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Rb-Sr Isotopic Age of Sphalerites from Qingchengzi Stratiform Pb-Zn Ores and Its Implication for the Ore Forming Process

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1 Introduction

The Qingchengzi orefield, situated in eastern Liaoning Province, northeastern China (123° 37'E, 40°44'N), is an important region with clusters of Pb, Zn, and precious metal deposits. The orefield contains more than ten Pb-Zn deposits and has a mining history of more than 400 years. Some precious metal (Ag, Au) deposits were recently found in the eastern part of the orefield. The orefield in which the Pb, Zn, Ag, and Au deposits are concentrated is also the location of magmatism of different ages, ranging from Proterozoic, Yindosinian (Triassic) and Yanshanian (Jurassic and Cretaceous). While much work on the origin of these deposits has been carried out, discrepancies as to the ages and the metal sources of the deposits remain (Zhang, 1984; Jiang, 1987; Ding et al., 1992; Liu and Ai, 2001; Xue et al., 2003). Many studies have shown that Rb-Sr dating of sulfide minerals, especially sphalerite and pyrite, can be used to determine the formation age of hydrothermal sulfide mineral deposits (Nakai et al., 1993; Christensen et al., 1995). In this study, we report the results of step-dissolution Rb-Sr dating of sphalerite from the stratiform Pb-Zn ores in Zhenzigou deposits and discuss its implication for the ore forming preocess.

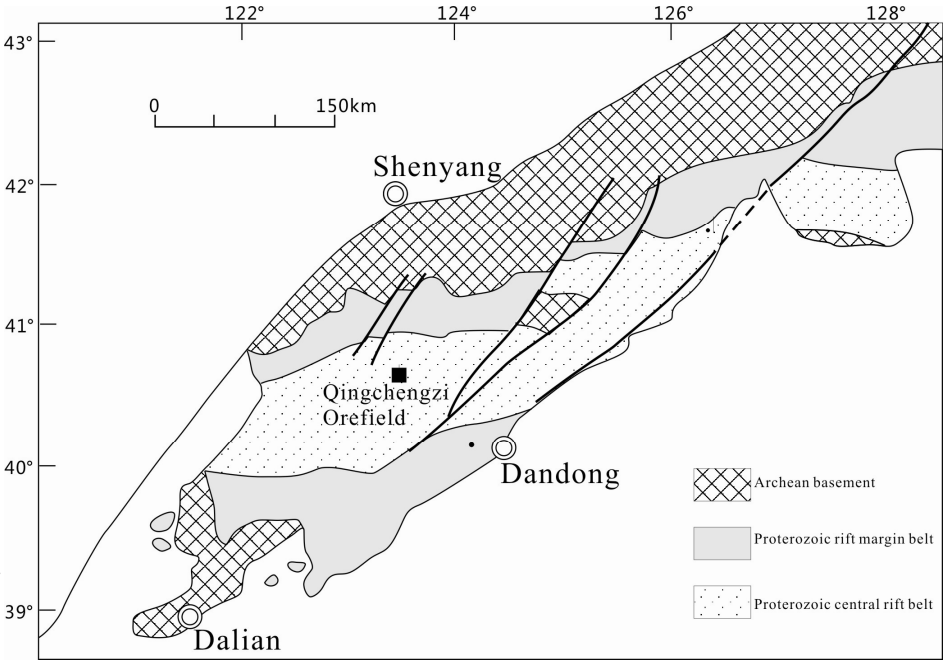

Fig.1. Sketch map showing the tectonical belt in Liaoji Rift and the location of Qingchengzi orefield

2 Geological Setting and Sample Location

The Qingchengzi orefield is situated in the Paleoproterozoic Liaodong rift zone in the eastern part of Liaoning Province (Fig.1). This intracontinental rift developed on the Archaean North China Craton and formed through the processes of crust extension, rapid subsidence, and compression folding in the Paleoproterozoic (Fang et al., 1994). The rift zone trends NEE with a total length of 700 km, is truncated by the Tanlu fault in the west, and runs into the Sea of Japan to the east. The rift zone can be divided into three tectonolithofacies belts: the northern marginal slope, the central depression and the southern marginal slope. The orefield is located in the central depression (Zhang et al., 1984) (Fig.1). The metamorphic rocks of the Archaean Anshan Group comprise the basement of the rift zone.

