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## Geochemical Characteristics of Zircon and Apatite in the Alkaline Porphyry in Beiya Gold-Polymetallic Deposit, Western Yunnan Province, South China

FU Yu<sup>1,2</sup>, SUN Xiaoming<sup>1,2,3\*</sup>, LIN Hai<sup>1,2</sup>, OUYANG Xianqing<sup>1,2</sup> and ZHOU Haoyang<sup>2,3</sup>

<sup>1</sup> School of Marine Sciences, Sun Yat-sen University, Guangzhou 510006, China

<sup>2</sup> Key Laboratory of Marine Resources and Coastal Engineering in Guangdong Province, Guangzhou 510275, China

<sup>3</sup> School of Earth Science and Geological Engineering, Sun Yat-sen University, Guangzhou 510275, China

### 1 Introduction

A series of deposits are associated with alkaline porphyries along the Jinshajiang-Ailaoshan fault zone in Sanjiang area, Yunnan Province, forming the Jinshajiang-Ailaoshan alkaline porphyry metallogenic belt (Deng et al., 2010; He et al., 2013). The Beiya gold-polymetallic deposit lies in the middle of the belt, and is the largest gold deposit in this area with a reserve of >200 t gold, and large amounts of iron, copper, silver, lead and zinc. Because of the paragenetic relationship between the Himalayan alkaline porphyries and the ore deposits (Xu et al., 2007; He et al., 2013), study on the rocks in the Beiya mineral district is of great significance for understanding the distribution of mineralization in the Beiya orefield, and indeed in the entire metallogenic belt.

### 2 Analyses and Results

In this study, samples were collected from the Wandongshan gold-polymetallic deposit, which is the main deposit within the Beiya orefield. The rock is mainly composed of quartz syenite porphyry. More than 1000 zircon grains were separated, most of which are stubby prisms. Cathodoluminescence (CL) images of most zircon grains show oscillatory zoning, and the Th/U ratios analyzed are all larger than 0.1, indicating a magmatic origin (Belousova et al., 2002; Hoskin et al., 2003). LA-ICPMS U-Pb measurements of zircon yield similar <sup>206</sup>Pb/<sup>238</sup>U ages with a weighted average of 32.8 Ma. The chondrite-normalized REE patterns of the zircons from Beiya porphyry are all strongly enriched in heavy REE relative to light REE, with positive Ce and light negative Eu anomalies, exhibiting the typical characteristics of

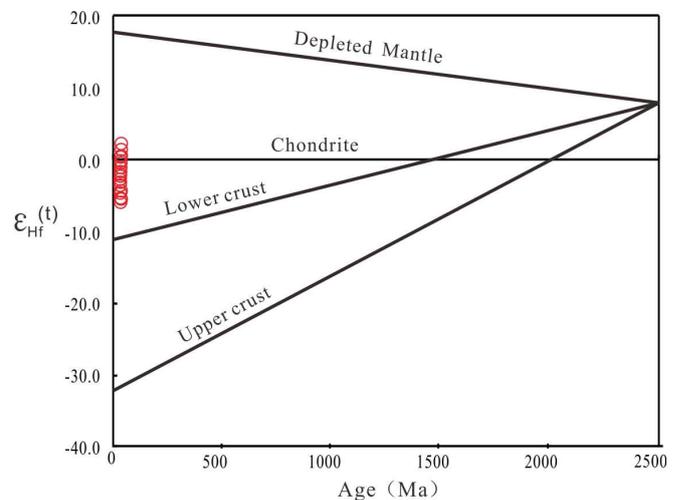


Fig. 1. Plots of  $\epsilon_{\text{Hf}}(t)$  vs. U-Pb age for zircon from the Beiya porphyry.

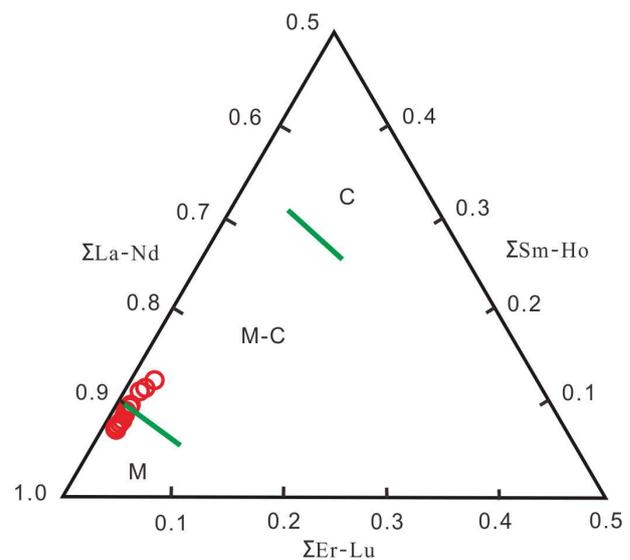


Fig. 2. Diagram of  $\Sigma\text{La-Nd}-\Sigma\text{Sm-Ho}-\Sigma\text{Er-Lu}$  for apatites in Beiya porphyry

\* Corresponding author. E-mail: fuyuemailfuyu@163.com

magmatic zircon. In-situ analyses of hafnium isotopes in zircon using LA-MC-ICPMS show that the average  $\epsilon_{\text{Hf}}(t)$  values for host porphyry are -2.3. On the  $\epsilon_{\text{Hf}}(t)$  vs. U-Pb age diagram (Fig. 1), the Beiya porphyry plots in the region between lower crust and mantle. This indicates that the magma is of mantle origin. The source of magma may be depleted mantle lithosphere which experienced a limited degree of crustal contamination.

The apatites from Beiya porphyry are mostly relatively coarse (150-200 $\mu\text{m}$ ), transparent and prismatic in shape. 15 grains of them were chosen for in-situ LA-ICPMS trace element analysis. Results show that the chondrite-normalized REE patterns of apatite commonly display a right-inclined REE distribution, indicating relative LREE enrichment. The  $\Sigma\text{REE}$  value ranges from 1128.4 to 4080.4 ppm with an mean value of 2040.8 ppm. We observe a weak relative Eu depletion (average  $\delta\text{Eu}$  of 0.78) but no Ce anomaly. On the  $\Sigma\text{La-Nd-}\Sigma\text{Sm-Ho-}\Sigma\text{Er-Lu}$  diagram (Fig. 2), all apatites plot in the fields of mantle and crust-mantle, indicating that the main source of porphyry is mantle, albeit with some crustal contamination. These findings are in good agreement with the experimental results of hafnium isotopes in zircon.

### 3 Discussion

Previous study show that, the ages of polymetallic deposits along Jinshajiang-Ailaoshan fault zone are mostly between 40 Ma and 30 Ma, approximately the same age as the associated alkaline porphyries (Liang et al., 2007; He et al., 2012). As a typical deposit of this belt, the Beiya gold-polymetallic deposit is an important and representative product of large scale Himalayan magmatic activity and displays a close genetic relationship with the Cenozoic alkaline porphyries. Our study of the porphyry closely related to the ore indicates that the geochemical signature of these intrusions has the characteristics of a mixture of crust and mantle, corresponding with previous results (Xu et al., 2006; Xu et al., 2006). We propose that the alkaline porphyry in Beiya deposit is related to partial melting of upper mantle caused by the intensive shear deformation associated with collision of the Indian and Asian continents. This deep-sourced magmatism also provided a rising force and heat for the mineralization fluid.

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