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Geochemistry and zircon U–Pb geochronology of Paleoproterozoic arc related granitoid in the Northwestern Yangtze Block and its geological implications

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ABSTRACT

The early history of the Yangtze Block has not been well constrained yet, due to the scarce outcrops of Archean to Paleoproterozoic rocks. In this study, we report an integrated study of zircon U–Pb age, major and trace element data and Sr–Nd–Hf isotope compositions for gray gneisses from the Houhe complex in the northwestern part of the Yangtze Block. Zircon U–Pb dating yields a weighted mean $^{207}Pb/^{206}Pb$ age of 2081 ± 9 Ma for a gneiss. This age is interpreted as the formation age of the Houhe complex and thus the Houhe complex represents the oldest rocks found in the western part of the Yangtze Block. The gray gneisses from the Houhe complex range in SiO_2 contents from 58.63% to 68.59% and Na_2O from 3.88% to 5.28%, and have relatively high Fe_2O_3 contents of 2.86–6.69%, Al_2O_3 of 16.01–18.88%, and MgO of 0.97–2.65%. These rocks show low Sr (149–390 ppm), Cr (9.07–45.1 ppm) and Ni (4.97–21.3 ppm) contents, but high Y (12.9–32.7 ppm) and Yb (0.95–2.25 ppm). They are characterized by a relative enrichment in LILEs and LREEs, but a depletion in HFSEs. These features are similar to those of calc-alkaline granitoids, suggesting that their formation might be related to a subduction-related process or remelting of preexisted arc rocks. Compiled age spectra of Archean to Paleoproterozoic zircon grains reveal that the western and eastern parts of the Yangtze Block have similar Archean and early Paleoproterozoic age ranges, indicative of the occurrence of an old continental nucleus in both parts. On the other hand, there are large amounts of ca. 2050–2400 Ma zircon grains revealed in the western part of the Yangtze Block, implying that there might be a microcontinent with an active-type continental margin during the Paleoproterozoic times in the western part of the Yangtze Block. Because of the poor outcrops of Archean to Paleoproterozoic rocks in the Yangtze Block, it is no possible to establish the exact nature of such an active margin yet. The occurrence of ca. 2.0 Ga khondalitic and metasedimentary rocks has been documented in the eastern part of the Yangtze Block, implying that there might be a passive-type continental margin in the eastern part of the Yangtze Block. At ca. 2.0 Ga, the collision between the western microcontinent and the eastern part may have resulted in the final arc-continental collision and the amalgamation of the Yangtze Block.

1. Introduction

It has been widely recognized that significant chemical changes in compositions of juvenile continental crust occurred in the late Archean to the Paleoproterozoic (Engel et al., 1974; Taylor and McLennan, 1985; Condie, 1993, 2008). In the late Archean, mafic crust was greatly thickened and underwent partial melting to produce the tonalite-trondhjemite-granodiorite (TTG) magma suites, whereas in the Early Proterozoic, large ion lithophile element (LILE) enriched calc-alkaline granitoids widely occurred (Champion and Sheraton, 1997; Moyen et al., 2003; Condie, 2008). Such a diversity suggests that these rocks were produced by contrasting petrogenetic processes in various geodynamic settings (Moyen et al., 2003) and the modern style mantle wedges may have come into existence during the early Proterozoic times (Condie, 2008).

The Yangtze and North China blocks are the two largest Precambrian blocks in China, which collided along the Qinling-Dabie-Sulu orogenic belt in the Triassic (Zheng et al., 2003; Wu et al., 2006, 2009a). The North China Block is one of the oldest blocks in the world, with widespread Archean rocks and crustal remnants as old as 3800 Ma (Liu et al., 1992; Song et al., 1996; Zheng et al., 2004), and its early evolution has been well constrained (Liu et al., 2002; Zhao et al., 2002a, 2005, 2008; Yin et al., 2009, 2011; Wang et al., 2010). The first occurrence of calc-alkaline granitoids was constrained at the late Archean to the early Paleoproterozoic, arguing for the initial subduction process in the North China Block (Liu et al., 2002; Zhao

