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鄂东南地区阮家湾和犀牛山花岗闪长岩的时代、成因及成矿和找矿意义

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## 摘要:

阮家湾花岗闪长岩和犀牛山花岗闪长斑岩位于鄂东南矿集区东南缘,前者产有鄂东南地区最大的矽卡岩型钨-铜-钼矿床,而后者迄今仅发现有斑岩型铜矿化点。本文对阮家湾花岗闪长岩和犀牛山花岗闪长斑岩开展了系统的锆石U-Pb年代学、元素地球化学和Sr-Nd-Hf同位素组成的研究,以深入讨论这些岩体的岩石成因及其成矿和找矿意义。锆石U-Pb定年结果表明,阮家湾花岗闪长岩和犀牛山花岗闪长斑岩的侵位年龄分别为 $143 \pm 1\text{Ma}$ 和 $147 \pm 1\text{Ma}(1\sigma)$ ,是鄂东南地区最老的含钨-铜-钼矿化侵入岩。阮家湾花岗闪长岩和犀牛山花岗闪长斑岩均为高钾钙碱性岩体,富集Rb、Ba、Th和La等大离子亲石元素,亏损Nb、Ta和Zr等高场强元素。岩石具有Sr含量高(分别为 $681 \times 10^{-6} \sim 874 \times 10^{-6}$ 和 $575 \times 10^{-6} \sim 687 \times 10^{-6}$ )、Y含量低(分别为 $12.0 \times 10^{-6} \sim 17.4 \times 10^{-6}$ 和 $9.7 \times 10^{-6} \sim 14.0 \times 10^{-6}$ )、Sr/Y比值大(分别为39~61和47~62)、轻重稀土分馏强烈(Yb含量分别为 $0.90 \times 10^{-6} \sim 1.49 \times 10^{-6}$ 和 $0.62 \times 10^{-6} \sim 1.01 \times 10^{-6}$ ; La/Yb比值分别为42~54和48~60)等特点。全岩Sr-Nd同位素分析和锆石Hf同位素分析结果表明,阮家湾花岗闪长岩的 $(^{87}\text{Sr}/^{86}\text{Sr})_i$ 为0.7062~0.7063,  $\epsilon_{\text{Nd}}(t)$ 为-5.8~-6.2,  $\epsilon_{\text{Hf}}(t)$ 为-12.0~-6.8; 犀牛山花岗闪长斑岩的 $(^{87}\text{Sr}/^{86}\text{Sr})_i$ 为0.7065,  $\epsilon_{\text{Nd}}(t)$ 为-5.6~-6.5。元素和同位素地球化学特征表明,阮家湾花岗闪长岩和犀牛山花岗闪长斑岩是由富集地幔部分熔融形成的岩浆同化混染下地壳物质并发生分离结晶作用的产物。矿物组合及矿物化学组成表明,阮家湾钨铜钼矿床的含矿岩体具有更低的氧逸度和更多的地壳物质混染,而犀牛山花岗闪长斑岩则具有较高的氧逸度(以出现岩浆硬石膏为标志)。另外,犀牛山岩体中挥发份的含量与鄂东南地区最大的斑岩-矽卡岩型铜矿——铜山口矿床的含矿岩体类似,表明有利于斑岩型铜矿床的形成。犀牛山岩体内部斑岩型铜矿点和铁帽发育,进一步说明犀牛山岩体具有较大的斑岩型铜矿床找矿潜力,在今后的找矿工作中应给予关注。

## 英文摘要:

The Ruanjiawan granodiorite pluton and Xiniushan granodiorite porphyry are located in the southeastern edge of the SE Hubei Fe-Cu-Au district. The Ruanjiawan granodiorite host the largest skarn W-Cu-Mo deposit in the SE Hubei district, whereas the Xiniushan granodiorite porphyry only contains some porphyry Cu spots. In this paper, we present U-Pb age, geochemical, and Sr-Nd-Hf isotopic data to provide, for the first time, constraints on the age and petrogenesis of the Ruanjiawan and Xiniushan intrusions and discuss their potential forming porphyry Cu deposits. LA-ICP-MS zircon U-Pb dating results indicate that the Ruanjiawan granodiorite pluton and Xiniushan granodiorite porphyry were emplaced at  $143 \pm 1\text{Ma}(1\sigma)$  and  $147 \pm 1\text{Ma}(1\sigma)$ , respectively, being the oldest intrusions associated with W-Mo-Cu mineralization in the SE Hubei district. Whole-rock samples from both intrusions are high-K calc-alkaline and metaluminous, enriched in large ion lithophile elements (e.g. Rb, Ba, Th and La), depleted in high field strength elements (e.g. Nb, Ta, Zr and Ti), and characterized by strong fractionation between LREE and HREE without obvious Eu anomalies. Both the Ruanjiawan and Xiniushan intrusions have geochemical features typical of adakites, such as high Sr ( $681 \times 10^{-6} \sim 874 \times 10^{-6}$  and  $575 \times 10^{-6} \sim 687 \times 10^{-6}$ ), low Y ( $12.0 \times 10^{-6} \sim 17.4 \times 10^{-6}$  and  $9.7 \times 10^{-6} \sim 14.0 \times 10^{-6}$ ), high Sr/Y ratios (39~61 and 47~62), and low Yb ( $0.90 \times 10^{-6} \sim 1.49 \times 10^{-6}$  and  $0.62 \times 10^{-6} \sim 1.01 \times 10^{-6}$ ) and high La/Yb ratios (42~54 and 48~60). They have relatively homogeneous whole-rock Sr-Nd and zircon Hf isotopic compositions. The Ruanjiawan intrusion has  $(^{87}\text{Sr}/^{86}\text{Sr})_i = 0.7062$  to  $0.7063$ ,  $\epsilon_{\text{Nd}}(t) = -5.8 \sim -6.2$ , and  $\epsilon_{\text{Hf}}(t) = -12.0 \sim -6.8$ , whereas the Xiniushan granodioritic porphyry is characterized by  $(^{87}\text{Sr}/^{86}\text{Sr})_i = 0.7065$  and  $\epsilon_{\text{Nd}}(t) = -5.6 \sim -6.5$ . Geochemical and Nd-Sr-Hf isotopic data indicate that these granodiorites were derived from partial melts of an enriched mantle source that experienced variable degree of fractional crystallization and contamination of lower crust materials during magma ascent. Compared to the Tongshankou granodioritic porphyry that contains the largest porphyry-skarn Cu-Mo deposits in the SE Hubei district, magmas forming the Ruanjiawan granodiorite have lower  $f_{\text{O}_2}$  and subjected to more significant crustal contamination. Such differences between the Ruanjiawan and Tongshankou granodiorite may explain the distinct mineralization therein. In contrast, the Xiniushan granodioritic porphyry has relative high  $f_{\text{O}_2}$  similar to that of the Tongshankou granodiorite porphyry. The presence of magmatic anhydrite in the Xiniushan granodioritic porphyry indicate oxygen fugacity

y at  $\log f_{O_2} > \text{FMQ} + 2.5$ , typical of numerous large-sized porphyry Cu deposits worldwide. The high oxygen fugacity, high contents of volatile component, and the occurrence of porphyry Cu spots in the Xiniushan granodiorite porphyry suggest great potential finding porphyry-type deposits in the intrusion.

关键词: [埃达克岩](#) [Sr-Nd-Hf同位素](#) [岩浆氧逸度](#) [斑岩型铜矿](#) [鄂东南矿集区](#)

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