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Research Advances

Source of the Ore-forming Adakitic Porphyry at the Beiya Super-large Au Deposit, Western Yangtze Craton: New Evidence from Zircon U-Pb Ages of the Amphibolite Xenoliths

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Objective

The Beiya super-large Au-rich porphyry deposit (304 t Au, 2.4 g/t Au) is located within the western Yangtze craton, to the southeast of the Sanjiang Tethyan Orogen (Fig. 1). The ore-forming porphyry is adakitic, characterized by high Sr/Y and La/Yb ratios coupled with low Y and Yb contents, and is generally thought to be derived from partial melting of thickened mafic lower crust. The lower crust underneath the western Yangtze craton is mainly composed of ancient crust with Archean ages, juvenile crust resulting from the Neoproterozoic subduction (740–1000 Ma), and late Permian juvenile crust related to the Emeishan mantle plume. Which lower crustal end-member has played a critical role in genesis of the Beiya ore-forming porphyry can be constrained by zircon U-Pb ages of amphibolite xenoliths hosted in the ore-forming porphyry, because these xenoliths represent direct samples of the source. In this study, we present new zircon U-Pb ages of these amphibolite xenoliths to have insight into the nature of the Beiya adakitic porphyry source.

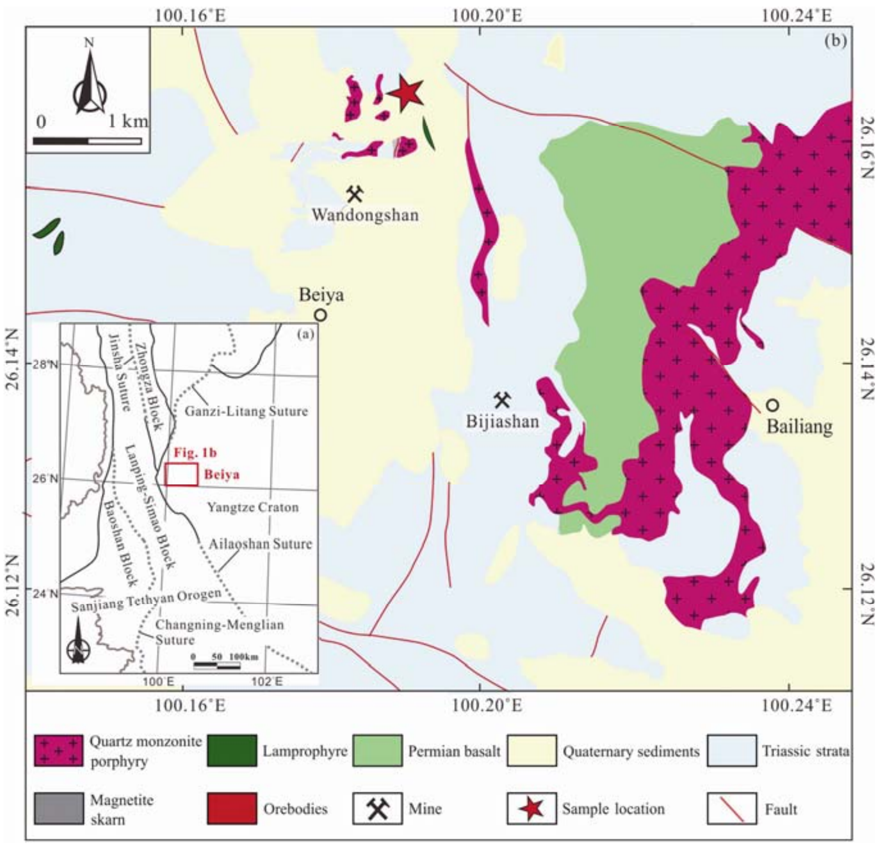

Fig. 1. (a) Tectonic framework of the western Yangtze craton, (b) simplified geologic map of the Beiya deposit area (modified from He et al., 2015).

Methods

LA-ICP-MS zircon U-Pb analyses were carried out at the Isotopic Laboratory, Tianjin Center, China Geological Survey. Laser sampling was performed using a quadrupole ICP-MS system (Agilent 7900) attached to a 193 nm laser with the automatic positioning system (Resolution LR). Data processing and plotting were completed by using ICPMSDataCal and Isoplot, respectively.

