Geological characteristics and genetic types of antimony deposits in the Weishan Yongping ore concentration area of Yunnan Province

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Abstract. The Weishan Yongping ore concentration area is located at the southern end of the "Jubao Basin" in the Lanping Basin, and is part of the Lanping-Simao mineralization belt. It is an important antimony ore belt in Yunnan Province. This article analyzes the geological characteristics of antimony deposits in the ore concentration area from the perspectives of regional geology and typical deposit characteristics, explores their genetic types, and provides a basis for the exploration and development of antimony resources in the area.

Keywords: Antimony deposit, Geological characteristics, Metallogenic conditions, Genetic types and patterns.

1. Introduction

The Weishan Yongping ore concentration area in Yunnan Province is located in the western region of Yunnan Province and is an important antimony ore belt. Over the years of geological exploration work, a large number of economically promising deposits (points) have been discovered. At present, more than 150 metal and non-metallic deposits (points) have been discovered in the area, especially the discovery of some large to ultra-large deposits, which strongly proves that the area has good mineralization potential.

2. Regional geological characteristics

2.1. Overview of regional geology

(1) Tectonic background

The tectonic location of the Weishan Yongping ore concentration area belongs to the southern section of the Ping-Simao Basin, as shown in Figure 1. It is located between the Lancang River Fault and the Jinsha River Ailaoshan Fault, and belongs to the middle section of the Sanjiang Tethys Lanping-Simao mineralization belt. Located between the Lancang River Fault and the Jinsha River Ailaoshan Fault, it belongs to the middle section of the Sanjiang Tethys Lanping-Simao mineralization belt. The Sanjiang Tethys is the composite part of the world's two giant mountain ranges: the Alps, the Himalayas and the Pacific Mountains. It is the intersection of the interaction of the three giant plates (Eurasia, India and the Pacific plates) and one of the two convergence centers of the global mantle convection system.

(2) Regional strata

The strata exposed in the mineralization concentration area mainly include the Upper Permian, Upper Triassic, Jurassic System, Cretaceous, Paleogene System, Neogene System, and the Quaternary system distributed in intermountain basins. The Mesozoic Triassic, Jurassic System, and Cretaceous are the most developed and widely distributed, making them the main body of the basin in this area. The Triassic and Jurassic System strata are mainly composed of marine platform facies, continental shelf facies, tidal delta facies, and tidal flat facies sediments. After the Cretaceous, they are continental sediments.

There is only a small amount of the Upper Permian Yangbazhai Formation in the Paleozoic strata of the area, which is exposed in the Weishan Waigucun Waijiaohe area. Its lithology mainly consists of lightly metamorphosed gray-black sandy sericite slate, carbonaceous slate, and metamorphic sandstone mixed with skeletal limestone. The Triassic strata are mainly exposed in the Weishan Zijinshan Anticline and the Shuixie Xinmin Gonglang area in the northern part of the Lancang River. From bottom to top, they are the Upper Triassic Waigucun Formation, Sanhedong Formation, Douluba Formation, and Maichuqing Formation. The middle and lower Triassic series are missing. The Lower Yangjiang Formation of the Jurassic System, the Middle Huakaizuo Formation, and the Upper Bazhulu Formation are widely distributed and belong to a part of the red beds in western Yunnan. The Cretaceous is mainly distributed in the Yunlong Yongping area and Weishan Weibaoshan area in the western part of the basin, and can be divided into the Jingxing Formation, Nanxin Formation, and Hutousi Formation from bottom to top. The distribution range of the Cenozoic strata is relatively small, with only the Paleogene System, Neogene System, and Quaternary exposed. The Lower Tertiary of the Paleogene System includes the Paleocene Mengyejing Formation and the Eocene Denghui Formation. The Mengyejing Formation is a lacustrine deposit and an important salt-bearing layer, located in the area east of Weishan. The Upper Tertiary of the Neogene System is only exposed in intermontane basins, while the Quaternary is mainly distributed in intermontane basins, mainly consisting of alluvial-proluvial and lacustrine deposits, including glacial accumulated gravel, sand and clay.