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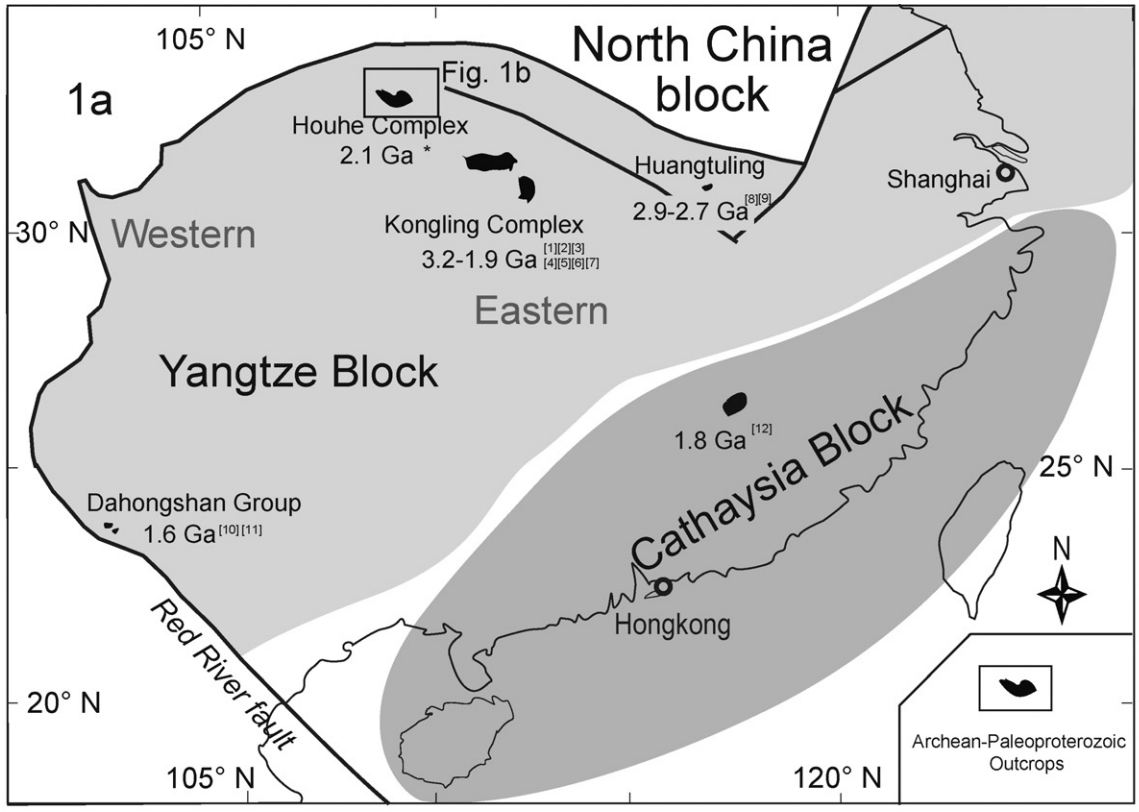

