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Early Paleozoic orogenesis along Gondwana's northern margin constrained by provenance data from South China

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ABSTRACT

The Cambrian–Ordovician boundary unconformity in the southern part of the South China Craton is spatially and temporally related to coeval orogenic activity along the Indian margin of east Gondwana. Detrital zircon age spectra from strata above and below the unconformity range in age from 3580–450 Ma, with peaks in the late Mesoproterozoic and Neoproterozoic. The patterns are similar to time equivalent sequences elsewhere in South China and together with regional facies relationships and paleocurrent data indicate derivation from a Gondwana source. The disconformity at the base of the Ordovician succession forms part of a regional break that has also been documented in the Himalaya, Qiangtang, Lhasa, Sibumasu, and Western Australia. All these successions have similar detrital zircon age spectra suggesting derivation from common source(s). In South China the effects of this tectonic event are relatively mild and are represented by a local disconformity at the base of the Ordovician succession, but elsewhere in north Gondwana this event is marked by an angular unconformity with metamorphism of older units and relatively widespread magmatic activity. South China was likely located in a distal location to the northeast of the pulse of tectonic activity, which was focused in the Himalaya region, and was close to the continent–ocean boundary between northern Gondwana and the proto-Tethys.

1. Introduction

Early Paleozoic successions around the margin of East Gondwana are marked by an unconformity between Cambrian and Ordovician strata. This stratigraphic break has been recognized from North India to Western Australia, and in displaced Gondwana fragments in Southeast Asia (Cawood and Nemchin, 2000; Cawood et al., 2007; Collins, 2003; Gehrels et al., 2006a,b; Li et al., 2010a; Metcalfe, 2013; Myrow et al., 2010; Wang et al., 2013a; Zhao et al., 2014; Zhu et al., 2011). It provides a record of tectonic activity involving deformation, metamorphism, igneous activity and post-exhumation subsidence and sedimentation (Cawood et al., 2007; DeCelles et al., 2000; Gehrels et al., 2003; Myrow et al., 2010; Wang et al., 2013a; Yin et al., 2010a,b). The tectonic driver for this event is disputed with proposed mechanisms including plate coupling during an ongoing subduction in accretionary orogens along the margin of the supercontinent, perhaps in response to Gondwana assembly (Cawood and Buchan, 2007; Cawood et al., 2007; Wang et al., 2013a; Zhu et al., 2012), terrane accretion (e.g. Greater Himalaya terrane, DeCelles et al., 2000), and regional extension during the latter stages of the pan-African orogenic cycle (Miller et al., 2001). Research into this event has been focused in the Himalayas but resolving the setting and mechanism of orogenesis has been hindered by the loss of the early Paleozoic northern margin of Gondwana during subduction of Greater India under Asia with surviving segments being strongly overprinted by associated Cenozoic collision-related deformation. Recent geochemical, provenance and paleontological data have shown that during the Neoproterozoic and Paleozoic South China was located along the northern margin of East Gondwana, in the general region of northern India (Hughes et al., 2005; Jiang et al., 2003; Wang et al., 2010) with more specific locations including the western Himalaya (Burrett et al., 2014; McKenzie et al., 2011b), the eastern Himalaya, situated at the nexus of India, Antarctic and Australia (Cawood et al., 2013; Xu et al., 2013) or shifting from west to east along the Himalaya via strike-slip faulting (Cocks and Torsvik, 2013). Thus, South China likely represents a fragment of Greater India lithosphere that thus could provide important new insights into the early Paleozoic paleogeography of North Gondwana (cf., Cawood et al., 2013). In this paper we outline the provenance record of strata pre- and post-dating early Paleozoic orogenesis to further constrain paleogeography along the North Gondwana margin.

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2. Geological setting

The South China Craton, one of the major crustal blocks in eastern Eurasia, consists of the Yangtze Block to the northwest and the Cathaysia Block to the southeast (Fig. 1a). Each consists of Archean and Paleoproterozoic basement units that were assembled and accreted along the northern margin of Gondwana via a series of early to mid-Neoproterozoic accretionary arc complexes (Fig. 1b) (Wang et al., 2013b; Zhao and Cawood, 1999; Zhao et al., 2011; Zhou et al., 2002). The unified craton is overlain by a middle to upper Neoproterozoic succession that accumulated in a failed rift environment (i.e. Nanhua and Kangdian rifts) (Shu et al., 2008, 2011; Wan et al., 2010; Wang and Li, 2003; Wang et al., 2012; Zhao and Cawood, 2012).

