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Phanerozoic polyorogenic deformation in southern Jiuling Massif, northern South China block: Constraints from structural analysis and geochronology

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ABSTRACT

The structure of the Jiuling Massif has been investigated in order to delineate the polyorogenic deformation and discuss its geodynamic evolution and orogenic mechanisms. Detailed structural analysis indicates that the D_1 event is characterized by top-to-the NNW ductile shearing with pervasive foliation, and mineral and stretching lineation developed in the entire region. Compared with the D_1 deformation, D_2 structures are localized in ductile shear zones with subvertical foliation and subhorizontal E–W trending lineation, indicating a dextral ductile shearing. The D_3 event, marked by folds and thrusts mainly in a brittle domain, modified the D_1 structures by asymmetrical folds. The dominant D_4 structures are gravitational folds and normal faults, corresponding to a later extension. Our new geochronological data suggest that the D_1 event occurred between 465 and 380 Ma with D_2 dextral shearing at the end of this Early Paleozoic orogen, and the D_3 event has been constrained at 245–215 Ma. The final uplift of the Jiuling Massif by the D_4 event can be correlated with the Late Mesozoic extension across the eastern South China block. Along with previous studies in the South China block, the structural pattern of the Jiuling Massif elucidates the influence of the Early Paleozoic and Early Mesozoic intracontinental belts triggered by repeated reactivation of the Jiangshan–Shaoxing Fault. Combined with deformation to the south, the Early Paleozoic belt shows a positive flower pattern, with opposing kinematics, rooted in the Jiangshan–Shaoxing Fault. During the Early Mesozoic, a general intracontinental belt was developed with uniform kinematics in both the Jiuling Massif and the Xuefengshan Belt, possibly resulted from the far-field effect of the Triassic NW-directed Paleo-Pacific subduction.

1. Introduction

The South China block (SCB) has a complex Phanerozoic tectonic history. An understanding of the polyphase deformation and syn-kinematic metamorphism and magmatism is the key to resolving questions on its geologic evolution. During the Early Paleozoic, a tectonothermal event has been well recorded in the SCB and is interpreted as intracontinental tectonics, indicated by well-preserved ductile deformation (Lin et al., 2008; Faure et al., 2009; Charvet et al., 2010), amphibolite-facies metamorphism (Wang et al., 2012a; Li et al., 2010; Wan et al., 2010), and a widespread magmatism from 450 to 400 Ma (Wang et al., 2007; Li et al., 2010). Similarly, an Early Mesozoic NE–SW trending fold-and-thrust belt, which is the dominant structure across the entire SCB, controls the final architecture of the SCB despite the extension during the late Mesozoic (Gilder et al., 1996; Lin et al., 2000; Wang et al., 2005; Zhou et al., 2006; Zhu et al., 2010; Chu et al., 2012a, 2012b). Although a large number of geochronological data have been documented for discussing the polyphase tectonics, a detailed presentation of deformation and their relationship is still lacking, leading to a controversy on the evolution of the inland area of the SCB. At first, the Xuefeng–Jiuling domain, occupied by a thick pile of Neoproterozoic sedimentary rocks, was described as the "Jiangnan orogen" with a trench-arc-back-arc basin system above a N-directed subduction (Guo et al., 1980). Some authors interpreted this area, and its southeasterly region as a collisional orogen formed at 1.0–0.8 Ga, along which the Yangtze block to the northwest, and the Cathaysia block to the southeast were amalgamated, accompanied with intense deformation and magmatism (Shu et al., 1994, 2008; Charvet et al., 1996; Li et al., 2002, 2009a, 2009b). Recent studies reveal that these deformed rocks were also involved in an Early Paleozoic intracontinental orogen, especially to the east of the Chenzhou-Linwu Fault (Fig. 1, Faure et al., 2009; Charvet et al., 2010; Li et al., 2010). In fact, according to newly published data, west to the Chenzhou-Linwu fault, the dominant deformation in

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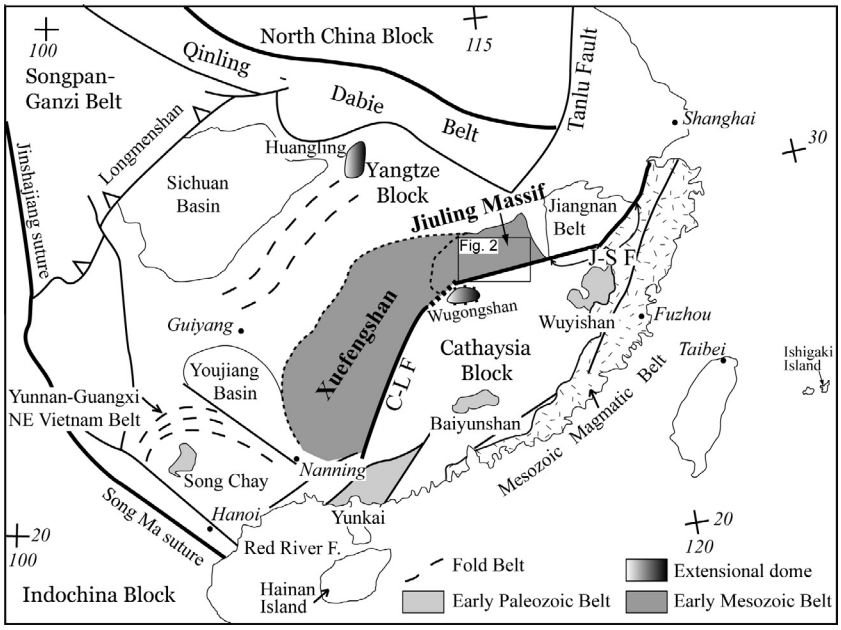