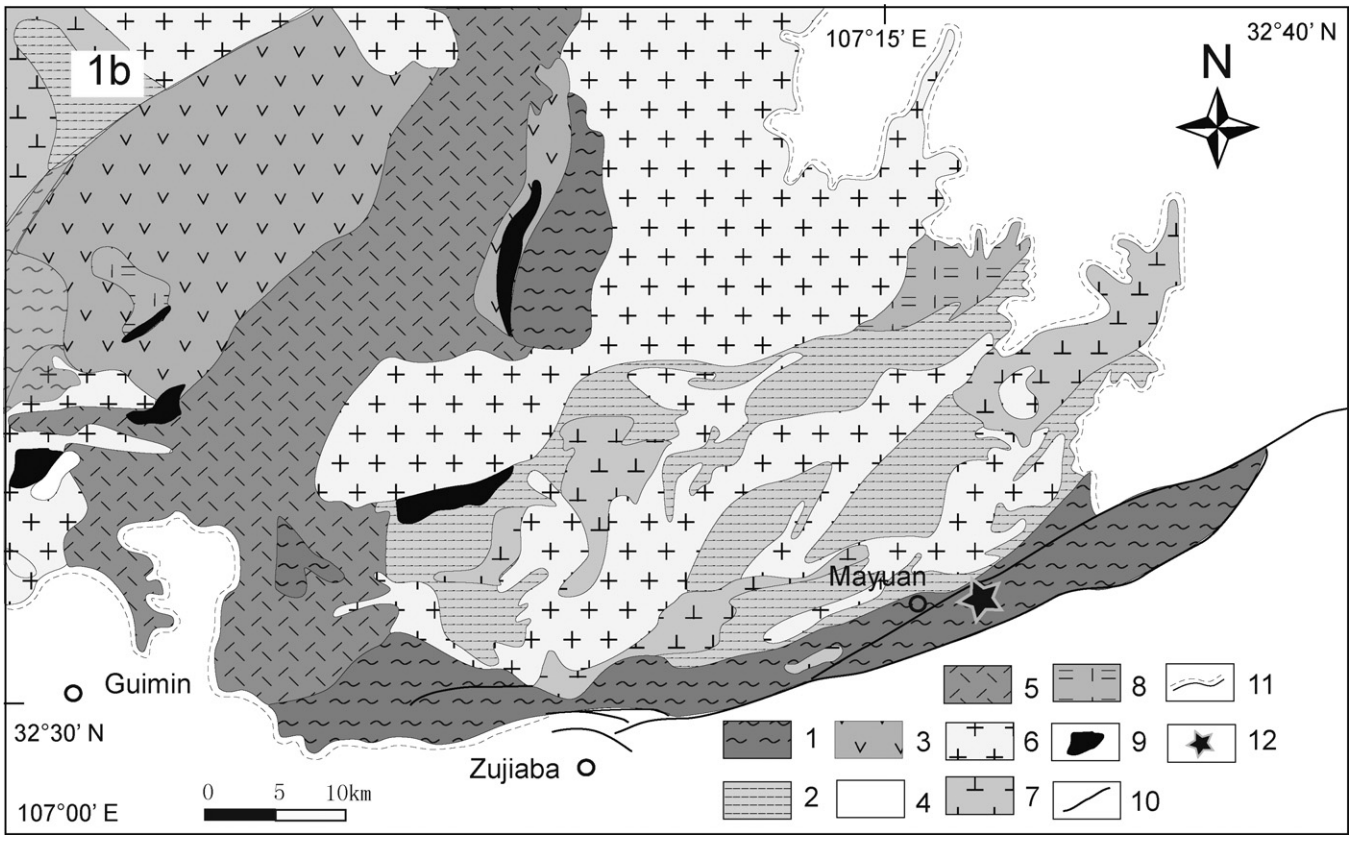

Fig. 1. (a) Sketch geological map showing the Houhe complex in the Yangtze and the Cathaysia blocks, and the Houhe complex in the northwestern part of Yangtze Block. Outcrops of Archean TTG and Paleoproterozoic rocks are also shown. References—*this study, 1: Qiu et al. (2000); 2: Zhang et al. (2006a); 3: Zhang et al. (2006b); 4: Zheng et al. (2006); 5: Jiao et al. (2009); 6: Wu et al. (2009b); 7: Gao et al. (2011); 8: Wu et al. (2008); 9: Sun et al. (2008); 10: Greentree and Li (2008); 11: Zhao et al. (2010); 12: Li (1997). (b) Geological map of the Houhe complex (modified after Ling et al., 2003). (1) Houhe gneiss complex; (2) Meso-Neoproterozoic Mawozi and Shangliang formations, lower and middle Huodiya Group; (3) Tiechuanshan volcanic-sedimentary succession, upper Huodiya Group; (4) Sinian and Phanerozoic sedimentary rocks; (5) Neoproterozoic gabbro; (6) granite; (7) diorite; (8) alkaline granite; (9) mafic dike; (10) fault; (11) unconformity; and (12) sample location.