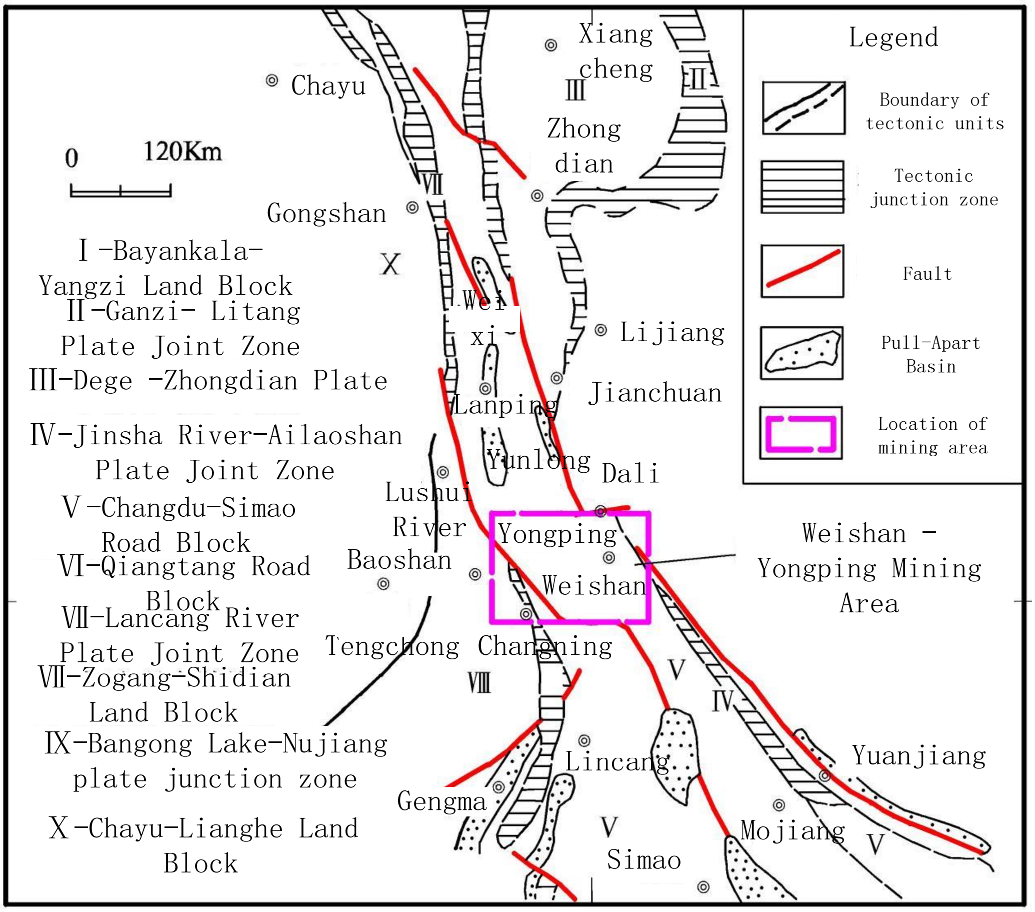

Figure 1. Outline of structural Zoning in the Sanjiang Area (part)
(According to li Xingzhen et al.1999)

(3) Regional structure

The structures in the area are mainly controlled by the western Lancang River Fault, the eastern Jinshajiang Ailaoshan Fault Zone, and the central axis fault of the basin. The main structures are distributed in a northwest direction, and these structures are believed to be caused by NE direction tectonic compression caused by the westward and eastward subduction of the Jinshajiang Ocean and

Lancang River Ocean, respectively. In the later stage, the westward subduction of the Jinsha River Ocean and the eastward subduction of the Lancang River Ocean formed the Lanping backarc basin. The tectonic compression in the near-northeast and near-north-south directions created fold structures such as the Zijinshan composite anticline and the Guangshan Liangzi anticline, as well as the nappe structures and NW, NEE trending fault systems and the Gonglang arc structures within the basin. Among them, the Zijinshan composite anticline and Gonglang arc structures are closely related to the mineralization in the area.

(4) Regional magmatic rocks

The ore concentration area is located between the Jinsha River Fault System and the Lancang River Fault System, belonging to the Mesozoic and Cenozoic depression basins developed on the Indosinian folded basement, with less developed magmatic activity.

