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Short Communications (Research Advances)

Report of 2.7 Ga zircon U-Pb age of orthogneiss in the Wenquan metamorphic complex, West Tianshan, China

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1. Objective

The Wenquan Group is one of the important medium- to low-grade metamorphic units within the Wenquan metamorphic complexes which distributes in Chinese segment of the Tianshan Belt, the southern part of the Central Asian Orogenic Belt. It mainly consists of pre-Neoproterozoic metamorphosed volcanic and sedimentary rocks (Wang B et al., 2014). Although the formation age of the orthogneiss in the Wenquan metamorphic complex was inferred as ca. 926–845 Ma (Wang B et al., 2014), the yielded zircon ages have been confirmed by partial data for the protoliths and metamorphism. The Paleo- to Mesoproterozoic analyses are consistent with the widely distributed ca. 2.44–1.44 Ga meta-volcanic rocks in the Kokchetau, Chu-Yili, and Central Tianshan area (Liu HS et al., 2014; Wu C et al., 2018). In this contribution, zircons from the orthogneiss of the Wenquan metamorphic complex have been analyzed by precisely SIMS U-Pb geochronologic dating to decipher the accurate Pre-Mesoproterozoic information of zircons.

2. Method

Neoproterozoic granite and migmatite are the major rock types in the Wenquan metamorphic complex, with widths of several hundred meters to tens of kilometers, and one hundred

kilometers in length (Fig. 1a; Wang B et al., 2014). Orthogneiss is deformed within the contemporaneous biotite quartz schist/gneiss, biotite amphibole schist, and quartzite layers (Fig. 1b). It has augen phenocrysts of feldspar, elongated quartz, and deformed biotite that indicated the main foliation (Fig. 1c), which suggesting that the protolith of the orthogneiss might be granite. A fresh orthogneiss sample (WQ) from the Wenquan metamorphic complex has been selected for zircon U-Pb dating by secondary ion mass spectrometry (SIMS). This analysis was conducted at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS). Zircon grains were separated using conventional heavy fraction and magnetic techniques. Representative zircon grains from metamorphic igneous rocks were mounted in epoxy mounts, which were then polished for analysis. All mounted zircons were documented with transmitted and reflected light micrographs, as well as cathodoluminescence (CL) images to reveal their internal structures, and the mounts were vacuum-coated with high-purity gold prior to SIMS analysis. Following the CL and other imaging, the samples were vacuum-coated with high-purity gold. Measurements of U, Th and Pb were conducted using the Cameca IMS-1280 SIMS. Data reductions were carried out using the Isoplot/Ex version 2.49 programs. Errors quoted as age dates are at the 1 σ levels. Zircon U-Pb results are presented in Supplementary Table S1.

3. Results

Zircons from orthogneiss (sample WQ) are tetragonal prismatic crystals and have oscillatory growth zone under CL images (Fig. 2). These characteristics are affinity to magmatic zircons. Most zircons are 50–150 μm in size with elongation