Fig. 1. Tectonic sketch map of the South China block (modified from Faure et al. (2009) and Chu et al. (2012a)).

the Xuefengshan Belt occurred in the Early Mesozoic with consistent top-to-the NW ductile shearing and thrusting developed in the Neoproterozoic to Early Triassic series (Wang et al., 2005; Li et al., 2011; Chu et al., 2012a, 2012b). The distinct structural patterns from different areas tell us a complex story in the interior of the SCB, and the Early Paleozoic and Early Mesozoic intracontinental orogens remain enigmatic in extent and geodynamics. The Early Paleozoic orogen resulted from a NW–SE or N–S intracontinental compression, however, the geodynamic behavior of the plate margin is still unsolved (Faure et al., 2009; Charvet et al., 2010; Li et al., 2010). Several models have also been proposed to interpret the Mesozoic inland fold-and-thrust belt in the SCB. Yan et al. (2003) suggested that this intracontinental belt was formed by large scale over-thrust in the Late Mesozoic associated with the long-lasting collision between the North China block and the South China block; Wang et al. (2005) considered that the Triassic thrust belt can be explained by the transpressional tectonics due to the collision in the north (Dabie orogen), and southwest (Indosinian orogen) margins of the SCB. An Early Mesozoic NW-directed flat-slab subduction of the Paleo-Pacific plate beneath the SCB is also suggested (Li and Li, 2007).

The Jiuling Massif, consisting of a sedimentary sequence from Neoproterozoic to Early Triassic, and episodic plutons, is located in a junction zone and possibly experienced Neoproterozoic, Early Paleozoic, and Early Mesozoic tectonic events (Zhong, 1992; Shu et al., 1994; Faure et al., 1998; Lin et al., 2001; Li et al., 2010). It therefore provides us an excellent natural laboratory to investigate the polyphase and even polyorogenic deformation during the Phanerozoic. In this paper, based on available observations and geochronological data in this area, we propose an integrated picture to evaluate the effect of polyphase deformation and tectonic implications in the northern part of the SCB.

2. Geological setting

The Jiuling Massif lies in the north of the SCB (Fig. 1) in a joint area where three belts converge, including the foreland of the Qinling–Dabie Belt, the Xuefengshan intracontinental belt, and the Jiangnan belt (Fig. 1). As part of the Jiangnan (Jinning or Sibao) orogenic belt, this massif was considered to be involved in an intense deformation, whereas the best evidence is provided by Proterozoic ophiolites and radiometric ages at 1.0–0.9 Ga of metamorphic and igneous rocks (Chen et al., 1991; Charvet et al., 1996; Li et al., 2002, 2009a, 2009b and references therein). Despite scarcely distributed exposures, the Jiangshan–Shaoxing Fault (JSF) and its southwestern extension, the Chenzhou-Linwu Fault, are regarded as the suture zone juxtaposing the Yangtze block and the Cathaysia block (Shu et al., 1994; Charvet et al., 1996; Zhang et al., 2013). The sedimentary sequence is continuous from Meso–Neoproterozoic to Early–Middle Triassic in the Jiuling Massif (Fig. 1), except a hiatus in Early–Middle Devonian (BGMRJX, 1984). The Precambrian strata consist of three groups that are Shuangqiaoshan Group, Luokedong Group and Sinian series (BGMRJX, 1984). The Meso–Neoproterozoic Shuangqiaoshan Group, which is equivalent of Lengjiaxi Group in northern Xuefengshan Belt and Sibao Group in southern Xuefengshan Belt (BGMRGX, 1985; BGMRHN, 1988; Wang et al., 2008, 2012b), was slightly metamorphosed into slate, phyllite, meta-conglomerates, and meta-sandstones, representing the oldest strata cropping out in the study area. Controlled by the Neoproterozoic rifting, conglomerate, sandstone, siltstone and mudstone of the Luokedong Group and Sinian series were deposited in the rifting-related basin in the inner regions of the SCB (Wang and Li, 2003; Wang et al., 2012c). Marine environment lasted until the Early Ordovician after the end of the rifting. During the Middle Ordovician–Silurian, the thick turbiditic series of mudstone–sandstone is interpreted as a foreland basin deposit (Faure et al., 2009; Li et al., 2010). In the study area, the Early Paleozoic sequence is nearly absent, but only exposed in the southern Pingxiang Basin (Fig. 2). As in most regions of the SCB, the Middle Devonian conglomerate, unconformably overlying the Pre-Devonian strata, indicates uplifting and erosion by the Early Paleozoic South China/Wuyi-Yunkai orogen (Faure et al., 2009; Li et al., 2010; Wang et al., 2012a).

The upper Paleozoic sequence is predominantly exposed in the northern Jiuling Massif and the Pingxiang Basin (Fig. 2). From Late Devonian to Early Triassic, a thick package of limestone and mudstone was accumulated in a shallow water environment (BGMRJX, 1984). The Late Triassic–Early Jurassic sedimentary rocks, composed of conglomerate and sandstone, were deposited in a