The Ag and Au deposits fill in interbed fractures in the schist, granulite, and marble of the uppermost horizons (D34 and D35) of the Dashiqiao Formation and near the

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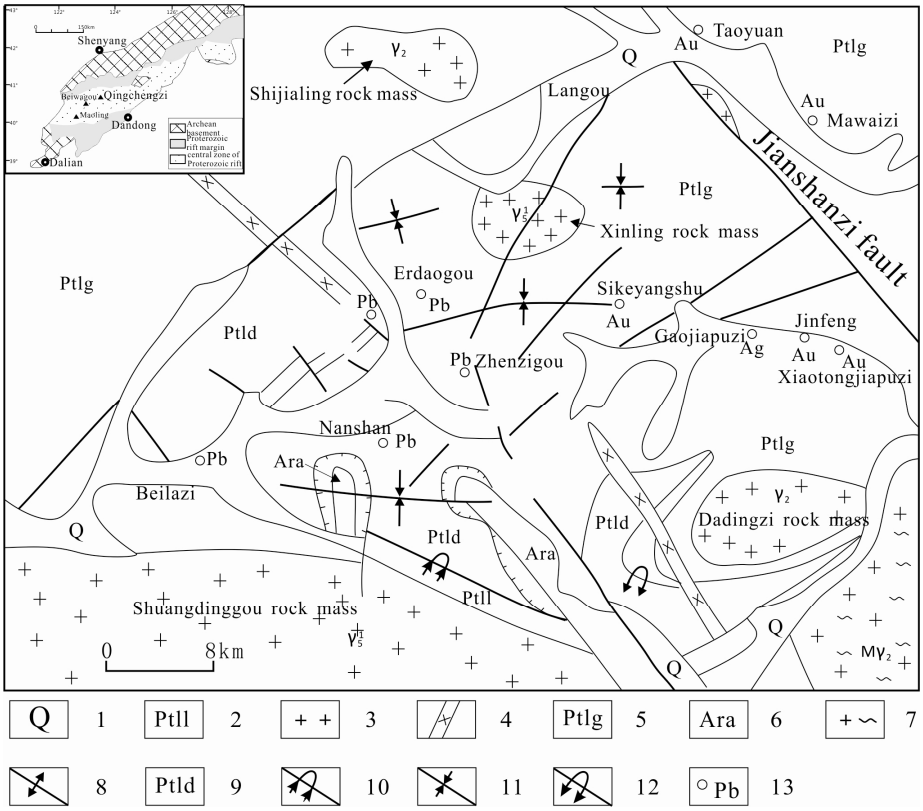

Fig.2. Generalized geologic map of Qingchengzi mineral district (Modified from Liu H G, 2009)

lowest horizon of the Gaixian Formation. These Ag-Au ores are associated with silicification, potashalteration, and late carbonation.

The Zhenzigou Zn-Pb is chosen for this study. Zhenzigou is a typical conformable stratiform deposit which consists of layered and lens Zn-Pb orebodies. The orebodies occurring in interbed fractures are strictly controlled by the folded bedding and are hosted by graphite -bearing marble and interbeded banded graphite-bearing marble, amphibolite, and biotite schist of the D1 horizon of the Dashiqiao Formation(Fig.2). Ore minerals are pyrite, pyrrhotite, sphalerite and galena, with minor arsenopyrite, marcasite, and argentite. The gangue minerals include dolomite and calcite, which are very similar to that of the wall rock.

3 Results and Disscussion

3.1 Rb-Sr dating results

Sphalerite residues have a range of $^{87}Rb/^{86}Sr$ ratios from 0.2185 to 6.146, which was similar to the range previously reported for sphalerite (Nakai et al., 1993). The sphalerite residues display a positive correlation between Rb concentrations and $^{87}Rb/^{86}Sr$, as reported by Chrisrensen et al. (Christensen et al., 1995). The data for sphalerite residues from the No. 2 and No. 320 ore bodies in level 390m form one linear array on the Rb-Sr isochron plot. Using York model 2 of the Ludwig program (Version 2.90) with 2 sigma index for dating errors, eight sphalerite residues from the No. 2 and No.320 orebodies gave an age of 1809 ± 110 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7098 ±0.0049 (MSWD=129). If sample 15 and 13 is excluded from the isochron, the other six sphalerite residues yielded an age of 1798.4±7.5 Ma with an initial $^{87}Sr/^{86}Sr$ ratio 0.71015±0.00037 (MSWD=0.82). The two indistinguishable ages indicate that the No. 2 and No. 320 orebodies were formed in the same geological event. Therefore, all of these samples are suitable for dating.

