REE Geochemical Characteristics of Volcanic Rocks in Zhejiang and Jiangxi Provinces and Their Geological Significance

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Abstract

Based on the data of 64 samples, the REE geochemical characteristics of volcanic rocks in northern Zhejiang and eastern Jiangxi provinces are discussed in this paper. The REE distribution patterns in acid and intermediate-acid volcanic rocks in these areas display some similarities, as indicated by rightward-inclined V-shaped curves with negative Eu anomalies, which are parallel to each other. In addition, their REE parameters (ΣREE, ΣLREE / ΣHREE, δEu, Ce/Yb, La/Sm, La/Yb, etc.) also vary over a narrow range with small deviations. HREE are particularly concentrated in the volcanic rocks associated with uranium mineralization. The initial ⁸⁷Sr / ⁸⁶Sr ratio in the volcanic rocks is about 0.7056 – 0.7139. All these features in conjunction with strontium isotopic data indicate that the rock-forming materials come from the sialic crust. The REE distribution patterns and REE geochemical parameters of the volcanic rocks, as well as La/Sm-La and Ce/Yb -Eu/Yb diagrams may be applied to the sources of rock-forming and ore-forming materials.

Developed in the Zhejiang-Jiangxi volcanic zone is a suite of Middle Jurassic-Late Cretaceous volcanic rocks which are characterized by extensive distribution and great thickness. The rock types include basic, intermediate, intermediate-acid and acid volcanic rocks, of which the Late Jurassic acid and intermediate-acid volcanic rocks are of most extensive occurrence. Many years of investigations have been made on the stratigraphy and petrography of volcanic rocks and related mineralizations of U, Mo and Ag in ten volcanic basins and depressions of Zhejiang-Jiangxi volcanic zone. Meanwhile, about seventy volcanic rock samples were analyzed for their REE contents and six sets of volcanic rock samples for their Sr isotopic composition. Generalized in this paper are the REE geochemical characteristics of volcanic rocks in the area studied and also discussed is the significance of REE in the study of the genetic origin of volcanic rocks and associated uranium mineralization.

REE Geochemistry of Volcanic Rocks

In recent years we have investigated the Mesozoic acid, intermediate-acid and basic volcanic rocks in ten volcanic depressions and basins at Xiangshan and Xinjiang, eastern Jiangxi and at Shouchang, Shidamen, Shegaiwu, Xindun, Chun'an, Baizhangling, Jinzijian and Tianmushan, northern Zhejiang to shed light on the REE distribution. The results of REE analyses for the representative samples collected from the locations mentioned above are given in Table 1. At the same time, some of the samples were analyzed by using NAA techniques for comparison. The analytical results are of good consistency.

From the REE data of Table 1, we may come to the following conclusions:

1. Volcanic rocks in the various volcanic depressions and basins show slight variations in ΣREE from 154.7 to 435.15 ppm. The ΣREE of mineralized volcanic rocks may be so high as to be 725.3 - 2048.8 ppm. If Y is not taken into consideration in our calculation, the average ΣREE contents of volcanic rocks from the eight volcanic depressions and basins in northern Zhejiang are within the range of 177.61 - 352.1 ppm, with a maximum value of 352.1 ppm for two samples of rhyolite from the Shidamen volcanic depression (on average) and a minimum value of 177.61 ppm for two samples of volcanic rock from the Xindun volcanic basin. The ΣREE contents of volcanic rocks in the various locations are all higher than those of the crust (Li Tong gave a value of 165.35 ppm, 1976)(Liu Yingjun, 1984). The average ΣREE content of three mortar rhyolite samples from the Xiangshan volcanic depression is 199.6 ppm, and that of five sub-granite-porphyry samples is 172.09 ppm, both also being higher than that of the crust. However, the ΣREE content of basic volcanic rock samples is relatively low, generally lower than, or close to, the crustal value. For example, the ΣREE content of diabase-porphyrionite at Xiaozizhou, Jiande is 166.18 ppm.

2. U-, Mo- and Ag-mineralized volcanic rocks of hydrothermal origin usually have higher ΣREE than non-mineralized volcanic rocks of the same type. For example, the ΣREE content of mineralized rhyolite samples from the Shidamen volcanic depression is 624.8 ppm, that of mineralized mortar rhyolite samples from the Xiangshan volcanic depression is 2048.8 ppm, and that of mineralized breccia latite samples from the Xinjiang volcanic basin is 618.6 ppm. This suggests that REE, especially heavy REE, and ore-forming elements can be transported together in hydrothermal solutions.

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Fig. 1. Chondrite-normalized REE distribution patterns in volcanic rocks from the Shouchang volcanic basin (curve Nos. are the same as sample Nos. in Table 1; the same below).
1. Rhyolitic crystal vitric tuff; 2. rhyolitic crystal tuff; 3. ball rhyolite; 4. rhyolite; 5. U-mineralized rhyolite; 6. U-mineralized rhyolite; 7. dactic crystal tuff.

Fig. 2. Chondrite-normalized REE distribution patterns in volcanic rocks from the Shidamen and Shigaiwu volcanic depressions.