The magmatic rocks developed in the area are the Himalayan Lianhuashan rock mass and the Zhuopan alkaline rock mass. The former infiltrated along the core fault of the Lianhuashan Dafoshan anticline and formed in the Eocene period. The lithology is mainly quartz monzonite porphyry and hornblende quartz monzonite porphyry. The latter intruded into the Cretaceous along the Dazhuopan anticline, mainly consisting of gabbro, pyroxenite, and syenite, formed in the late Paleogene.

2.2. Regional mineral distribution and characteristics of typical antimony deposits

(1) Regional mineral distribution

The ore concentration area is located at the southern end of the "Jubao Basin" in the Lanping Basin. Currently, more than 150 metal and non-metallic deposits have been discovered, including gold, copper (cobalt), antimony, mercury, lead-zinc, iron, etc. The non-metallic deposits mainly include Salt, Gypsum, rock crystal, et al.

The main metal element combinations are: Au-As-Sb-Hg; Sb-As-Hg; Cu-Co-As-Sb-Au. The main genetic types of Cu-Co-As-Sb-Au include: medium to low temperature hydrothermal deposits, hydrothermal liquid deposits, and hydrothermal altered rock types.

The gold deposits (points) in the area are mainly distributed in the two wings of the Zijinshan anticline, the Lianhuashan monzonite porphyry, and the Zhuopan alkaline rock mass. The types of deposits are mainly independent gold and hydrothermal alteration. The genetic types of copper and copper polymetallic deposits (points) are mainly hydrothermal alteration rock types, while arsenic, mercury, and other deposits (points) are mainly distributed in the Zijinshan anticline area. The medium-sized ones include the Shiyancun Ti deposit and the Bijiashan antimony deposit, which are hydrothermal alteration rock types. Salt, gypsum, and other sedimentary products are mainly distributed in the Cenozoic basins of Yunlong and other areas.

(2) Characteristics of typical antimony deposits

1) Shiyancun antimony mine

The Shiyancun antimony deposit occurs in the fractured zone between the silicified quartz rock layers in the lower section of the Sanhedong Formation and the black shale in the upper section. Mineralization is clearly controlled by the silicified zone and nearly north-south trending faults. The ore-bearing layer and the top and bottom surrounding rocks form a gradual transition, and its lithology (from bottom to top) is limestone, silicified limestone, silicified secondary quartzite, silicified shale, and black shale.

The Shiyancun Antimony Mine has a total of 5 ore bodies. The largest ore body is layered or quasi-layered, with a north-south strike, a total length of about 740m, a width of over 80-290m, an average thickness of 3.11m, and an average grade of Sb 2.75%.

The ore fabric has granular metamorphic structure, idiomorphic to semi-idiomorphic granular structure, colloidal, disseminated, massive, and brecciated structures. Huiti ore is an aggregate of plate-shaped, columnar, granular, needle-shaped, and radial shapes. The main types of ore are blocky, disseminated, network vein, fine vein or clump. The alteration of surrounding rock is mainly characterized by silicification, carbonization, and fluidization.

2) Bijiashan antimony deposit

The Bijiashan antimony deposit is located at the outer edge of the Gonglang arc-shaped structure and the intersection of the nearly north-south and northwest trending structures. The main exposed strata are the Triassic and Jurassic System, mainly occurring in the interlayer fracture zone where the Triassic upper Sanhedong Formation (T_3sh) limestone and the Tuoluba Formation (T_3w^1) mudstone and slate contact in the near axis and two wings of the Bijiashan anticline. The ore body is produced in a layered, quasi-layered, thin-layered, and lenticular form, with poor continuity. Metal minerals are mainly composed of antimonite, followed by pyrite. Gangue minerals mainly include calcite and quartz. The ore structure is mainly granular and metamorphic, followed by long columnar needle structure, pseudomorphic structure, soil structure, and colloidal structure. The stone structure is mainly blocking structure and infectious structure, followed by breccia and crystal cluster structure. Surrounding rock alteration mainly includes silicification, fluorization, carbonization, kaolinization, baritization, et al.

