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Multi-Stage Mineralization of the Early Yanshanian Granites from the Central Nanling Region, South China: Implications from REE Geochemistry

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1 Geological Background

Granitic rocks are widespread in the Nanling region of South China. Among them, the Early Yanshanian (ca. 190–140 Ma) granitoids are predominant, and closely associated with numerous non-ferrous and rare metal mineral deposits (Li et al., 2007). Magmatic evolution in this region is characterized by multi-stage intrusions, which formed most of the composite granite bodies and mineralization series. Therefore, the Nanling region in the central part of South China is a unique and very important W, Sn, Mo, Bi, Pb, Zn, Cu, REE, and U metallogenic belt (Chen et al., 2002).

2 REE Geochemistry

Based on the whole rock REE characteristics, the granite composites in the central Nanling region can be divided into five types:

Type I is represented by the Qitianling, the Shuikoushan, the Tongshanling and the Baoshan granitoid bodies. These composites are formed by two or three intrusive stages with similar REE patterns. They are characterized by LREE enrichment and slight Eu negative anomalies with ratios of LREE/HREE and δEu ranging from 7.35 to 12.55 and from

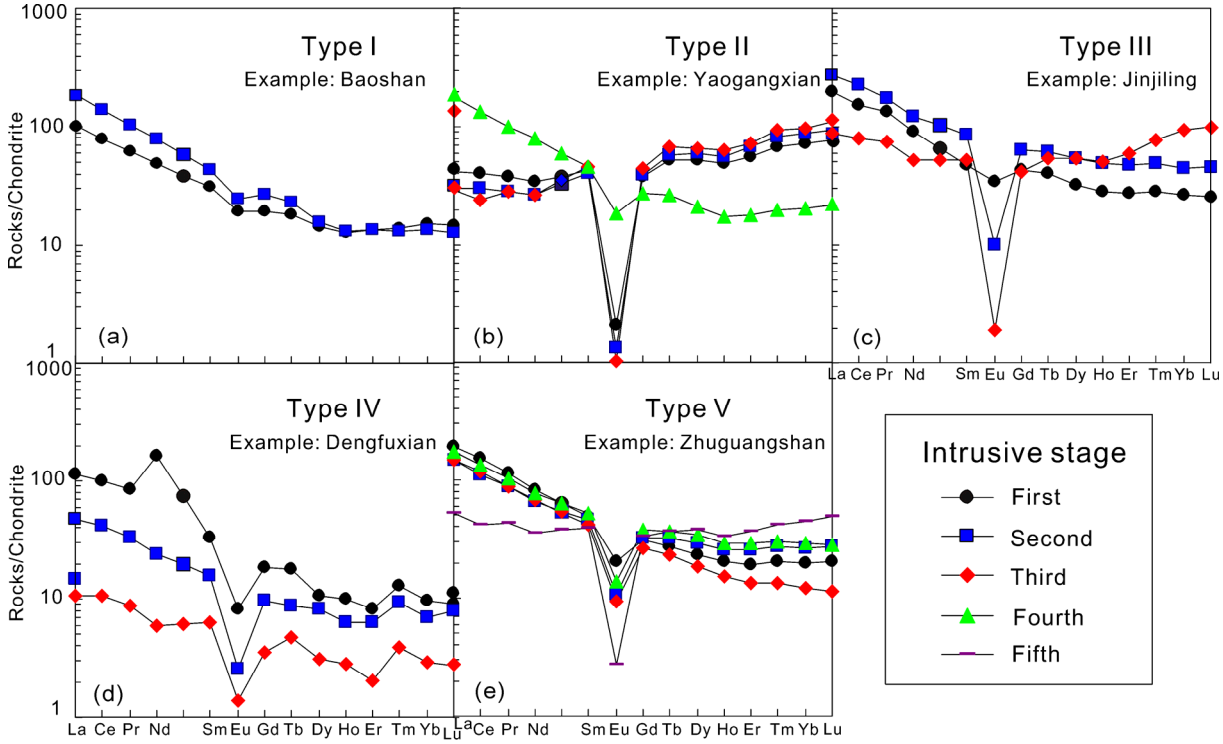

Fig. 1. REE patterns of some representative Early Yanshanian granite composites from the central Nanling region

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0.19 to 0.90, respectively (Fig. 1a).

Type II includes composites of the Qianlishan, the Yaogangxian, the Xihuashan and the Wangxianling-Hehuaping. These granitic composites are formed by four intrusive stages which have distinct REE concentrations. From the first stage to the third stage, the LREE contents gradually decrease, whereas the HREE concentrations sequentially increase, accompanied by increasing Eu negative anomalies. The Fourth intrusive stage has the most inclined patterns from the LREE to the HREE, with weaker Eu anomalies (Fig. 1b).

Type III granite composites are the Xitian, the Jinjiling, the Dupangling, the Dayishan, the Guposhan, the Huashan, the Huangshaping and the Zhuguangshan-Neidong bodies. They are mainly formed by three intrusive stages, with increasing Eu negative anomalies and HREE/LREE ratios from the early to late stages (Fig. 1c).

Type IV granitic plutons consist of the Xianghualing, the Dengfuxian, the Dajishan, the Limu and the Shangbao bodies. They have dispersed patterns in the chondrite-normalized diagrams, with decreased REE concentrations from the early to late stages (Fig. 1d).

Type V has two typical granite bodies: the Guiding and the Zhuguangshan plutons. They are formed by five intrusive stages with compact REE patterns in the chondrite -normalized diagrams characterized by LREE enrichment and slight Eu negative anomalies (Fig. 1e).

3 Mineralization Associations

The Type I granitoid composites are mainly associated with Pb, Zn, Cu, Mo and some amount of W and Sn mineralization. These metallogenic series are mainly related to the first intrusive stages of these composites.

The Type II granitic bodies are associated with two kinds of metallogenic series: the first one is W–Sn–Bi–Mo mineralization related to the first and the second intrusive stages; and the second one is Pb–Zn–Cu–Be mineralization related to the third and the last intrusive stages.

The Type III composite granitic plutons mainly contributed to the mineralization of W, Sn, Cu, Pb, Zn and REE in a complex manner. In general, the first intrusive stage is mainly associated with W–Sn–Cu–Zn mineralization, whereas the second stage resulted in Sn–W –Pb–Zn mineralization, and the last stage is predominantly associated with intense Sn–W–Mo–Pb–Zn mineralization.

The Type IV granite composites are mainly associated with two metallogenic series: the W–Sn mineralization related to the first and the second intrusive stages; and the Nb–Ta–Be–W–Sn–Mo mineralization related to the last intrusive stages of these composites.

The Type V composites are conducive to U–polymetallic mineralization primarily related to the first three intrusive stages.

This study indicates that the REE geochemistry can be used as an indicator of mineral prospecting for the specified granite composites in the central Nanling region, South China.

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