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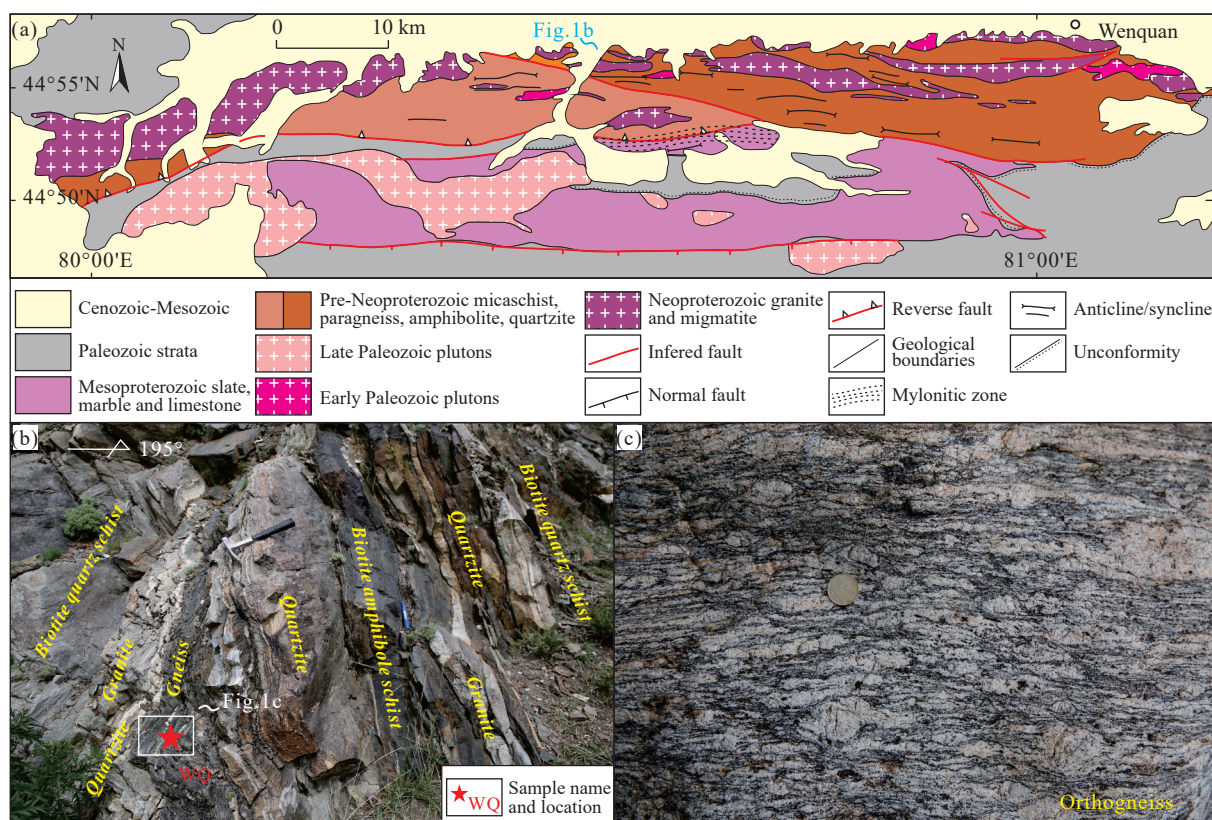


Fig. 1. a—Geological map of the Wenquan area in West Tianshan, NW China (modified from Wang B et al., 2014); b—the field-photo of the biotite quartz schist/gneiss layers with the contemporaneous biotite amphibole schist and quartzite interlayer and the late granitic intrusion; c—augen orthogneiss with feldspar phenocrysts and elongated quartz and biotite ribbons.

ratios from 1 to 3. SIMS analyses results suggest the $^{207}\text{Pb}/^{206}\text{Pb}$ ages are ranging from 821 ± 8.7 Ma to 2679 ± 6.9 Ma (Fig. 2a), and the youngest $^{206}\text{Pb}/^{238}\text{U}$ age is 766 ± 10.9 Ma (Supplementary Table S1). Grains 46 and 38 are typical Neoproterozoic–Early Paleoproterozoic magmatic zircons that have similar isotopic ages with the $^{207}\text{Pb}/^{206}\text{Pb}$ age of 2679 ± 6.9 Ma and 2525 ± 6.5 Ma, respectively. The grain 28, 29, 33, 37, 45 and 47 are also the representative of Mesoproterozoic magmatic zircons. Moreover, the rest sixteen magmatic zircons have Th/U ratios ranging from 0.1 to 0.5 and define a Concordia age of 914.5 ± 4.4 Ma (MSWD=0.86) (Fig. 2b), which might represent the formation time of the orthogneiss.

4. Conclusion

Orthogneiss in the Wenquan metamorphic complex has ca. 2.7–0.8 Ga magmatic zircons and yielded a concordia age of 914.5 ± 4.4 Ma (MSWD=0.86). Although previous studies have reported the Neoproterozoic zircons in the Wenquan Group, it is hard to confirm whether these zircons came from nearby sources (basement of the northern Yili Block) or alternatively, transported from distant sources (e.g., Tarim or Siberia Craton, Wang B et al., 2014). In this contribution, the authors propose the newly discovered Neoproterozoic and Mesoproterozoic zircons may derive from the basement of the northern Yili Block based on zircon characteristics and comparisons of geochronology and tectonics. Firstly, the analytical zircons which have euhedral morphology and

oscillatory zoned are magmatic or inherited zircons that derived from a local source and captured by subsequent granitic magma normally. Secondly, the Neoproterozoic and Mesoproterozoic analyses result of orthogneiss in the Wenquan metamorphic complex are consistent with 2.79 Ga granitic gneisses recognized in south Kazakhstan and 1.56–1.00 Ga meta-volcanic rocks in the Kokchetau and Central Tianshan area (Wu C et al., 2018). Thirdly, the conclusively demonstrates that the Yili block has an uninterruptedly tectonic link to Kazakhstan continent (Wang B et al., 2014; Liu HS et al., 2014). These Neoproterozoic and Mesoproterozoic ages evidence might indicate the Late Neoproterozoic–Early Paleoproterozoic worldwide crust formation events and the assembly and breakup of the Rodinia supercontinent in West Tianshan, NW China. Moreover, the newly discovered 2679 ± 6.9 Ma zircon in the Wenquan metamorphic complex combine with previous records of old ages may imply that the Kazakhstan continent may have an Archean basement.