3) Marbyun antimony polymetallic mine

The tectonic location belongs to the Qiangtang Sanjiang orogenic system, the Changdu-Lanping-Simao block, the Beidou depression (Qianyuan) basin, sandwiched between the Lancang River fault and the Jinsha River Ailaoshan fault. The Triassic marine strata are widely developed, with strong structures and well-developed folds and faults. Along the structural weakening zone, a sliding and fractured zone between the limestone of the Upper Triassic Sanhedong Formation and the sand shale of the Maichuqing Formation has been formed, which is an important ore-controlling, guiding, and hosting structure in the area. Mineralized bodies and ore bodies are significantly controlled by their layers and structures, mainly occurring in the contact area between the upper part of the Sanhedong Formation and the black carbonaceous mudstone of the Maichuqing Formation.

The ore body occurs in a lenticular shape in the fractured zone, mainly distributed in the contact area between limestone and sandstone. The ore types are mainly silicified, fluorinated, carbonated breccia-type, and sandstone-type antimony ore. The breccia-type ore often has filling structures, while the sandstone-type has obvious characteristics of infiltration, metasomatism, and alteration.

3. Genetic types and models

3.1. Metallogenic conditions and ore-forming fluid system

1) Metallogenic conditions

Fault structures create favorable structural conditions for the upward migration of ore-forming solutions, serving as the main ore-guiding structure. Under the long-term action of later structural superposition, destruction, and secondary fold structures, through mineralization such as metasomatism and filling, ore is enriched in the fold core, two-wing sliding zone, and compression fracture zone derived from fault structures.

Basin sedimentation provides excellent conditions for metal mineralization: firstly, due to the rapid accumulation of sediments from surrounding rocks, the maturity is very low, and there is a large amount of basic to medium acidic igneous rock material in the basin, making it a good source of mineral resources. Especially, the earliest accumulated Late Triassic sediments during the Paleo Tethys Ocean closure basin formation period are more obvious; The Jurassic System strata and some Cretaceous strata also show high abundance of many ore-forming elements. Secondly, the abundant basin water contained in the basin provides an important source of ore-forming fluids. The deposits in the basin include both red beds representing the oxidizing environment and black shale containing organic or even asphaltene representing the reducing environment, There are also gypsum and salt layers formed under evaporation conditions, as well as carbonate rocks that are easily metasomatized and mineralized, providing an ideal host rock combination. Especially the oxidation-reduction interface in the strata is a favorable condition for the reduction and precipitation of oxidized ore-forming fluids that dissolve a large amount of metal elements.

The relative changes in sedimentary strata, rock sequence combinations, and rock particle size provide sufficient space for the retention and migration of ore-forming minerals. Magmatic activity and tectonic movements promote early hydrothermal transformation, and in addition, the area is located in subtropical regions (such as Ren Zhiji and Zhu Zhihua) where biological activity is active. The red formations containing gypsum salts formed under arid paleoclimatic conditions provide sufficient brine for the formation of metal deposits in the area.

2) Ore-forming fluid system

With the collision and orogeny between India and the Asian continent, the Qinghai Tibet Plateau uplifted, forming the Lanping strike slip pull-apart basin. Affected by the force from SW towards NE, a thrust nappe structure was formed on the west and south sides of the basin; The area has been in the stage of basin development from the Late Triassic to the Eocene, and the sediment contains extremely rich basin water. This water reacts with low maturity sediment for a long time, thus containing more ore-forming elements.

During the process of compaction and diagenesis, pore water in the sediment is discharged and circulated along the fractures in the basin, further extracting ore-forming elements from various rocks. The tectonic magmatic events that began in the late Eocene Oligocene transformed the main body of the basin into mountain ranges and generated large-scale porphyry magma activity. The addition of magmatic fluids and their mixing with basin fluids ultimately formed the ore-forming fluids in this area. The sources of ore-forming fluids in this area are very abundant and have good ore-forming fluid conditions.

3.2. Metallogenic stage

Based on the characteristics of typical antimony deposits, the antimony deposits in the area can be roughly divided into sedimentary (diagenetic) stages; The stage of primary brine migration after diagenesis; Deep to shallow hot brine circulation and superimposed transformation stage. Based on the size of mineral particles, it can be determined that the mineralization temperature in the early stage of the low-temperature hydrothermal period is relatively high, while the temperature in the later stage is relatively low.

