Re-Os Dating of Pyrite From the Taocun Fe Deposit, Ningwu Basin, Lower Yangtze River Valley, Eastern China

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1 Introduction

The Ningwu basin is one of the largest ore concentrations in the middle-lower Yangtze River Valley, eastern China. The Taocun iron deposit, located in the central part of the Ningwu basin, is closely associated with volcanic and subvolcanic rocks both in time and space (Ningwu Research Group, 1978). Alteration zoning of the deposit is evident, and including an upper light zone of kaolinite, silica, carbonate and pyritic alteration, a middle dark zone of diopside, garnet, fluorapatite–magnetite and a lower light zone of albitic alteration (Ningwu Research Group, 1978; Yu et al. 2011). The geology and mineralization of the Taocun deposit has been extensively described and studied (Institute of Geochemistry, Chinese Academy of Sciences, 1987; Zhai et al., 1992).

However, precise geochronological constraints of this ore district are relatively rare. The ore-related diorite porphyry has a LA-ICP-MS U-Pb zircon age of 130.7 ± 1.8 Ma (Fan et al., 2010). Yu and Mao (2002) reported a ⁴⁰Ar-³⁹Ar isochron age of 124.9 ± 0.3 Ma for albite from the iron ore. Due to the limitation of the analytical method and low closure temperature of the ⁴⁰Ar-³⁹Ar system, this dating result is younger than the emplacement age of the diorite porphyry. Rhenium and osmium are relatively immobile siderophile and chalcophile elements enriched in sulfide minerals, such as molybdenite and pyrite (Fleet and Stone, 1991). In this study, ten pyrite samples from the Taocun Fe deposit were chosen for Re–Os isotope analysis in order to constrain the timing of mineralization and to discuss the genetic relationship between magmatism and mineralization.

2 Deposit Geology

The exposed rocks at the Taocun deposit are mainly andesitic tuff, andesite and tuff breccia of the Cretaceous Dawangshan cycle volcanic rocks. The iron ores are mostly related with diorite porphyries that intrude volcanic rocks of the Cretaceous Dawangshan cycle.

This iron deposit mainly consists of 8 ore bodies adjoining the apical zones of the related diorite intrusion. The mineralization zone is approximately 1600 m long, 500–800 m wide and 30–50 m thick.

Mineralization zone mainly comprises medium- and coarse-grained magnetite disseminated in epidotized albite rock, and fine-grained magnetite disseminated in albitized diorite porphyry. Ore minerals in this deposit are mainly vanadium-bearing magnetite, with minor amounts of pyrite, hematite, siderite and limonite. The gangue minerals are dominantly albite and plagioclase, with trace amounts of apatite. The Taocun deposit contains 219 Mt Fe ores with an average grade of 22.38 wt.% (up to 44.92 wt.%).

3 Sampling and Analytical Methods

All the ten samples of pyrite were collected from the drill hole TC01 in the Taocun deposit. The pyrites is present as disseminations or massive accumulations coexisting with magnetite, hematite, siderite and plagioclase.

Pyrite Re-Os isotope analysis was carried out at State Key Lab of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang. The detailed analytical method was described by Qi et al. (2010). The decay constant of ¹⁸⁷Re of 1.666×10⁻¹¹ y⁻¹ used in this study has an absolute uncertainty of ± 0.017.

4 Results and Discussion

The total Re and Os concentrations of pyrite range from 1.13 to 10.47 ppm and 1.58 to 11.92 ppm, respectively. Model ages for individual analyses range from 125.6 ± 5.1
to 148.4 ± 1.7 Ma (1σ). A regression analysis was applied to ten analytical data of pyrite, yielding an isochron age of 128.7 ± 6.4 Ma (1σ) with an initial \(^{187}\text{Os} / ^{188}\text{Os}\) of 0.00016 ± 0.00021, and mean square weighted deviation (MSWD) of 0.83 (Fig. 1).

The isochron age (128.7 Ma) is within uncertainty in agreement with a previously reported U-Pb age (130.7 ± 1.8 Ma) of the hosting diorite porphyry, indicating coeval magmatism and mineralization.

The time of ore-forming and magmatic activity in the middle and lower Yangtze River Valley metallogenic belt were concentrated in three periods: 145-136, 135-127 and 126-120 Ma, which respectively correspond to the skarn-prphyry Cu-Au mineralization in the uplift area, the Fe mineralization in depression area as represented by the Ningwu basin, and the Au-U mineralization related to A-type granite (Zhou et al. 2008a; Zhou et al. 2008b). Combined with the zircon U-Pb age (130.7 Ma) of the related intrusion, the Re-Os age (128.7 Ma) of pyrite indicates that the Taocun Fe deposit was formed in the second metallogenic period.

5 Conclusions

In this work we report precise isochron age of 128.7 ± 6.4 Ma by Re-Os dating of pyrite in the Taocun Fe deposit. The Re-Os age is well consistent with the previously reported U-Pb age (130.7 ± 1.8 Ma) of the ore-related diorite porphyry, suggesting a genetic relationship between magmatism and mineralization.

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References


