

Research Advances

Petrogenesis and Tectonic Significance of the Xiuwacu Two-Period Magmatism in Geza Arc of Yunnan Province: Constraints from Lithogeochemistry, Zircon U-Pb Geochronology and Hf isotopic Compositions

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Objective

The Late Cretaceous Xiuwacu ore-bearing porphyry is located in the Geza area of southern Yidun arc, SW China. In this area, the rock mass is mainly composed of three lithofacies: biotite granite porphyry, monzonitic granite and light alkali feldspar granite. As a part of the Yidun arc, the Geza arc has common structure and temporal-spatial evolution with the Yidun arc, which has experienced three stages of oceanic crust subduction, collision orogeny and intracontinent convergence stages. The molybdenite ores in the area are mainly hosted in monzonitic granite-porphyry and structural fracture zone, and the ore bodies are strictly controlled by faults. In recent years, great geological prospecting results have been achieved in Xiuwacu, and the deposit has reached a medium scale. However, there are few researches on the metallogenic porphyry. Based on the previous research, we determined the rock-forming and ore-forming age of the porphyry, and found that there were two stages of magmatism intrusion in Xiuwacu: Indosinian and Yanshanian. We also discussed the geochemical characteristics and source area of the rocks in the area.

Methods

U-Pb dating of single grain zircons was performed using the LA-ICP-MS dating technique. In situ analysis of zircon Lu-Hf isotopes was performed using laser ablation system. We obtained the composition of Hf isotope and discussed the source area of magma.

Results

The zircon LA-ICP-MS dating shows that the zircon grains have good euhedral degree and regular rhythm, indicative of a typical magmatic origin. The formation age of the granodiorite porphyry was 202 ± 3.5 Ma (MSWD=1.19), and the zircon $\varepsilon_{\text{Hf}}(t)$ values range from -2.87% to 4.12% (0.09% on average), with corresponding two-stage model ages ranging from 541 to 828 Ma and 719 to 1109 Ma. The $^{176}\text{Yb}/^{177}\text{Hf}$ values range from 0.021 to 0.081 (0.047 on average), and the $^{176}\text{Lu}/^{177}\text{Hf}$ values range from 0.0009 to 0.0028 (0.0017 on average). The granodiorite porphyry $\varepsilon_{\text{Hf}}(t)$ values range from positive to negative, with a wide range, and the ratio of $^{176}\text{Yb}/^{177}\text{Hf}$ is low (<1.2). It indicates that in addition to crustal material, there is also mixed mantle material. This provides evidence for the interaction of crust and mantle components. The formation age of the monzonitic granite-porphyry was 83.3 ± 1.7 Ma (MSWD=2.6), and the zircon $\varepsilon_{\text{Hf}}(t)$ values range from -7.96% to -2.75% (-5.54% on average), with corresponding two-stage model ages ranging from 820 to 1019 Ma and 1102 to 1391 Ma. The $^{176}\text{Yb}/^{177}\text{Hf}$ values range from 0.022 to 0.087 (averaging 0.05), and the $^{176}\text{Lu}/^{177}\text{Hf}$ values range from 0.0008 to 0.0031 (averaging 0.0018). The monzonitic granite-porphyry $\varepsilon_{\text{Hf}}(t)$ is less than zero, indicating that the rock was formed by partial melting of the crust. The ratio of $^{176}\text{Lu}/^{177}\text{Hf}$ basically represents the initial Hf isotopic composition, and the ratio of $^{176}\text{Lu}/^{177}\text{Hf}$ is low (<0.002), suggesting that the zircons have low radiogenic Hf accumulation (Fig. 1). The rock has experienced two stages, and the age of the two stage Hf model, which is calculated by the standard of the earth's crust, has a large gap with the age of the rock mass. It is shown that oceanic crust subduction to the west occurred in the late Indosinian. First, the partial melting of the ancient crust mixed with the mantle source material to form the original

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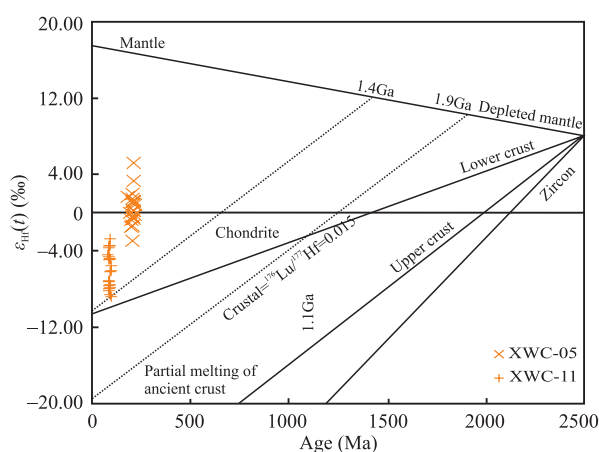


Fig. 1. $\varepsilon_{\text{Hf}}(t)$ - t diagram of the Xiuwacu ore-bearing porphyry in the Geza arc.

magma in the source area. Then, the mixed magma of the crust and mantle has experienced multiple stages of differentiation and evolution, and the rock bonded and formed the Xiuwacu granite porphyry in the late Indosinian. Later the Indosinian subduction gradually reduced and it got into the stage of collision orogeny in Yanshanian. Thickening of the crust and the upwelling of the asthenosphere resulted in the partial melting of the thickened continental crust, and the rock bonded and formed the monzonitic granite-porphyry of Xiuwacu in the late Yanshanian, and formed W-Mo mineralization.

Conclusion

The formation age of the Xiuwacu granodiorite porphyry was 202 ± 3.5 Ma (MSWD=1.19), which was formed in the late Indosinian oceanic crust subduction orogenic environment. The ore-forming materials are mainly derived from a mixing source of the crust and mantle. The formation age of the Xiuwacu monzonitic granite-porphyry was 83.3 ± 1.7 Ma (MSWD=2.6), which was formed in the late Yanshanian collisional orogenic environment. The ore-forming materials mainly come from the crustal source magma. In the area, from subduction of oceanic crust in Indosinian to continent collision orogenic process in Yanshanian, tectonic-magmatic mineralization occurred, which indicates that there is continuity and inheritance of the magmatic tectonic activity.

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