental orogenic belt was overprinted by alternative episodes of compressional and extensional events in the Mesozoic and Cenozoic times (e.g., Li et al., 2013, 2014a,b; Zhang et al., 2012).

3. Seismic-reflection data

We obtained a 400-km-long high-resolution seismic-reflection profile across the central South China including the