CRedit authorship contribution statement

Chu Wu and Xing-wang Xu conceived of the presented idea. Chu Wu and Tao Hong carried out the experiment. All authors discussed the results and contributed to the final manuscript.

Declaration of competing interest

The authors declare no conflicts of interest.

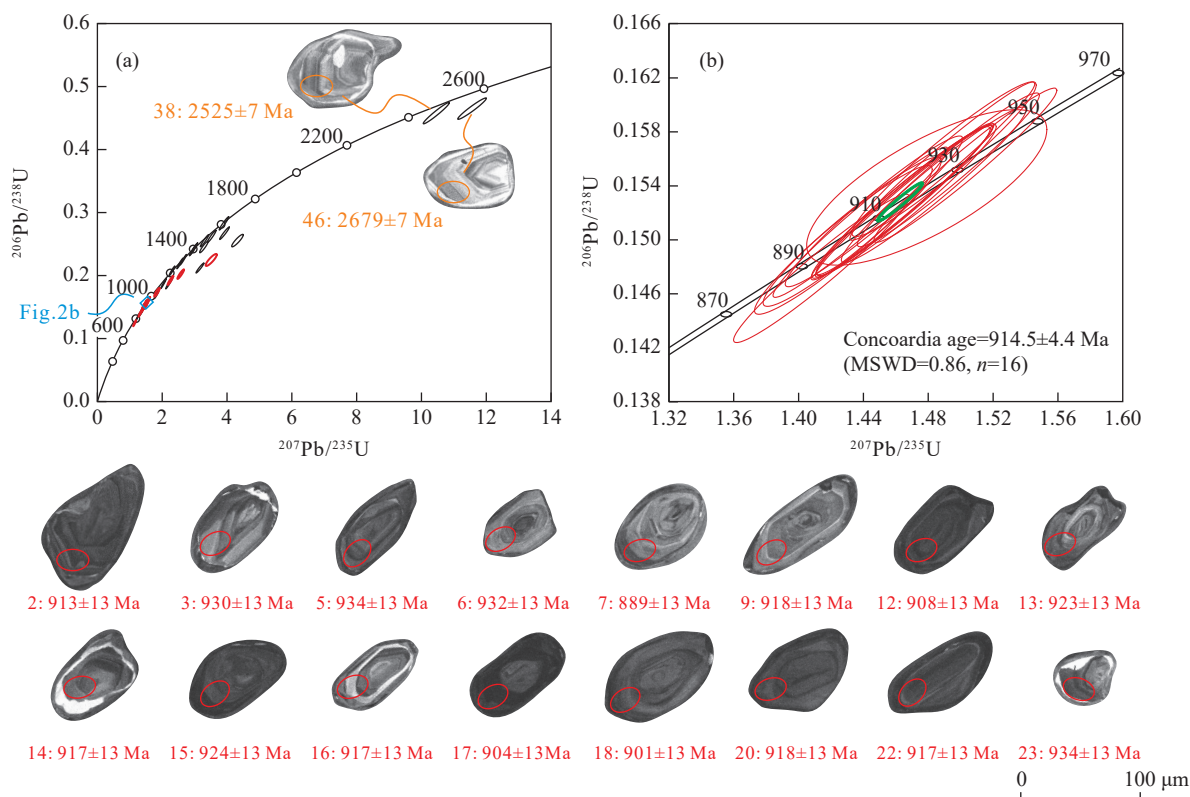


Fig. 2. CL images and SIMS U-Pb concordia age diagrams of zircons in orthogneiss. The solid ellipses in CL photos of zircons represent the analytical location of U-Pb age. The orange numbers adjacent to CL photos in (a) show the plot number (n) with $^{207}\text{Pb}/^{206}\text{Pb}$ age data, and the red numbers under CL photos show the plot number (n) with $^{206}\text{Pb}/^{238}\text{U}$ age data.

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Supplementary data

Table S1 to this article can be found online at doi:

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