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Re–Os Isotopic Dating of the Molybdenite from the Tongshan Porphyry Cu–Mo Deposit in Heilongjiang Province, NE China

HAO Yujie¹, REN Yunsheng^{1*}, DUAN Mingxin¹, TONG Kuangyin², CHEN Cong¹ and LI Chao³

¹ College of Earth Sciences, Jilin University, Changchun 130061, China

² Heilongjiang Heilong Mining Group Co., Ltd, Harbin 150090, China

³ Re–Os Laboratory of National Research Center of Geoanalysis, Chinese Academy of Geological Sciences, Beijing 100037, China

The Tongshan porphyry Cu–Mo deposit is located in the northeast segment of the Xing'an–Mongolia Orogenic Belt, and the west of the Hegenshan–Heihe fault which is the boundary of the Xing'an Block and the Songnen Block. It represents the typical Early Paleozoic porphyry Cu–Mo mineralization (Zhao et al., 1997; Liu et al., 2010; Zeng et al., 2014) and provides good examples for the scientific research on such type of ore deposits in NE China.

1 Geological characteristics and Ore Genesis of the Tongshan Deposit

Strata outcropped in Tongshan area is mainly composed of the Middle Ordovician Tongshan Fm. and Duobaoshan Fm. The Ordovician granodiorite intrusions spread widely. The NW–trending reversed S-shaped structures control the occurrence of alteration and mineralization. Four ore bodies have been identified in the deposit. No. III ore body, also in the footwall of the Tongshan fault, is the largest and the major ore body in the area, with 1140 m in length, more than 800 m along the dip. Metallic minerals account for 3–7% of the minerals in the ore, primarily pyrite and chalcopyrite, with some molybdenite, bornite, galena, sphalerite, etc.. Wall–rock alteration is well developed in the Tongshan deposit, and from southwest to northeast are successively potassium–silicification zone, sericite–silicification zone and propylitization zone. The data mentioned in this paper and previous studies (Zhao et al., 1997, 2011; Wu et al., 2009) demonstrate that the Tongshan is a porphyry Cu–Mo deposit.

2 Molybdenite Re–Os Isotopic Analysis

Six molybdenite samples were selected for the Re–Os isotopic analysis, which were collected from open pit in the Tongshan area. Re–Os isotopic analysis was conducted at the Re–Os Laboratory of National Research Center of Geoanalysis, Chinese Academy of Geological Science.

The $w(^{187}\text{Re})$ contents in six samples from the Tongshan deposit range from 97.291 ppm to 1037.591 ppm, and $w(^{187}\text{Os})$ from 0.7697 to 8247 ppm. The contents of ^{187}Re and ^{187}Os change concordantly. The modal ages range from 471.3 ± 7.5 Ma to 475.2 ± 7.6 Ma; the weighted average age is 472.4 ± 2.9 Ma (MSWD = 0.17) and the isochron age is 473 ± 4 Ma (MSWD = 0.28) (Fig.1). The weighted average age (472.4 ± 2.9 Ma) can

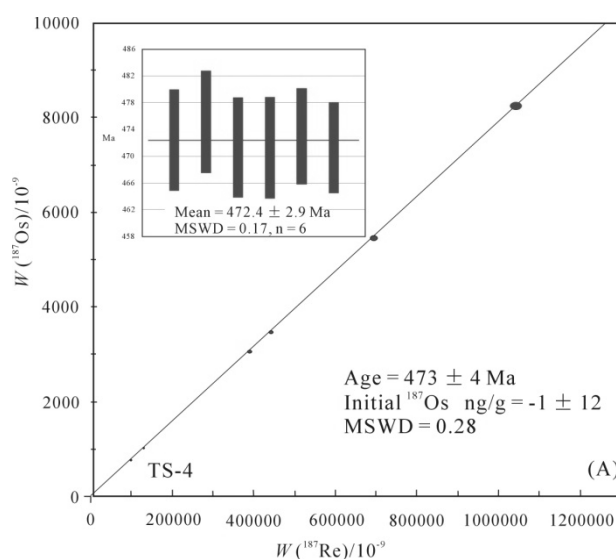


Fig. 1. Weighted mean age and isochron Re–Os ages of molybdenites from the Tongshan deposit.

* Corresponding author. E-mail: renys@jlu.edu.cn

represent the age of porphyry copper molybdenum mineralization in the Tongshan deposit, suggesting the deposit was formed during the Ordovician period.

3 Discussions

There are two popular view points about the age of the Tongshan porphyry Cu–Mo deposit. Most researchers believe that the Tongshan deposit has the same age with the Duobaoshan deposit, due to their similarities in ore-forming conditions, geological characteristics and ore genesis (Zhao et al., 1997, 2011; Chen et al., 2012). However, some prefer to regard Tongshan as a Jurassic deposit (Liu et al., 2011) in consideration of lacking of geochronology data. This paper reported the weighted average age of the molybdenite in the Tongshan deposit, 472.4 ± 2.9 Ma, and the Re–Os isochron age, 473 ± 4 Ma. Basically, the isotopic dating results in this paper match the modal weighted average age of the molybdenite in the Tongshan deposit, 476.6 ± 6.9 Ma (Zeng et al., 2014), and proves that the Ordovician granodiorite is the metallogenic intrusion and that the Tongshan and Duobaoshan porphyry Cu–Mo deposits formed in the Ordovician period.

Controversy always exists on the source of ore-forming elements and the tectonic setting of the Tongshan deposits. Recent studies have proved that the Re–Os isotope composition in the molybdenite is not only reliable in the dating of metal deposits but also in the determination of the source of ore-forming elements. It is generally recognized that, from the mantle, mixing of mantle and crust, to crust, Re content in molybdenite would decrease exponentially from $n \times 10^{-4}$, $n \times 10^{-5}$ to $n \times 10^{-6}$ accordingly (Mao et al., 1999). Re contents in the six samples from the Tongshan Cu–Mo deposit range between 1.55×10^{-4} and 16.51×10^{-4} , indicating a possible mantle origin, which is corresponding with most of researchers' (Zeng et al., 2014).

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