3.3. Metallogenic model

The ore concentration area is located between the Jinsha River Fault System and the Lancang River Fault System, and belongs to a Mesozoic and Cenozoic depression basin developed on the Indosinian folded basement, with underdeveloped magmatic activity. The thick volcanic rocks formed in the Late Paleozoic to Mesozoic volcanic magmatic arc during the late Indosinian period provided rich material sources for the later mesothermal mineralization. The strong thrusting napping, strike slip shearing and other tectonic processes that occurred in the context of the Himalayan intracontinental convergence and compression structure controlled the movement of the crust surface ore-forming fluid system, becoming the most important ore-forming element in fluid mineralization. The ore bearing strata are mainly composed of clastic and carbonate rocks of the Triassic and Cretaceous systems, with mineralization enrichment mainly occurring in regional interlayer fracture zones.

Controlled by the Zijinshan Waigucun anticline thrust nappe fault fracture zone and its interlayer fracture zone, Hg-Sb mineralization generally occurs in the Upper Triassic Sanhedong Formation, while Sb mineralization generally occurs in the Cretaceous Upper Hutousi Formation. Most ore deposit mineralization solutions are mainly derived from atmospheric precipitation, and mineralization occurs in hot brine water with medium to low temperature (high temperature and pressure in the early stage, low temperature and pressure in the later stage), medium salinity, and weak acidity to neutrality.

In summary, it is believed that the antimony deposit in this area should belong to a medium to low temperature hydrothermal deposit with multiple sources, multi-stage superposition characteristics, and controlled by faults and fold structures, with certain layer controlled characteristics.

4. Conclusion

In this paper, the metallogenic conditions and genetic types of antimony deposits in Weishan-Yongping ore concentration area are analyzed from the aspects of regional geological characteristics, regional mineral distribution and typical characteristics of antimony deposits, and the metallogenic stages and metallogenic models of antimony deposits in the area are summarized. It provides a theoretical basis for the exploration of antimony ore resources in this area, and also provides a useful reference for the research of antimony ore deposits under similar geological background.

References

[1] Yunnan Provincial Bureau of Geology and Mineral Resources. Summary of Regional Mineral Resources in Yunnan Province [R]. 2006.

[2] WANG Yonglei. Summary of Metallogenic Regularities of Antimony Deposits in China [J]. Acta Geologica Sinica, 2014, 12 (12): 2209 ~ 2215.

[3] YU Kaiji. GEOLOGICAL CHARACTERISTICS AND EXPLORATION EXPERIENCE ON YUNNAN ANTIMONY ORES [J]. Yunnan Geology, 1990, 9 (2): 83 ~ 94.

[4] WANG Yong. Study on the Characteristics of Ore-forming Fluids and Fluid Geological Mapping in the Copper Gold Polymetallic Mineralization Concentration Area of Yongping, Weishan, Yunnan [D]. China University of Geosciences (Wuhan), 2002.

[5] WANG Yong, HOU Zengqian, et al. Stable isotope characteristics and origin of ore-forming fluids in copper-gold polymetallic deposits within strike-slip pull-apart basin of Weishan-Yongping continental collision orogenic belt, Yunnan Province, China [J]. Mineral Deposits, 2006, 25 (1).

[6] CHANG Kaiyong. ON THE GENESIS OF BIJIASHAN SB DEPOSIT IN WEISHAN, YUNNAN [J]. Yunnan Geology, 2007, 26 (2): 197 ~ 206.

[7] TONG Zida. A Study on the Mineralization of the Bijiashan Antimony Orefield in Weishan, Western Yunnan [D]. China University of Geosciences (Beijing), 2018 ~ 05.

[8] SHI Ping, LI Xue-mei, YANG Wei. THE GEOLOGICAL CONDITIONS AND METALLOGENESIS MODEL OF YANGHUTOU SB DEPOSIT IN WEISHAN, YUNNAN [J]. Yunnan Geology, 2019, 38 (02): 233 - 237.