1 Introduction

Lanping Basin is one of the most important copper-lead-zinc-silver metallogenic belts in southwest China. Nearly 20 kinds of minerals are produced in this area, such as copper, lead, zinc, silver and mercury, antimony, strontium, gypsum-salt etc. Meanwhile, more than 220 deposits (occurrences) have been found during the past 50 years (Gao Shande, 1998). Jinding Zn-Pb deposit in this area is well known to the world for the reserve of ~200 Mt Zn-Pb ore, which is also the largest Pb-Zn deposit in China. In recent years, a lot of lead zinc copper and silver polymetallic deposits (more than 30) have been found in Baiyangping and Hexi district, which, located in the north of Lanping basin, are believed to be the best prospecting potential area of Pb-Zn deposits (Yang Weiguang, 2003; He Longqing, 2004; Chen and Kai Xu 2000; Zhu Huaping 2008).

At present there is great controversy on the ore genesis and regional metallogenic regularity, concerning the ore genesis, and the major view is the hydrothermal ore deposits controlled by the thrust nappe structure in foreland basin (Tian Hongliang, 1998; Xue Chunji, 2003; He Longqing, 2004, 2007; Hou Zeng Qian, 2008). On the other hand, some scholars find that the lead zinc mine in Hexi district may be formed during the hydrothermal sedimentary (Chen Kaixu, 2000; Xue Shunrong, 2000; van family, 2006; Chen Liang, 2009; Huang Yufeng, 2011), but no detailed evidence is provided.

In this paper, through a large amount of field evidence from petrology, geochemistry analysis, we propose that Lanping lead-zinc-silver polymetallic deposits are the exhalative sedimentary in origin, and put forward the prospecting direction of this kind of deposit. The identification of SEDEX lead-zinc mine is not only an important supplement to the metallogenic types in Lanping basin, but also of significance in recognizing the metallogenic mechanism of regional Pb Zn deposit, which can provide important guidelines for exploration of these deposits in Lanping Basin.

2 Ore Deposit Geology and Typical Ore Fabric

These kinds of deposits are mainly distributed in Hexi...
area, the north side of Lanping basin (Fig. 1). Some of the important deposits of this type are Caizidi, Qingdianwan, Huishan, Heishan and other Pb-Zn-Ag polymetallic ore. These deposits commonly occur in the Upper Triassic Sanhedong Formation, which was formed during intra-continental rifting, and consist of siliceous rocks, laminated finely crystalline dolomite and dolomitic limestone. Petrographic and geochemical studies indicate that the host rocks (siliceous rocks and dolomite) are typical exhalative-sedimentary products (Hou et al. 2007; Wang et al., 2000a). The Ag-Pb-Zn polymetallic ore bodies are normally strata bound or stratiform and, in places, lenticular (Huang Yufeng, 2011), local strong deformation as the Indo-Asian collision and subsequent oblique convergence during the stage from Paleocene to Eocene. The main ore-forming elements are lead, zinc, silver, copper, cadmium, thallium, associated elements such as gallium, but zinc is the most ore-reserves element in these deposits, followed by lead, the average Pb:Zn=1:1.68. Primary ore minerals are sulfide sphalerite, galena, pyrite, argentite, etc. Gangue minerals are calcite, dolomite, and also a large number of barite, a small amount of gypsum and celestite. Ore types are divided into oxidized ore and sulfide ore. The sulfide ores are banded, laminated, brecciated, honeycomb, massive and disseminated (Fig. 2). Ore fabric is mainly hypidiomorphic xenomorphic granular structure, fine aggregate (0.5-1mm), with galena, sphalerite and pyrite chalcopyrite as major metallic minerals. In addition, there is also a small amount of euhedral to subhedral structure.

3 Geochemistry Characteristics

3.1. Elements Zoning Sequence

Within Caizidi mine area, we have random tested various types ores, mineralized rock and surrounding rock. The results show that in vertical direction of the deposit, at an altitude of 2600 meters to 2734 meters, the Pb/Zn is obviously divided into two groups. Above the altitude of 2600 meters, wall rock mineralization and the ore obvious enrich Pb element, Pb/Zn=2.06. However, under the 2600 altitude of meters, the enrichment Zn is the main characteristics, Pb/Zn=0.2. Based on the current landscape, Pb and Zn element of Caizidi ores has obvious vertical zoning features. This is very similar to the SEDEX Pb-Zn deposit metal zoning characteristics, vertical for Cu-Zn-Pb-Ba (Hanfa, 1999).

