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Magma Property, Evolution and Metallogenic Significance of Adakitic Alkali-Rich Porphyry from Machangqing in Western Yunnan, China

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1 Introduction

There is a large number of Cenozoic alkali-rich porphyry along Ailaoshan-Jinshajiang in Western Yunnan, an important part of which is alkali-rich porphyry from Machangqing. This article further discusses the magma property and magma evolution of this alkali-rich porphyry, and further proves the relationship between mineralization and magma evolution by the method of elements geochemistry.

2 Elements Geochemical Characteristics

There are a series of datas about alkali-rich porphyry from Machangqing, w (SiO_2) is 65.38%～71.63% , average value is 68.63%, Si is supersaturation; w (Al_2O_3) is 14.58%～15.80%, average value is 15.12%; Rittmann index is 2.3～5.4, average value is 3.36; w (K_2O) is 4.10% ～6.68%, average value is 5.14%; w (Na_2O) is 3.08%～4.93%, average value is 4.02%; w (Na_2O+K_2O) is 7.78% ～10.95%, average value is 9.16%; w (K_2O) / w (Na_2O) is 0.87～2.05, average value is 1.13; so the alkali-rich porphyry from Machangqing generally belongs to the high content of K-Ca alkalic series with the K-rich characteristic especially. w (MgO) is 0.6%～2.08%, average value is 1.19%; $Mg^{\#}$ is 0.40～0.76, average value is 0.62, which implies the existence of crust-mantle mixing; TFeO is 1.34%～3.29%, average value is 2.02%; $Mg^{\#}$ and TFeO both have wide ranges, which reflects that alkali-rich porphyry melt is mixed by alkali-rich magma and mantle fluid from enriched mantle, or the alkali-rich porphyry melt reacts with hot peridotite from the mantle wedge area, and these both can increase the content of $Mg^{\#}$ and TFeO dramatically. Liu et al. (2010) also think that endogenetic metallic deposits about alkali-rich porphyry in western Yunnan are related to mantle fluid. In general, the major elements of alkali-rich porphyry from Machangqing show the typical adakite characteristics, such as, the high content of Si, Na and Al, the low content of Mg, the high value of $Mg^{\#}$.

∑REE is 109.14×10^{-6}～ 211.43×10^{-6}, average value is 141.23×10^{-6} ; ∑LREE is 96.41×10^{-6} ～ 199.74×10^{-6}, average value is 130.63×10^{-6} ; ∑HREE is 5.07×10^{-6}～19.93×10^{-6}, average value is 10.59×10^{-6}; LREE /HREE is 6.33～29.52, average value is 15.04, LREE and HREE have strong differentiation, the distribution curves of REE are smooth to the right, which is one sign of the mantle fluid participating in the diagenesis and mineralization. δEu and δCe both show no or very weak negative anomaly. Especially, the characteristic of δEu shows that the magma migrates fast and doesn't experience distinct crystal separation in the process of crystallization and diagenesis. LILE are rich, but some HFSE are deficit. The distribution curves of trace elements are similar to the distribution curves of lower crust, which implies that alkali-rich porphyry from Machangqing is related to crustal magma. The distribution curves of trace elements are superposition mostly, which also implies that it may be the product of comagmatic region. However, some elements' contents have big difference and show the nonuniformity, which implyies that the magma has its complexity in composition and origin.

3 Magma Property, Evolution and Metallogenic Significance

Tu et al. (1986) puts forward the concept of alkali-rich intrusive rock including alkali rock and alkali granite, the intrusive rock is alkali-rich (w (Na_2O) + w (K_2O))>8%), and has the essence characteristic of alteration and

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metasomatism by mantle fluid. According to this, alkali-rich porphyry from Machangqing belongs to the alkali granite, and it must be metasomatic and mixed by alkali-rich magma and mantle fluid from enriched mantle in the process of magma evolution.

In chart of *w* (La / Sm) - *w* (La) and *w* (La / Yb) - *w* (La), the distribution of sample points have linear positive correlation generally, showing strong molten causing, and magma evolution doesn't experience significant crystal separation, which is consistent with the δEu and δCe both showing no or very weak negative anomaly. If granitic magma from thickened lower crust melting experience plagioclase crystal separation, it will form the strong negative anomaly of δEu, however, no or very weak negative anomaly implies that it doesn't directly originate from granitic magma, but from the alkali-rich granitic mixing melt including alkali-rich magma, mantle fluid and granitic magma. Because granitic magma migrates fast after being mixed by alkali-rich magma and mantle fluid, the granitic magma experiences mantle fluid metasomatism without distinct crystal separation in the process of crystallization and diagenesis, which leads to the granite with the characteristics of K-rich, LREE-rich, no or very weak negative anomaly of δEu. Alkali-rich porphyry from Machangqing enrichs LILE which have the characteristic of crust source, also enrichs some transition metal elements which have the characteristic of mantle source. Especially, Cr and Ni have wide range, which shows the nonuniformity of some elements' content and the magma source components. High contents of Cr and Ni show that the melt from thickened crust melting mixes with the alkali-rich magma from enriched mantle, which also implys that the mantle fluid participates in the magma evolution. In chart of (La/Yb)- δEu, sample points fall into the crust-mantle contamination area, which further proves that alkali-rich porphyry from Machangqing experiences crust-mantle mixing in the process of magma evolution.

The underplating of mantle-derived magma and mantle fluid provides not only hot rising power but also Mo, Cu, Au, other ore-forming elements and ore-forming fluid. The underplating initiates the thickened low crust remelting and forming the alkali-rich granitic mixing melt. With the interaction of mantle-derived magma and mantle fluid, the alkali-rich granitic mixing melt carrys and activates metallogenic material to mineralization space.

4 Conclusion

The alkali-rich porphyry from Machangqing has many characteristics, such as, high content of Si, Na and Al, low content of Mg, the high value of $Mg^{\#}$; LILE and LREE are rich, the value of La/Yb is high, δEu and δCe both show no or very weak negative anomaly, which all show the geochemical characteristics of typical adakite. However, some elements have wide ranges and show the nonuniformity, the content of K is higher, which are all different from the geochemical characteristics of typical adakite. Moreover, LILE and some transition metal elements are rich, which also implies the existence of crust-mantle mixing. The alkali-rich porphyry from Machangqing derives from alkali-rich granitic mixing melt; mantle fluid and alkali-rich magma from enriched mantle participate in the magma evolution, the metasomatism and alteration are the key factors in promoting the alkali-rich porphyry from Machangqing mineralization.

Ackonwledgenments

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Key words: alkali-rich porphyry from Machangqing, elements geochemistry, Adakite, magma evolution and mixing, metallogenic significance