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Paleoproterozoic magmatic and metamorphic events link Yangtze to northwest Laurentia in the Nuna supercontinent

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ABSTRACT

Zircons from granitic gneisses in North Vietnam have magmatic cores dated at 2.28–2.19 Ga, and constitute the first reported evidence of continental crust with these ages in the Yangtze Block of the South China Craton. Overgrowths on zircon rims indicate two periods of metamorphism at 1.97–1.95 Ga and ~1.83 Ga. These events, along with a previously reported ~2.36 Ga metamorphic overgrowth on ~2.9 Ga crystallized zircons from the same region, suggest a sequence of events similar to that recorded for the northwestern region of Laurentia and possibly Siberia, which are associated with assembly of the Nuna supercontinent. These include the 2.4–2.3 Ga Arrowsmith Orogen and a range of events in the interval 2.32–1.80 Ga, including accretionary magmatism in northwestern Laurentia and Siberia (2.32–2.07 Ga), the Thelon orogeny (2.02–1.96 Ga) and the 1.85–1.80 Ga collision between the Superior and Hearne–Rae cratons during the Trans-Hudson Orogen in Laurentia, and the Akitkan Orogen in Siberia (2.03–1.86 Ga). Subsequent attempted breakup of Nuna may be represented by ca. 1.80 to 1.59 Ga consanguineous extension related sedimentation and magmatism in the southwestern Yangtze Block and northwestern Laurentia. These correlations favor location of the Yangtze Block adjacent to northwest Laurentia, and possibly Siberia, within the Nuna supercontinent.

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1. Introduction

Supercontinents record the periodic amalgamation and dispersal of continental blocks through a Wilson cycle of oceans closing and opening, and have played an important role in the evolution of the Earth system over at least the latter half of its history. Although the configuration of Phanerozoic supercontinents is relatively well constrained enabling the interaction between paleogeography and surficial and deep Earth processes to be evaluated, the configuration of Precambrian supercontinents is less resolved. This uncertainty reflects the increasingly incomplete nature of the rock record with increasing age (e.g., Cawood et al., 2013). Thus, establishing the position of continental blocks in Precambrian supercontinents is a first order constraint on their links with the Earth system, as changes in the history of one segment of the supercontinent must be accommodated by rearrangements and refinement in the positions of the other blocks.

Nuna (also termed Columbia), which assembled in the Paleoproterozoic, is the earliest recognized pulse of supercontinent assembly. Earlier late Archean continental amalgamations have been proposed but whether they were large enough to be classified as supercontinents is unknown (Evans, 2013). The number and configuration of the continental blocks within Nuna are disputed reflecting the incomplete rock archive but proposed assemblages generally share a common association in which Siberia lies off northern Laurentia and Baltica to the northeast of Laurentia (current orientations; Rogers and Santosh, 2002; Zhao et al., 2002; Evans, 2013). The position of the Yangtze Block within the Precambrian supercontinents of Nuna and Rodinia has been assigned both internal and external locations, or its position has been omitted (Li et al., 2008; Zhao et al., 2002; Evans and Mitchell, 2011; Zhang et al., 2012; Cawood et al., 2013; Pisarevsky et al., 2014).

In this paper, we outline new data on the age and character of Paleoproterozoic rock units in the Yangtze Block of southern China with respect to the core cratonic blocks of Nuna providing further insight into its paleogeographic development. New U–Pb results of gneisses and migmatite from Phan Si Pan Complex, North Vietnam, located in the southwestern Yangtze Block,

