LAI Jianqing and ZHANG Chenguang , 2014. Genesis of the Galonggema Cu-polymetallic Deposit, Qinghai. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 172-173.

Genesis of the Galonggema Cu-polymetallic Deposit, Qinghai

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The Galonggema Cu-polymetallic deposit is located in the north part of Sanjiang metallogenic belt in northeastern margin of the Tibetan Plateau. Preliminary geology of this deposit has been studied, and it can be concluded that this deposit belongs to VMS type deposit (Zheng et al., 2012). On the basis of identification of ore-forming stages, in accordance with fluid inclusion and stable isotopic analysis, character of ore-forming fluids, ore-forming material sources, physicochemical conditions for mineralization and the genesis of Galonggema polymetallic deposit were discussed.

1 Geological Setting

The deposit, situated at the joint part of the Xijinwulan-Jinshajiang River suture zone and Ganzi-Litang suture zone, is located in the Batang volcanic-magmatic arc zone. Strata exposed in this area are Batang Group intermediate felsic volcanic association of Lower Triassic. Magmatic activities characterized by multiple stages and circles were widely developed. Major structures can be broadly divided into two groups: NW-SE trending and NNE trending structures. The former group controls distribution of the volcanic rock belt while the latter crosscuts the volcanic rock belt.

2 Deposit Characteristics

Orebodies are mainly hosted in dacitic tuff and tuffaceous siltstone in the second lithologic member of the second lithologic formation of Batang Group, and steeply dip to the northeast direction, consistent with the occurrence of the schistosity.

With petrographic analysis and field observation in tunnels, it has been revealed that there are two primary ore-forming periods. The earlier period (A) is related to volcanic-sedimentary hydrothermal fluids while the later period (B) is relevant to moderate temperature hydrothermal fluids which have caused extensive sulfide precipitation. A period consists of three stages, namely hydrothermal sedimentary banded massive pyrite stage (A1), quartz-pyrite stage (A2) and carbonate stage (A3). In addition, B period can be subdivided into to two stages, namely Cu-Pb-Zn sulfide stage (B1) and sphalerite carbonate stage (B2).

3 Fluid Inclusion Study

Fluid inclusion assemblages can be used to divide different ore-forming stages based on macroscopic and petrographic evidence (Chi and Lai, 2009). Fluid inclusion assemblages of this area are maily formed in stages A3, B1 and B2. Primary aqueous inclusions in dolomite from one sample formed in stage A3 show a range of homogenization temperatures from 178°C to 235 °C, with an average of 213.8 °C, and salinities are varing from 1.32% to 11.22%, with an average of 5.46%. Moreover, primary aqueous inclusions in quartz and calcite from 11 samples formed in stage B2 exhibit a range of homogenization temperatures from 188°C to 265°C, 238.6 °C on average, and salinities are ranging from 0.66% to 3.76% , 1.76% on average. Given that mineralization is related to volcanic activities and always takes place at shallow level, the maximum estimated homogenization pressure of fluid inclusions is 20.5 MPa.

4 Discussion of Mineral Deposit Genesis

The tectonic setting of Galonggema deposit is arc extensional environment, similar to those Kuroko-type deposits in Japan (Hou and Urabe, 1996). Such tectonic environment is favorable for volcanic rock-related mineral deposits. But this deposit is distinguishable from those typical Kuroko-type deposits in terms of deposit characteristics and ore-forming process.

Kuroko-type deposits contain massive sulfides, high ore

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grades and obvious mineralization zonation. In contrast, Galonggema deposit has relatively low ore grade and massive sulfides are locally present. Also, there is a lack of typical ore-bearing textures and minealization zonation in this area.

Geochemical characteristics of ore-forming fluids in this area are different from that of Kuroko-type deposits. Results of microthermometry study show that fluid of different stages is not a product of continuous evolution. Before mineralization, fluid of the carbonate stage is characterized by low temperature (178 ~ 235 ℃), representing an ore-forming process caused by sedimentation and hydrothermal metasomatism related to volcanic activities at shallow level in the crust or submarine environment. Late ore-forming fluid is a mixture of different fluids. At the beginning, fluid is characterized by high temperature (202 ~ 373 ℃) and moderate salinity (1.32 ~ 11.22%) which comes from the recent magmatism. With the addition of ground water, the ore-forming fluid is evoluted to low temperature (188 ~ 265 ℃) and low salinity (0.66 ~ 3.76%) fluid, suggesting the end of mineralization.

Compared to Kuroko-type deposits, sources for metallogenic material in this area are various. Sources of metallogenic material during the two ore-forming periods are different. The pyrite, precipitated from the earlier volcanic-sedimentary hydrothermal fluid, has $\delta^{34}S$ values range from 1.13‰ to 2.45‰, close to that of meteorite, and is similar to typical Kuroko-type deposits and the Xiacun deposit. In contrast, the chalcopyrite, formed in the moderate temperature hydrothermal sulfides stage, exhibits variable $\delta^{34}S$ values vary from 12.36‰ to 12.37‰, ranging between that of magmatic water and sea water. All these suggest that there are multiple sources for sulfur, including early magma, magmatic fluids derived from a later deep-seated magma and circulated ground water from the strata.

In summary, Galonggema Cu-polymetallic deposit is different from the typical volcano massive sulfide deposits (VMS). Indeed, it is formed by hydrothermal enrichment after bedded exhalative sedimentary metallization.

Lithogenesis, mineralization and evolution of tectonic in this area are as following: firstly, the marine volcanoe eruption leaded to volcanic sedimentary hydrothermal mineralization (Lydon, 1984). Then, accompanied by a kind of NE-SW tectonic stressing, the strata experienced a strongly folding process, and an anticline has been formed as the center of crater in Galonggema. Lately, acidic magma moving along fractures leaded to the middle temperature magmatic hydrothermal mineralization, and it superimposed on the early ore-bodies.

Acknowledgements

This research project was funded by Central Geological Exploration Fund. Acknowledgements should also be given to the colleagues at Qinghai Nonferrous Metals Geological Exploration Institute for their contribution to understanding the geology of the Tibetan Plateau.

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