

Research Advances

A New Potential Caledonian–Indosinian Ore Concentration Area: Evidence from Diagenesis and Mineralization Ages of the Miao'ershan–Yuechengling Region

ZHANG Wenlan^{1,*}, CHE Xudong¹, CHEN Wendi¹, WANG Rucheng¹ and ZHANG Di²

¹ State Key Laboratory for Mineral Deposits Research, School of Earth Sciences and Engineering, Nanjing University, Nanjing 210023, Jiangsu, China

² Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

Objective

The Miao'ershan–Yuechengling composite granite, located in northern Guangxi at the western section of the Nanling Range, is a multi-period and multi-stage composite pluton with an exposed area of more than 3000 km² (Fig. 1). Paleozoic and Proterozoic strata are exposed around it, and magmatic activities mainly occurred during the Caledonian and Indosinian periods. Till now, more than one hundred W-Sn-Mo-Pb-Zn-Cu (U) deposits and ore occurrences have been discovered along the inner and outer contact zones of this granite. Through recent years' research, we infer that this area is not only a preferred area for studying granite and mineralization in Caledonian and Indosinian periods, but also a potential Caledonian–Indosinian ore-concentrated area.

Methods

The ages of the granite emplacement related to the mineralization were obtained by the zircon U-Pb dating method with LA-ICP-MS. The ages of mineralization were obtained by Sm-Nd isotopic dating of scheelite, Ar-Ar dating of mica during mineralization phase, U-Pb dating of titanite in the ore samples, and Re-Os isotopic dating of molybdenite.

Results

Caledonian period: The large Niutangjie skarn-type scheelite deposit consists of A ledge and B ledge. The ages of the fine-grained two-mica granite in the A ledge yielded 421.8±2.4 Ma and 410±4.9 Ma, and the age of the coarse-grained biotite granite in B ledge is 411Ma. The ore-forming age of the Niutangjie deposit is 421±24 Ma by the scheelite Sm-Nd isotopic dating. These results

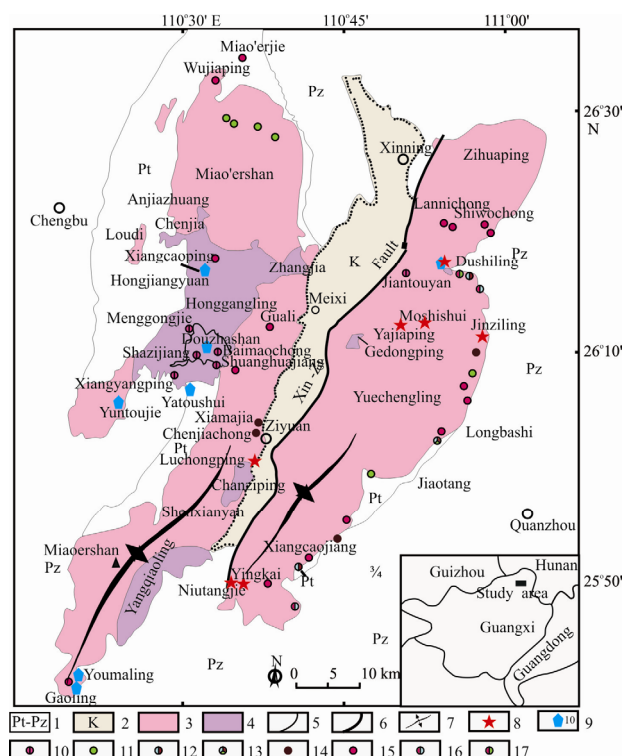


Fig. 1. Geological map of the Miao'ershan-Yuechengling area (modified from Guangxi Regional Geological Survey, 1964; Shi et al., 2010).

1, Proterozoic-Paleozoic; 2, Cretaceous; 3, Caledonian granite; 4, Indosinian granite; 5, Stratigraphic boundary; 6, Fault; 7, Anticline; 8, Caledonian deposit; 9, Indosinian deposit; 10, Uranium deposit; 11, Copper deposit; 12, Pb-Zn deposit; 13, Polymetallic deposit; 14, Sn deposit; 15, W deposit; 16, W-Mo deposit; 17, W-Cu deposit.

indicate that both the diagenesis and mineralization in the Niutangjie deposit occurred in the Caledonian period (Yang et al., 2014).

The Luchongping deposit is a quartz vein- and greisen-type W-Sn-Cu deposit. The parent rock is fine-grained biotite granite, and its diagenetic age is 401.6±6.3 Ma. The Re-Os isotopic dating of molybdenite from the ore sample got a model age of 389.8–437.3 Ma ($n=11$). Since the data points are concentrated, the ideal isochron age could not

* Corresponding author. E-mail: zhangwl@nju.edu.cn

be obtained, and the model age with 11 points should be the ore-forming age. Therefore, the W-Sn-Cu mineralization in the Luchongping deposit occurred during the Caledonian period.

