Evolution Sequences of Granitic Magma and Uranium Mineralization in the Nanling Region, China

LIU SHIXIAN (刘师先)
(Institute of Geological Sciences of Guangdong Province. Guangdong, 510080)

Abstract
Granites are widespread in the Nanling region of China, which were emplaced in different tectonic environments as a result of frequent and intense magmatic activity. Two evolution sequences have been distinguished: the extrusive-hypabyssal and plutonic-hypabyssal sequences. Different mechanisms governing the evolution, especially the differentiation, of the two sequences may account for the different mechanisms of uranium mineralization leading to the formation of various types of uranium deposits in the Nanling region.

As a result of frequent and intense granitic magmatic activity, granites were widely emplaced in the Nanling region of China, accounting for about 28.82% of the entire region, and the outcrop area tends to increase from 8.6% in the west to 66.67% in the east. The distribution of magmatic rocks is controlled by regional structures. The leading tectonic system in this region consists of latitudinal structures, along which the magmatic rocks are distributed, constitution nearly EW-striking granite belts; coming next are the SN-, NE- and NNE-trending magmatic rock belts. Differentiation-evolution, intrusion and effusion of magmas are associated with alternating activities of the latitudinal, longitudinal, Cathaysian and Neocathaysian systems, which is particularly noticeable in the coastal area along eastern Nanling region.

The evolution-differentiation of the magmas has resulted in abundant tungsten, tin, rare-earth element and other mineral resources. Uranium reserves in the Yenshanian granites and volcanic rocks of this region amount to more than 50% of the total uranium reserves in China. This kind of uranium deposits occupies an important position not only in China, but also in other parts of the world.

Characteristics of the Magmatic Evolution Sequences in the Nanling Region
Two magmatic evolution sequences are distinguished in terms of geological setting, tectonic stress field, mode of magmatic activity and petrology, i.e., the extrusive-hypabyssal sequence and the plutonic-hypabyssal sequence. In the former case magmatic extrusion took place in accompany with magmatic intrusion, with no difference in composition between the extrusive and the intrusive rocks; in the latter case magmatic intrusion played a leading role relative to volcanism. During the Calidonian to the Yenshanian, especially during the Yenshanian, more intensive and frequent magmatic activities were recorded over this region, resulting in the two magmatic evolution sequences.
Characteristics of the Two Magmatic Evolution Sequences of the Yenshanian Period

The plutonic-hypabyssal magmatic evolution sequence

It is developed in the middle and western parts of the Nanling region, but most completely and most intensively in the Jiufeng EW-trending sub-belt (the principal stress plane of the Nanling latitudinal structural system). This sequence possesses the following characteristics: a. It is dominated by intrusive rocks, especially granites. b. Intrusive activities can be divided into four stages including at least ten phases, which started with a strong impetus, and enhanced progressively until they reached the maximum, followed by a weakening trend, hence giving rise, in most cases, to composite rock bodies. c. From early to late, changes took place in environment of granite emplacement from plutonic and stable to shallow, ultra-shallow and instable. Meanwhile, the oxidation rate also tends to increase. Moreover, granite bodies also show changes in shape from batholith to stock, as well as in outcrop area from large to small. All these changes may be attributed to the transformation of geological setting from gigantic folds to deep large faults. d. The rocks exhibit porphyroid textures (Photo 1) and have experienced no rock facies transformation in the earlier phases, while in the later phases, fine-grained granitic texture and porphyritic texture (Photo 2) are commonly observed and rock facies transformation is noticeable. e. Magmatic differentiation is remarkable from early to late, with an increase in differentiation index (Table 1, Fig. 1) and a decrease in $\delta$ Eu value (Table 2). The magmatic evolution in the

![Diagram of magmatic rock assemblages of the Yenshanian plutonic-hypabyssal sequence ($\delta$ : Rittman index).](image)

last two stages came to the end with the complementary intrusion of lamprophyre dykes (Photo 3). With increasing crystallization -differentiation, the rocks evolved from intermediate acid through acid to ultra-acid in composition, and their $\text{SiO}_2$ and $\text{Na}_2\text{O}$ contents increased progressively against a decrease in $\text{K}_2\text{O}$, $\text{P}_2\text{O}_5$, and $\text{TiO}_2$ contents (Table 1). Moreover, the content of quartz increased in the order