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Hydrothermal mineralization on Dengfuxian W-Sn-Pb-Zn orefield, SE China

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1 Introduction

Dengfuxian orefield lies at the intersection of the Qin-Hang Combined Zone (QCZ) and the Nanling Metallogenic, and comprises Xiangdong W-Sn deposit (Also known as Dengfuxian W-Sn deposit), Jiguanshi W-Sn deposit, Taihexian Au-Pb-Zn deposit and Dalong Pb-Zn deposit. Besides, Xiangdong W-Sn deposit was one of the world's largest reserves of W-Sn deposit. These deposits are basically distributed in and around Dengfuxian Granite, which the granite is a complex granite with multiple invasive activities, and closely related to the ore deposits (Cai et al., 2013).

A series of W-Sn-Pb-Zn deposits are distributed in the Dengfuxian orefield, previous studies mainly aim at the study of W-Sn (Chen et al., 1991; Huang, 2014; Sun, 1990; Xiong et al., 2017), rarely on Pb-Zn deposits. Are the other deposits the same as the ore-forming source of Xiangdong deposit? Are these W-Sn-Pb-Zn deposits formed by the same mineralization? What are the respective metallogenic physical-chemical conditions? These problems still need to be resolved.

In this paper, Xiangdong W-Sn and Dalong Pb-Zn deposits are chosen to conduct the Rb-Sr geochronology, H-O-S-Pb isotope and ore-forming fluid inclusions studies in order to solve the above problems.

2 Geology of the major ore deposits

Xiangdong W-Sn deposit is located in the SE of Dengfuxian Granite, is also in the intersection the Gannan uplift and Xianggui depression. The strata of the area are Cambrian metamorphic sandstone, slate and phyllite, Upper Devonian Xikuangshan Formation shale and quartz sandstone, Lower Permian Longtan limestone, Jurassic quartz sandstone and siltstone, Cretaceous red conglomerate, sandstone, siltstone and mudstone, and Quaternary alluvium. The fault structure is extensively developed in the area, Laoshanao fault is the largest fault, striking to the NEE, controlled the output of the granite and orebody. The orebody is mainly occurred in the Dengfuxian Granite, and the wolframite-bearing quartz-vein type orebody is the main orebody of Xiangdong W-Sn deposit, which mainly exists in the bioceramic granite and the two mica granite. Ore minerals are wolframite, cassiterite, scheelite, arsenopyrite, pyrite, chalcopyrite, molybdenite, galena and sphalerite, gangue minerals are quartz and fluorite. The alteration are mainly greisenization, silicification, sericitization. Greisenization are the most closely related to mineralization.

Dalong Pb-Zn deposit is located in the north of Dengfuxian Granite. The Quaternary is mainly composed of granite weathering, composed of sandy clay and sand and gravel. Fracture is the main structure of the deposit, and can be divided NE, NW, near EW and SN to four groups, which SN-fracture controlled the occurrence of the orebody. Ore minerals are mainly galena, sphalerite, pyrite, chalcopyrite, etc; gangue minerals are mainly quartz, fluorite, and etc. Silicification, flouritization and chloritization are closely related to mineralization.

3 Fluid inclusion study

Fluid inclusions in Xiangdong W-Sn deposit can be classified into six types: liquid-rich aqueous NaCl fluid inclusions (Ia), vapor-rich aqueous NaCl fluid inclusions (Ib), liquid-rich aqueous $CaCl_2$ fluid inclusions (Ic), CH_4 fluid inclusions (II), CO_2-rich fluid inclusions (III), and

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daughter-mineral-bearing fluid inclusions (IV). Fluid inclusions in Dalong Pb-Sn deposit are mainly Type Ia. Laser Raman spectroscopy show that the ore-forming fluid of Xiangdong W-Sn deposit contains H_2O, CH_4, CO_2, N_2, $CaCO_3$ and $CaSO_4$. Dalong Pb-Zn deposit contains H_2O, CH_4 and N_2.

Fluid inclusion microthermometry and Laser Raman spectroscopy show that the ore-forming fluid of Xiangdong W-Sn deposit is a medium-high temperature, medium-low salinity NaCl-$CaCl_2$-H_2O-CH_4-CO_2 fluid system, and ore-forming fluid of Dalong Pb-Zn deposit is a medium-low temperature, low salinity NaCl-H_2O fluid system.

4 Isotopic study

The results of hydrogen and oxygen isotopic analysis on quartz indicate that the ore-forming fluids of the Xiangdong W-Sn deposit and the Dalong Pb-Zn deposit may derive from the same post-magmatic hydrothermal fluid system, which primarily originates from magmatic water with meteoric water mixed in later. The results of sulfur and lead isotopic analysis on pyrite, arsenopyrite and chalcopyrite suggest that the sulfur of the two deposits primarily originate from magma, and the lead may predominantly derive from the upper crust and have some mantle material mixed in.

The Rb-Sr isochron age obtained from four sphalerite samples of the Dalong Pb-Zn deposit is 154±8.0Ma（MSWD=9.0）, corresponding to early Yanshanian, and it is consistent with molybdenite Re-Os age of the Xiangdong W-Sn deposit obtained by previous research within a reasonable error range. These evidences suggest that the hydrothermal mineralization of the orefield is related to the diagenesis of the early Yanshanian granites of the Dengfuxian pluton, both of which took place under the geodynamic setting of the extension and thinning of lithosphere.

5 Hydrothermal mineralization

Comprehensive and integrated study reveal that the Xiangdong W-Sn deposit and the Dalong Pb-Zn deposit exhibit highly similarity in geodynamic setting, metallogenic age, origins of ore-forming fluids and materials, and both their mineralization mechanisms are probably related to post-magmatic hydrothermal metallogenesis, but the ore-fluids underwent different evolution process, resulting in different ways of ore deposition.

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