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Geochemical Characteristics and Genesis of Pyrite from the Dongguashan Cu-Au Deposit, Anhui Province, China

ZHANG Jiandong, SHAO Yongjun and LIU Zhongfa

Key Laboratory of Metallogenic Prediction of Nonferrous Metals, Ministry of Education, School of Geosciences and Informatophysics, Central South University, Changsha 410083, China

1 Introduction

The Dongguashan Cu-Au deposit with more than 98 Mt @ 1.01% Cu reserve is located in the Shizishan ore field, Tongling district, Yangtze metallogenic belt, eastern China. The genesis of this deposit remains controversial so far (Mao et al., 2011). A major reason is the lack of a method to test the geochemical significances and genesis of pyrite which can provide useful information for understanding the physicochemical condition and genesis of deposit (Zheng et al., 2013). LA-ICP-MS has been proven to be a powerful tool for defining pyrite occurrence and ore-forming process (Cook et al., 2009; Thomas et al., 2011; Zheng et al., 2013). Our research focus on the data obtained by the LA-ICP-MS and discusses the genesis of the Dongguashan deposit.

2 Geologic Setting

The Shizishan ore field, occurring in the central part of the Tongling district, is located at the intersection of the E-W trending Tongling-Shatanjiao tectonic-magmatic belt and the NE-SW trending Qingshan anticline. The strata is dominated by Middle to Lower Triassic limestones, banded limestones, argillaceous limestones, and argillites underlain by Upper Devonian and Middle to Upper Carboniferous and Permian sandstones, sandy shales, shales, and limestones. The major magmatic rock related to the mineralization is the Qingshanjiao quartz diorite intrusion with SHRIMP zircon U-Pb age of 138.8 ± 1.6 Ma (Yang et al., 2011). There are more than 10 ore deposits having been discovered. Copper-dominated deposits including the East Shizishan and Hucun Cu deposits; the West Shizishan, Datuanshan, Huashupo, and Dongguashan Cu-(Au) deposits; and the Laoyaling Cu-(Mo) deposit are controlled by NNE-SSW, NE-SW, and

E-W trending structures, and are stratiform or lensoidal.

The Dongguashan Cu-Au deposit is the deepest (below -730 m). All the orebodies are stratiform and strictly bounded in the carbonates of Middle to Upper Carboniferous and above the sandstone of Upper Devonian, and controlled by the Qingshan anticline and the Qingshanjiao intrusion. Ore minerals are mainly pyrite, pyrrhotite, chalcopyrite and magnetite, with minor galena, sphalerite, tetrahedrite. A gangue assemblage is dominated by garnet, diopside, quartz, calcite, and chlorite. Hydrothermal alteration associated with hosting rocks of orebody is dominated by skarnification, silicification, sericitization, chloritization, epidotization and serpentinization.

3 Pyrite types

In the Dongguashan Cu-Au deposit, the pyrites are widely developed and very complex. According to their composition, texture and distribution positively associated with the diorite intrusion, the major pyrites can be classified into 3 types. ① porphyry pyrite (Py1): pyrite occurring as veinlets and disseminated grains in diorite; ② skarn pyrite (Py2): pyrite occurring as veinlets and disseminated grains in the skarn consisting of diopside, actinolite, garnet, epidote and carbonate; ③ stratiform pyrite (Py3): pyrite occurring as laminae in the metasomatic rocks consisting of serpentine and talc. It is a typical wrigglyite skarn and is generally considered to be a consequence of self-organization during metasomatism process.

4 Samples and Analytical Technique

In this study, 13 samples were selected for pyrite trace element analysis using LA-ICP-MS technique. Analytical instrumentation performed at the University of Akita

* Corresponding author. E-mail: csuzjd@sina.com

consists of a New Wave Research 5906 Laser Ablation System coupled with an Agilent 7500i Quadrupole ICP-MS instrument.

5 Results and Discussions

From Py1 through Py2 to Py3, the Au contents gradually decrease. Au contents in Py1 range from 0.10 to 0.63 ppm, those in Py2 range from 0.21 to 0.27 ppm. The Py3 have lowest Au concentrations of 0.04 to 0.18 ppm. Au concentrations are relatively constant in each sample indicating that gold occurs as solid solution or nanoparticles in pyrite lattice.

Arsenic is the most abundant trace element in pyrite with As concentrations ranging from 1.63 to 354.60 ppm for Py1; 3.89 to 38.48 ppm for Py2; 0.47 to 60.19 ppm for Py3. The As–Au plot shows that a positive correlation exists between Au and As.

Cu is detectable in most pyrites, but, Zn and Pb is generally lower than the detection limit and relatively constant in each sample. The good correlation between Cu and Zn is likely linked to inclusions of co-existing sphalerite and chalcopyrite. The consistent concentrations of Pb indicate Pb occurs primarily as solid solution in pyrite lattice.

The Co and Ni contents in pyrite can reflect the origin of pyrite and the geological setting (Cook et al., 2009). Co and Ni are the common trace elements in pyrites and are usually included in pyrite lattice. The Co/Ni ratios of Py1 range 1.73–11.18 with an average of 5.85; The Co/Ni ratios of Py2 range 0.02–20.69 with an average of 7.42; The Co/Ni ratios of Py3 range 0.02–18.57 with an average of 2.88. The results are characterized by magmatic hydrothermal pyrite and well consistent with our field investigations related to the Qingshanjiao diorite intrusion for three types pyrite. Combined with a review of published data, this paper considered that Dongguashan deposit should be a porphyry-skarn-stratabound Cu-Au deposit which was closely associated with Yanshanian

magmatic hydrothermal activity. Stratabound skarn-type orebody on the top and porphyry orebody in the deep were the same magmatic hydrothermal ore-forming system and hydrothermal mineralization had the multi-stage characteristics (Mao et al., 2011).

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