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Drivers for late Paleozoic to early Mesozoic orogenesis in South China: Constraints from the sedimentary record

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ABSTRACT

Unconformity bound Permo-Triassic successions in the Qinfang Basin, South China Craton, reflect tectonic processes associated with tectonothermal activity along the margins of the craton. The provenance record of these successions, based on modal analysis, geochemical composition, detrital zircon U–Pb ages, and paleocurrent data indicate derivation from the adjoining Precambrian Yunkai massif and surrounding Paleozoic sedimentary units. The quartz dominated nature of the siliciclastic units, along with their high Th/Sc and Zr/Sc ratios indicate a recycled orogen source. Detrital zircons from Late Permian to Early Triassic samples display major age groups at 1100–800 Ma, 650–500 Ma, 480–420 Ma, with subordinate age groups at 2800–2400 Ma, 1900–1600 Ma and 1400–1200 Ma. Late Triassic sandstones show a similar detrital zircon age pattern as well as a 300–250 Ma age group. Integration of this provenance data with regional geological information suggests that the unconformity at the base of the Permian succession is related to subduction of the Paleo-Tethys ocean to the south of the craton, whereas the major driver for Triassic tectonic activity corresponds with terrane accretion and the termination of Paleo-Tethys Ocean subduction along the southwest margin of the craton.

1. Introduction

Permo-Triassic sedimentary successions in the South China Craton are bound above and below by unconformity surfaces (BGMRFP, 1985; BGMRGP, 1988; BGMRGR, 1985; BGMRYP, 1990; He et al., 2005; Liang and Li, 2005). A variety of models have been proposed as the drivers for regional uplift and deformation associated with these boundaries. The unconformity surface at the base of the Permian succession has been ascribed to regional uplift resulting from emplacement of the Emeishan Large Igneous Province(Chen et al., 2007; He et al., 2003, 2005) or from initiation of subduction of the Paleo-Pacific ocean beneath the South China Craton (Li and Li, 2007; Li et al., 2012). The upper contact is an expression of the Indosinian Orogeny, and has been related either to closure of the Paleo-Tethys Ocean and subsequent collision between the South China Craton and Indochina Block (Cai and Zhang, 2009; Shu et al., 2008; Yang et al., 2012a; Zi et al., 2013) or to tectonothermal reactivation along the previously united Indochina–South China block due to accretion of the Sibumasu Block (Carter and Clift, 2008; Carter et al., 2001).

During the late Paleozoic to Mesozoic, the southwestern and southeastern margins of South China were bounded by the Paleo-Tethys and Paleo-Pacific oceans, respectively. The Qinfang Basin occupies an intermediate position between these two margins (Fig. 1). In this paper we focus on the provenance of unconformity bound Late Permian to Early Triassic strata and the unconformably overlying Late Triassic units in the Qinfang Basin, South China Craton (BGMRGR, 1985) to establish the effect of tectonothermal activity on the nature of the source region(s) and to constrain the tectonic drivers for development and preservation of the unconformities and the sedimentary succession.

2. Regional geology and sampling

2.1. Regional geology

The South China Craton formed through amalgamation of the Yangtze and Cathaysia blocks during early-middle Neoproterozoic (Fig. 1a) (Cawood et al., 2013; Li et al., 2007, 2008a; Shu et al., 2011; Wang et al., 2013b; Ye et al., 2007). In the Paleozoic and early Mesozoic, two orogenic events affected the craton. An early-mid Paleozoic orogeny (480–420 Ma) variously referred to as the Caledonian, Kwangsian or Wuyi-Yunkai orogeny, which resulted in Devonian and younger strata unconformable on early Paleozoic sequences (Charvet et al., 2010; Li et al., 2010; Wang et al., 2012, 2013a); and the Indosinian Orogeny, manifested by metamorphism and magmatism at 260–200 Ma, development of a regional unconformity between Late Triassic and underlying strata, and the termination of carbonate sedimentation across the South China Craton (Fig. 2) (Chu et al., 2012; Shu et al., 2008; Wang et al., 2013a; Yang et al., 2012a).