3.2 Discussion

Some age datas were recently published that outcrop at Qingchengzi and adjacent regions. Bsed on those datas, we can preliminary established the diagenetic mineralization sequence, in this sequence, there are three concentrated period: paleo-Mesoproterozoic , Triassic (Yindosinian) and Jurassic-Cretaceous (Yanshanian). The aboved Rb-Sr data, 1798.4±7.5Ma, can fit this sequence and correspond to the Lüliang movement, which is not a main metallogenic epoch in this area.

Base on the diagenetic mineralization sequence of Qingchengzi orefield and adjcent area, this study regrad the Rb-Sr age is not the initial mineralization age but the transformation age. The REE analysis of Qingchengzi Pb-Zn deposits show that the ore-forming hydrothermal fluids were mixed by deep hydrothermal fluids and seawater,which was the initial mineralization age (Ma et al., 2013) , and then the initial stratiform Pb-Zn ore was strongly transformed and destroyed by Lüliang movement which was happened during Paleoproterozoic, the Rb-Sr age (1798.4±7.5Ma) is this transformation age. This movement destroyed lot of stratiform Pb-Zn ore and only part of them were preserved. After that, the stratiform ore of Qingchengzi experienced multi-phase Magmatic hydrothermal superimposed transformation in Yindosinian and Yanshanian, which further destroyed the stratiformed ore and transformed it into veined ore in weak tectonic belt (Fig. 3).

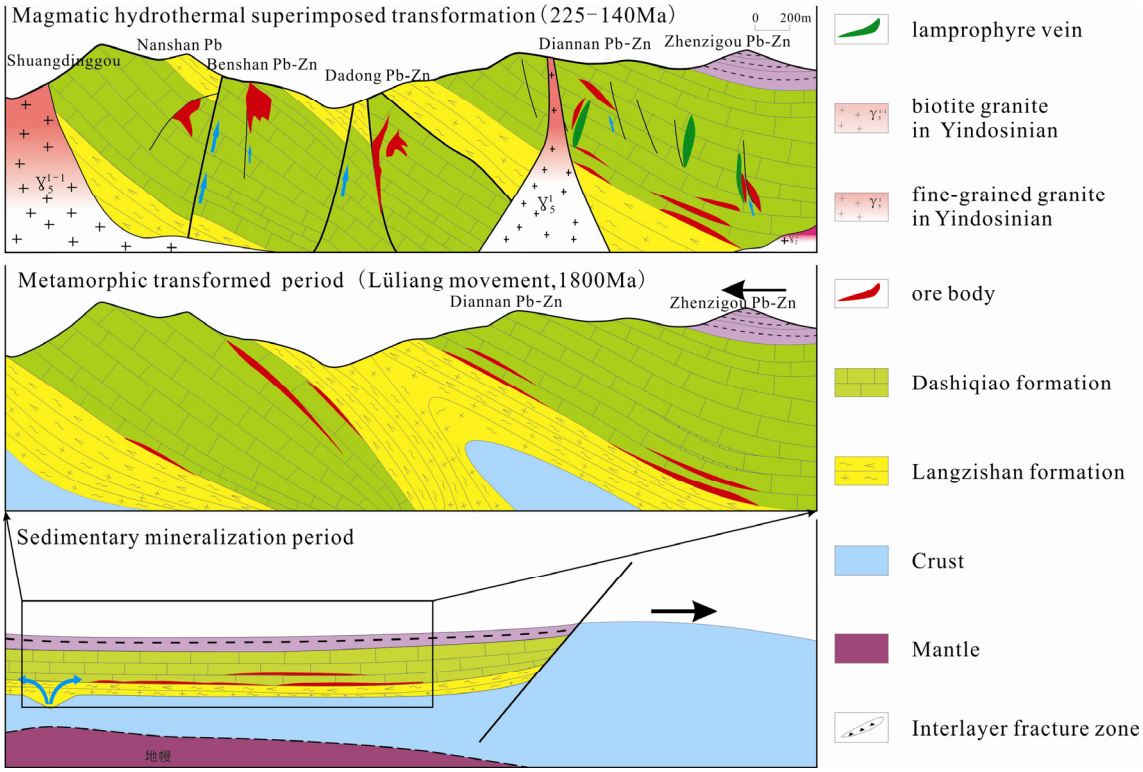

Fig.3. Metallogenic model of Qingchengzi Pb-Zn deposits

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