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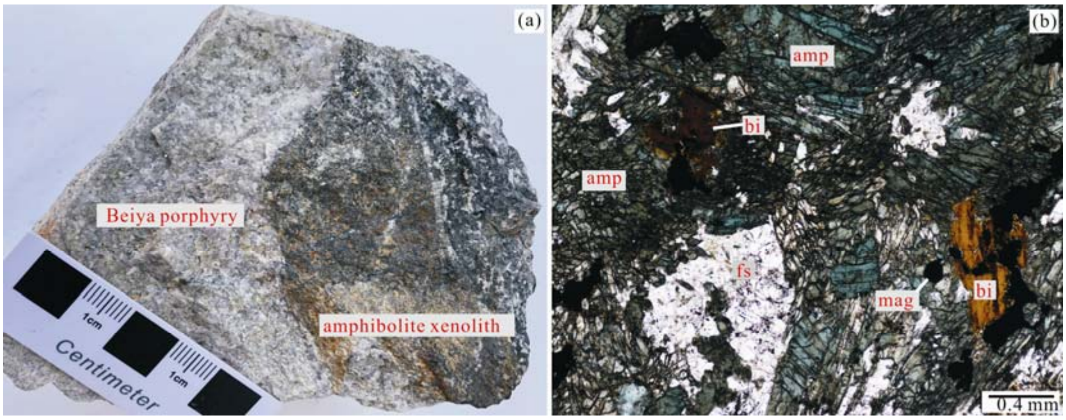

Fig. 2. Hand-specimen photograph (a) and photomicrograph (b) of the Beiya amphibolite xenoliths. Abbreviations: amphibole, amp; feldspar, fs; biotite, bi; magnetite, mag.

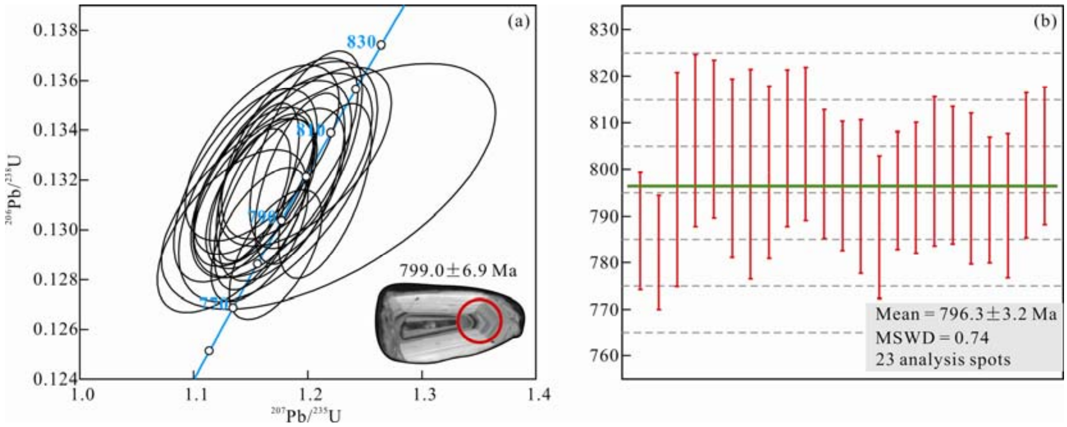

Fig. 3. Zircon U-Pb concordia (a) and weighted average (b) diagrams for the Beiya amphibolite xenoliths.

Results

The amphibolite xenoliths are black, with sharp boundaries that lack quenched margins (Fig. 2a). These amphibolites show heterogranular texture, and massive and gneissic structure, composed of amphibole (50–60 vol.%), feldspar (25–35 vol.%), biotite (3–10 vol.%), quartz (2–5 vol.%) and small amounts of epidote, magnetite, sulfide, zircon and apatite (Fig. 2b). Zircons used for LA-ICP-MS U-Pb dating are collected from sample 19BY06-4. These zircons are transparent, colorless with lengths ranging from 60 to 180 μm and width-to-length ratios of about 1:1.5–1:3. They have typical oscillatory zoning (Fig. 3a), and possess relatively high Th/U ratios (0.48–1.83; Appendix 1), indicative of a magmatic origin. Twenty-three analyses yielded ^{206}Pb/^{238}U ages varying from 782 to 807 Ma with a weighted mean of 796.3±3.2 Ma (1σ, MSWD=0.74; Fig. 3a and b), which can represent the crystallization age of the amphibolite xenoliths in Beiya. The zircon U-Pb dating results suggest that lower crustal source of the Beiya adakitic porphyry formed at ca. 796 Ma, generated by underplating of Neoproterozoic arc magmas (740–1000 Ma). This further indicates that the juvenile mafic lower crust resulting from previous arc magmatism as a fertilization process plays a significant role in the generation of Au-rich porphyry deposits at cratonic edges.

Conclusions

The LA-ICP-MS zircon U-Pb dating suggests that the amphibolite xenoliths hosted by the Beiya adakitic ore-forming porphyry have the crystallization age of 796.3±3.2 Ma, which are formed by underplating of Neoproterozoic arc magmas in the lower crust. The juvenile mafic lower crust associated with previous arc magmas plays a significant role in the generation of Au-rich porphyry deposits at cratonic edges.

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