Outside the mine area, from the southeast to the northwest, there are Maliping, Caizidi, Qingdianwan Pb-Zn mine. Dasanjie celestite deposits, Hexi Pb-Zn-Sr ore, Cijiao-Munian gypsum mine, Qingfuling iron deposits occur in the Late Triassic strata, and these deposits distribute in an area less than 10 km. The mineralization elements are of obvious horizontal zoning, and the element zoning sequence of this district is Pb-Zn-Sr-Ba-Fe. The element zoning of Caizidi is almost completely conforming to the ideal SEDEX model.

3.2 Major element Composition

The major elements of all kinds of ore samples from the mining area show that Fe₂O₃ and FeO content is a little higher than the earth's crust abundance value, obvious higher than that of the Sanhedong Formation. The Ag-Pb-Zn polymetallic ore bodies are normally strata bound or stratiform and, in places, lenticular (Huang Yufeng, 2011), local strong deformation as the Indo-Asian collision and subsequent oblique convergence during the stage from Paleocene to Eocene. The mean total iron content of Laminated-massive ores is 0.65%~1.7%, but that of breccia-net vein ores is 15%. The Al₂O₃, TiO₂ content of all sorts of type ores is pretty low, which is similar to the typical ore produced by...
hydrothermal sedimentation (Fangweixuan, 1999). The MgO content of these ores is also relatively low, which is 0.77% (average) of massive, net vein ores and 1.12% of brecciated lamellar ores, and this is far lower than the crustal abundance value. The depleted of MgO may indicate that these ores are hydrothermal sedimentation. The Fe/Ti ratio is very large, form 350.4 to 1713.4, the average value is 888.9. Al/(Al+Fe+Mn) is 0.218. This further indicated that Caizidi Pb-Zn deposit has obvious characteristics of hydrothermal sedimentation (Bostrom, 1973).

3.3. Trace element composition of ores

The positive anomaly of the Ba, U, Sr and negative anomaly of Nb, Zr, Tb in the trace element spider diagram show that the ore-forming fluid maybe closely related to the ancient seawater. As Barium is the inert element in supergene conditions, it can’t be transported in long distance, unless there is a biological action. Neither fossils nor biological remains have been found in the mining area, therefore, the large numbers of barium element are not originated from terrigenous. According to the Sr/Ba ratios(0.065), it can be concluded that the enrichment of Barium would be the result of the submarine exhalative activity, which ultimately lead to the mineralization of Pb-Zn elements (Qisijing, 1993).

3.4 REE composition of sulphide ore

The total REE content of the Qingdianwan sulphide ores is relatively low (average content=38ppm). In the REE distribution diagram, Ce element shows faint negative anomaly, contrast, Eu element exists obviously positive anomaly. REE fractionation is not clear in the REE curve, and it presents a little right inclined tendency. All these REE characters of the Qingdianwan ores are the similar to that of the SEDEX deposits (Han fa, 1996).

3.5 Sulfur isotope geochemistry of sulfide

The sulfur isotope composition of the sulfide (galena, sphalerite and pyrite) shows tower distribution, indicating that the depth sulfur source is dominant. The δ34S value of sulfide is 0~10. The δ34S value of all kinds of sulfide show that sulfur isotope fractional distillation in the hydrothermal system didn’t reached equilibrium state, which would be the result of quickly sedimentation (Huangyufeng et al, 2011).

4 Discuss and Conclusions

1. Lamellar structure, soft sedimentary of pyrite, syngenetic slump structure, framboidal pyrite, concentric ring structure of pyrite and sphalerite of Pb-Zn ores in Caizidi and Qingdianwan deposits located in the north side of Lanping basin indicate that these deposits can’t be formed during the thrusting movement and they are not the hydrothermal vein like deposits.

2. The characters of the major elements, trace elements, REE composition, Sulfur isotope geochemistry of Caizidi and Qingdianwan ores show that the deposits are the exhalative sedimentary in origin.

3. The identification of Lanping basin SEDEX lead-zinc deposit is an important supplement to the metallogenic types within the basin, and besides that, it is of significance to recognize of the metallogenic mechanism of the regional Pb Zn deposit, which provide important guidelines for exploration of these deposits in Lanping basin, that is, the Triassic Sanhedong Formation may be the main direction of prospecting this type of deposits.

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