The Dushiling deposit is a large-scale altered rock- and skarn-type W-Cu polymetallic deposit, which is located at the junction of the eastern Yuechengling granite and the Pz surrounding rock. The mineralization was occurred during both the Caledonian and Indosinian periods. The Caledonian ore-forming parent rocks have two types: medium-grained porphyritic biotite granite and medium- to fine-grained biotite granite, whose diagenetic ages are (422.9 ± 2.1) Ma– (423.2 ± 2.4) Ma and (420.9 ± 2.3) Ma– (421.5 ± 2.5) Ma, respectively. The mineralization age obtained from the Sm-Nd dating of scheelite is 417 ± 35 Ma, and the U-Pb dating of hydrothermal titanite yielded an age of 423–425 Ma. However, the Indosinian metallogenic parent rock is medium-grained biotite granite with ages of (217.2 ± 1.1) Ma– (217.5 ± 1.3) Ma. The Indosinian mineralization age is 218 ± 8 Ma, which was also obtained by the U-Pb dating of the hydrothermal titanite samples (Chen Wendi et al., 2016).

In addition, the diagenetic ages of other four tungsten deposits in the Yuechengling area were obtained as follows. The diagenetic age of the Yanjiaping mineralized granite with veinlet-disseminated scheelite is 426.6 Ma. The metallogenic parent rock of Moshishui, a veinlet-disseminated scheelite deposit, is fine-grained biotite granite, and the diagenetic age is (390.6 ± 2.7) Ma– (401 ± 2.6) Ma. The parent rock of the Yingkai skarn-type tungsten deposit is fine-grained two-mica granite, with a diagenetic age of 481 ± 11 Ma. The parent rock of the Jinziling quartz vein- and crushed zone-type W-Pb-Zn deposit, is medium-grained biotite granite, with a diagenetic age of 447 ± 6.8 Ma.

Indosinian period: The Gaoling quartz vein-type scheelite and wolframite deposit is located at the southernmost of the Miao'ershan area. The mineralization parent rocks are a porphyritic two-mica granite and a two-mica granite, and the diagenetic ages are 224.9 Ma and 220.2 Ma, respectively. The mineralization age of the Gaoling deposit is obtained by the Sm-Nd isotopic dating of scheelite and ^{40}Ar - ^{39}Ar dating of mica. The Sm-Nd isochron age of scheelite is 212 ± 20 Ma. The mica from the GL-4 sample yielded a ^{40}Ar - ^{39}Ar plateau age of 197.8 ± 2.4 Ma and an isochron age of 199.5 ± 2.4 Ma, while the mica from the GL-5 sample yielded a ^{40}Ar - ^{39}Ar plateau age of 200.1 ± 2 Ma and an isochron age of 200.3 Ma (Zhang et al., 2015).

The large Yuntoujie W-Mo deposit is a veined, disseminated, and greisen-type deposit, located on the west side of the Miao'ershan area. There are two kinds of granites related to the mineralization: early medium-grained porphyritic biotite granite with an age of 243.0 ± 5.8 Ma, and late muscovite monzonitic granite with an age of 216.8 ± 4.9 Ma. The Re-Os dating of molybdenite yielded a metallogenic age of 216.8 ± 7.5 Ma (Wu Jing et al., 2012).

The Yatoushui quartz vein- and skarn-type tungsten deposit is located in the middle part of the Miao'ershan area. The mineralization parent rock is fine-grained biotite granite with a zircon U-Pb age of 219.9 Ma. The mineralization age of the deposit is obtained by the ^{40}Ar - ^{39}Ar dating of mica. The ^{40}Ar - ^{39}Ar plateau age is 199.7 ± 4.2 Ma and the isochron age is 206.7 ± 3.8 Ma.

Therefore, the diagenesis and mineralization ages of the Gaoling, Yuntoujie and Yatoushui deposits are consistent, both belonging to the Indosinian mineralization.

The Youmaling skarn-type tungsten deposit is located in the southernmost Miao'ershan area, which belongs to the same mining area as the Gaoling tungsten deposit, but the types of the two deposits are different. The mineralization parent rock of Youmaling is a medium- to fine-grained two-mica granite with an age of 212–215 Ma (Yang Zhen et al., 2013).

Conclusions

(1) The diagenesis and mineralization ages of the 11 deposits indicate that strong magmatism and mineralization occurred in the Miao'ershan–Yuechengling area during the Caledonian and Indosinian periods. Thus, this zone is regarded as a potential Caledonian–Indosinian ore-concentrated area in the western part of the Nanling Range.

(2) There are obvious differences of magmatism and mineralization between the western Miao'ershan and the eastern Yuechengling area. The magmatism and mineralization in the eastern Yuechengling area mainly occurred in Caledonian and then Indosinian period. Although the Caledonian magmatism also occurred in the western Miao'ershan area, the Indosinian magmatism and mineralization in this area are obviously stronger than those in the eastern Yuechengling area.

Acknowledgments

This research was supported by the National Natural Science Foundation of China (grants No. 41572058 and 41672065).