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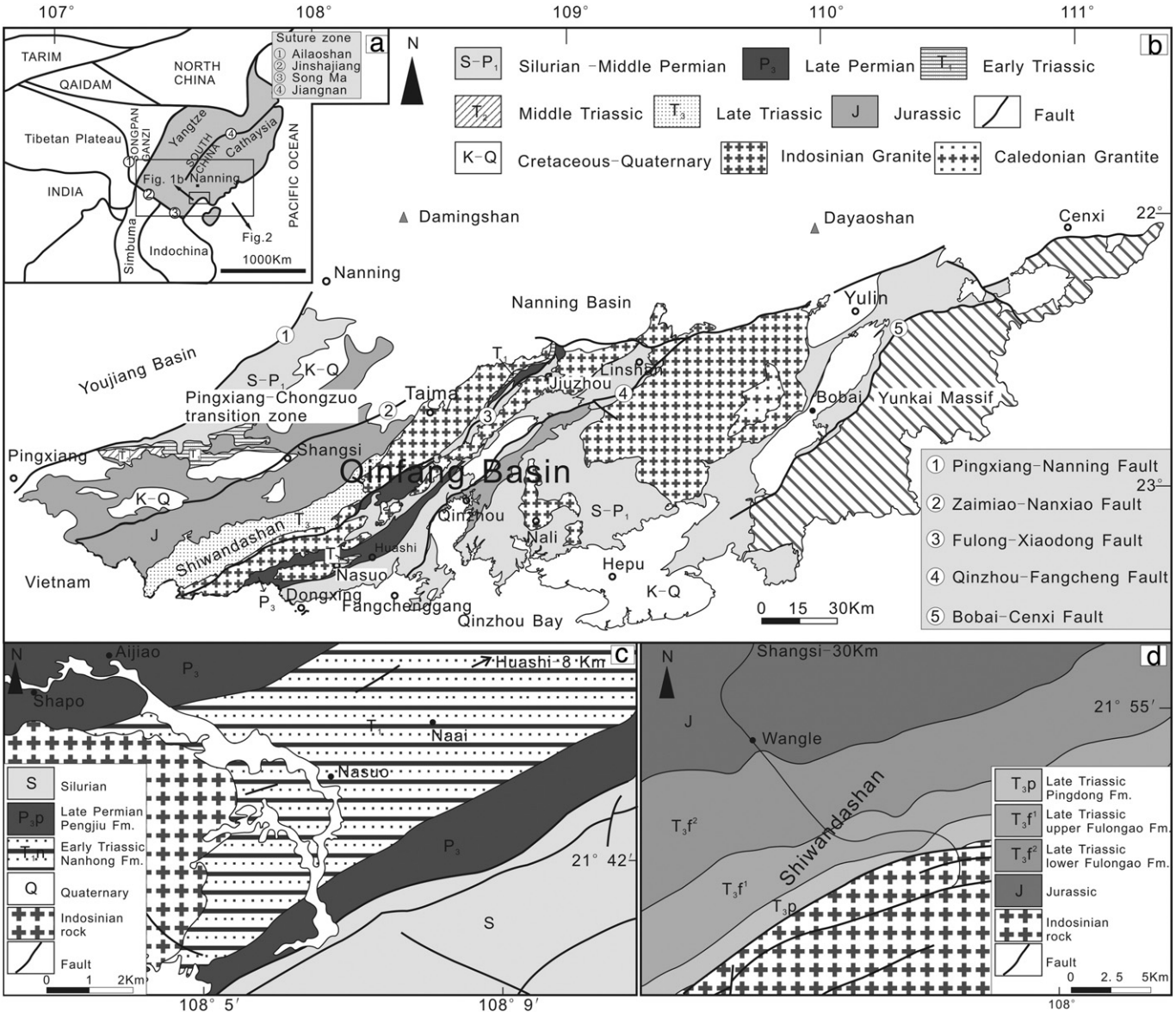

Fig. 1. a: Simplified geological map of the East Asia Block (revised from Metcalfe, 2006). b: Geological map of the Qinfang Basin and environs (modified from 1:500,000 Geologic Map of Guangxi). c and d: Simplified geological maps of Nasuo (c) and Shangsi sections (d)(modified from 1:50,000 Geologic Map of Nasuo xu).

Paleozoic and Mesozoic strata within the craton provide a record of tectonothermal activity and been assigned to a variety of basins, which often have conflicting definitions. For example, the term Shiwandashan Basin has been applied to both Late Permian to Early Triassic successions (Liang and Li, 2005; Liang et al., 2004) and to Mesozoic–Cenozoic strata (Guo, 2004; Sun et al., 2005), and the Qinfang Trough has been applied to Silurian-Permian successions (Zhang et al., 2002). In this paper, we combine them both into the single Qinfang Basin. Strata within the basin range in age from Silurian to Cretaceous with the Paleozoic succession principally preserved in the central and eastern parts of the basin (e.g., Qinzhou and Fangcheng areas) whereas the Mesozoic succession is mainly exposed in western part of the basin (e.g., Shiwandashan area) (BGMRGR, 1985) (Fig. 1). Silurian to Middle Permian strata are siliciclastic and constitute a largely conformable succession. The Late Permian succession is an unconformity bound package on the older strata (BGMRGR, 1985). A mid-Permian break in sedimentation within the basin is represented by a disconformity and succeeded by a major sediment influx during the Late Permian to Early Triassic indicating a pulse of exhumation in the basin hinterland. A basin wide Middle Triassic unconformity caps the Paleozoic to Early Triassic succession and corresponds with widespread emplacement of Indosinian-aged granite into the pre-Middle Triassic strata (BGMRGR, 1985) (Figs. 1, 3). The basin abuts, and locally unconformably overlies, the Yunkai Massif to the SE. The NW margin of the basin is marked by the Pingxiang–Nanning Fault (Fig. 1), which separates it from the Devonian to mid-Triassic Youjiang Basin (Yang et al., 2012a).

The Yunkai Massif, along with North Hainan Island (Zhang and Cai, 2009), constitute part of the Precambrian basement of the South China Craton (Qin et al., 2006; Wan et al., 2010; Yu et al., 2010; Zhao and Cawood, 2012). The massif comprises Paleoproterozoic metamorphic complexes, early Mesoproterozoic units restricted to Hainan Island (Li et al., 2008b), amphibolite-facies Neoproterozoic metasedimentary and metaigneous rocks, and late Neoproterozoic to early Paleozoic clastic rocks (BGMRGP, 1988; BGMRGR, 1985; Huang et al., 2001; Qin et al., 2006; Yu et al., 2010; Zhang et al., 2012). Permo-Triassic igneous rocks are exposed in Hainan Island (Li et al., 2006; Tang et al., 2013).