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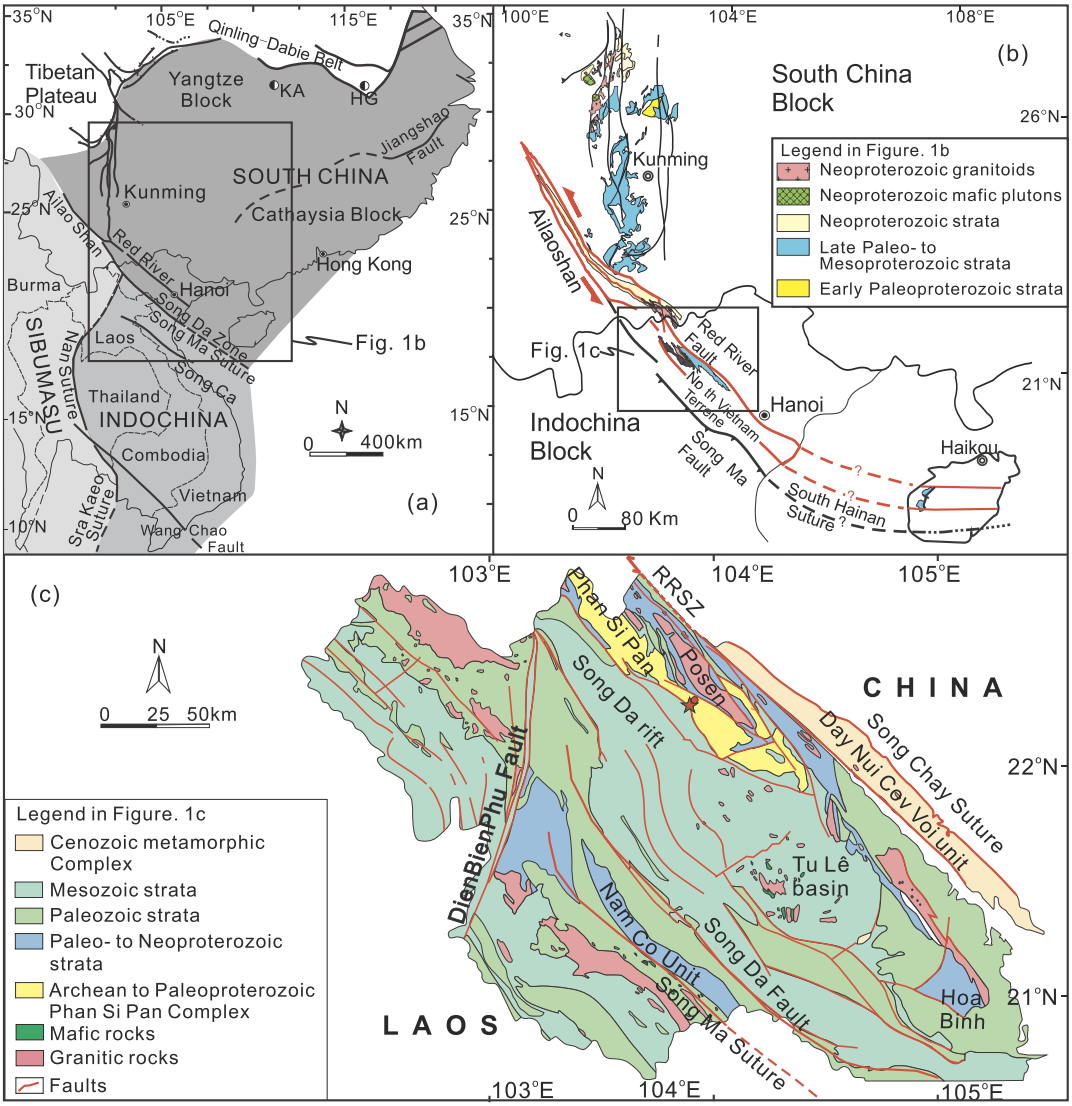

Fig. 1. Tectonic framework of South Asia (a), southwestern Yangtze Block and adjacent area (b) and northwestern Vietnam (c) (modified after Pham, 2010 and Faure et al., 2014). Abbreviations in (a): KA – Kongling Amphibolite metamorphosed at 1.97 Ga (Zhang et al., 2006); HG – Huangtuling Granulite metamorphosed at 2.03–1.99 Ga (Sun et al., 2008; Wu et al., 2008). Abbreviation in (c): RRSZ – Red River Shear Zone. Early Paleoproterozoic strata in (b) refer to the Tangdan Group and Paleo- to Mesoproterozoic strata refer to the Dongchuan Group and its equivalents. Red circle in the Phan Si Pan complex of (c) represents the location of village Đền Bảo Hà and the star represents the approximate sampling location. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

indicate the presence of early Paleoproterozoic continental crust and mid-Paleoproterozoic metamorphism related to the assemblage of the Nuna supercontinent. With these new results, we suggest that the Yangtze Block was accreted to northwestern Laurentia at 2.4–2.3 Ga and the two regions then experienced a similar geological history, including 2.32–2.07 Ga accretionary events, 2.02–1.83 Ga orogeny, and 1.80–1.59 Ga continental rifting, before separating at ~1.59 Ga.

2. Setting of the Yangtze Block and sampling

The Yangtze Block comprises the northwestern part of the South China Craton, which was formed by amalgamation between the Yangtze and Cathaysia blocks along the Jiangnan Fold Belt (or orogen) during the Neoproterozoic (Fig. 1a). The block incorporates the Archean Kongling complex in the north, composed of a diorite-tonalite–trondhjemite–granodiorite association, sporadically exposed Paleoproterozoic igneous rocks and metamorphic gneiss assemblages, and early Neoproterozoic accretionary orogenic assemblages, the latter developed along its western and northwestern margins, and all of which are unconformably overlain by late Neoproterozoic and younger successions (Zhao and Cawood, 2012 and references therein). Paleoproterozoic metamorphism, likely related to the assembly of the Nuna supercontinent, has been previously identified in the northern Yangtze Block and is represented by the Kongling amphibolite and Huangtuling granulite (KA and HG in Fig. 1a). The North Vietnam area, southwestern Yangtze Block, contains Proterozoic basement and Paleozoic sedimentary rocks, which along with surrounding units, were strongly disrupted by the Red River Shear Zone during Mesozoic to Cenozoic India–Asia convergence and collision (Yin and Harrison, 2000) (Fig. 1b).

The Day Nui Con Voi unit consists of masses of gabbro, diorite, and granodiorite that experienced high temperature metamorphism and strong deformation along the Red River zone (Fig. 1c). NW–SE strike ductile structures, such as the Song Da Fault, observed southwest of the Red River Zone are older than late Triassic and are deflected to a NNW-SSE trend by the dextral Dien Bien Fault (Fig. 1c; Faure et al., 2014). Late Permian rift-related magmatism, gabbro, pillow basalt and mafic volcanic breccia, are

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