Lower Paleozoic strata conformably overlie the Neoproterozoic succession and show significant facies variation across the craton (Fig. 1b). Cambrian and Ordovician strata overlying the Cathaysia Block are siliciclastic-dominated with minor interstratified limestone and show a transition to an interstratified carbonate–siliciclastic succession in the eastern Yangtze Block which in turn passes to a carbonate dominated platform succession over the remainder of the block. Silurian sequences are absent from the Cathaysia Block, except for the Qinfang area in the southern Cathaysia block (e.g., Bureau of Geology and Mineral Resources of Fujian Province, 1985; Bureau of Geology and Mineral Resources of Guangdong Province, 1988; Bureau of Geology and Mineral Resources of Guangxi Zhuang Autonomous Region (BGMRGZAR), 1985; Bureau of Geology and Mineral Resources of Hubei Province (BGMRHP), 1990; Bureau of Geology and Mineral Resources of Hunan Province (BGMRHP), 1988; Bureau of Geology and Mineral Resources of Jiangxi Province (BGMRJP), 1984; Bureau of Geology and Mineral Resources of Sichuan Province (BGMRSP), 1982; Bureau of Geology and Mineral Resources of Zhejiang Province (BGMRZP), 1989). In the Yangtze Block, Silurian strata conformably overlie the Cambrian–Ordovician succession, mark a change to siliciclastic sedimentation and extend in age to the Lower Silurian in the southeastern part of the block to the Upper Silurian in the northwestern and northeastern parts of the block (BGMRHP, 1988; BGMRJP, 1984; BGMRSP, 1982; BGMRZP, 1989). Paleocurrent data for Cambrian–Lower Silurian sandstones indicates flow from the southeast with the source considered to lie beyond the current exposed limit of the craton (Wang et al., 2010; Xu et al., 2013). Unconformity surfaces are locally developed within the early Paleozoic succession (Fig. 2) including a disconformity between the Cambrian and Ordovician strata in the Yunkai area of the Cathaysia Block (Fig. 3; BGMRGP, 1988) and an angular unconformity between the Ordovician and Silurian sequences at the juncture between the Yangtze and Cathaysia blocks (BGMRHP, 1988; BGMRJP, 1984).

The South China Craton was deformed and metamorphosed during the mid-Paleozoic intracontinental Kwangsian orogeny (e.g. Charvet et al., 2010; Faure et al., 2009; Li et al., 2010b; Wang et al., 2010), the effects of which are focused in the Cathaysia Block and immediately adjoining Yangtze Block. Orogenesis resulted in a regional angular unconformity between Devonian cover and metamorphosed pre-Devonian strata along with granite intrusion between 460–400 Ma (Li et al., 2010b; Wang et al., 2011, 2012).

3. Stratigraphic section and samples

This study is focused on the Cambrian–Ordovician strata in the Yunkai domain located in the southern part of the South China Craton (Fig. 1). The domain is bounded in the east by the Wuchuan–Sihui fault zone and in the west by the Cenxi–Bobai fault zone (Fig. 3). The basement of the domain contains the undated amphibolite to granulite

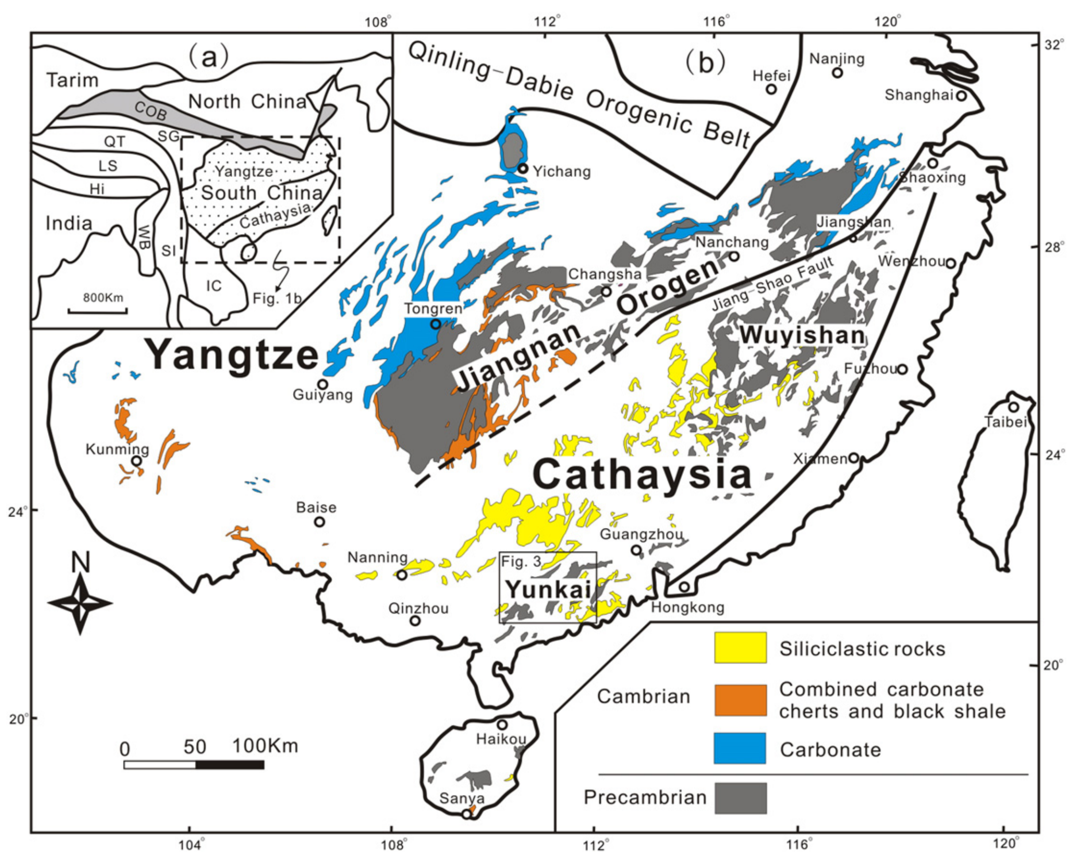

Fig. 1. (a) Tectonic outline of East Eurasia (modified from Metcalfe, 2006) and (b) simplified geological map of the South China Craton showing the main tectono-stratigraphic units and the Cambrian sequence. Abbreviations in (a): COB = Central Orogenic Belt of China, SG = Songpan–Ganze Accretionary Complex, QT–Qiangtang Block, LS = Lhasa terrane, Hi = Himalaya terrane, SI = Sibumasu Block, WB = West Burma terrane, IC = Indochina Block.