

Research history and prospecting potential of gold deposits in Dongchuan Area, Yunnan, China

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Abstract. The Dongchuan area in China is part of the Sichuan–Yunnan–Guizhou polymetallic metallogenic field and contains extensive ore-deposits. Although gold was first discovered in the area in the 1990s, gold exploration and research are currently limited; only five areas have currently been identified as containing gold deposits with reserves of more than 20 tons. However, the area is believed to have considerable prospecting potential. Gold deposits mainly occurring in the wall of the rock mass have been found in the upper-middle section of the Pingdingshan Group to the lower-bottom section of the Yinming Group in relation to the intrusive action and development of sodium diorite. It has been determined that the core of the anticline complex and its nearby fault zone are the major ore hosting structures and that gold-deposit prospecting should be conducted around the N–S compressive shear zone. In this study, sites are determined that have certain characteristics accompanied by a high degree of rock formation and complete assemblages of lithological composition; these are considered to be locations conducive to the prospecting of gold deposits.

1. Introduction

The Dongchuan area is the third largest ore-deposit production region in China. It is famous for Dongchuan-type ore deposits and its rich resources, attracting both local and international geological experts ^[1, 2, 3]. Since the Boka gold mine was discovered in the 1990s, geologists have had been working in the Dongchuan area and have gathered a substantial amount of geological information ^[4, 5, 6]. However, research on gold exploration in the Dongchuan area remains immature compared to research on copper exploration in the same region. The Dongchuan area's gold deposits are the main research focus of this article, which reviews the research history and analyzes future ore prospecting in order to provide further insights into gold exploration in the Dongchuan area.

2. Geological background

The Dongchuan area is in the middle of the southwestern margin of the Yangzi Plate, which has a complicated crustal movement evolution history ^[7, 8, 9]. Exposed strata in the area are mainly composed of low-grade green schist facies layers of the Mesoproterozoic Dongchuan and Kunyang groups. The Dongchuan area is bounded by the Xiaojiang fault to the east, the Puduhe fault to the west, the near E–W trending Baojiu fault to the north, and the Matang fault to the south, forming a trapezoidal rift basin.



The Dongchuan area is situated in the southern part of the Sichuan–Yunnan–Guizhou polymetallic metallogenic domain, so it has an excellent metallogenic geological setting. Because of its special crustal evolution and dynamic background, tectonic deformation in the area is extremely complex. Fold deformation is great, fault structures are extremely developed, and the area experiences multi-phase, multi-type magmatic activities ^[10].

3. History of gold exploration

The complicated topography, geology, and mineralization characteristics of the Dongchuan area have limited gold exploration in the area.

(1) During a period from the 1950s to the 1980s, the Dongchuan Mining Bureau's geological exploration team conducted basic geological and prospecting research of the Dongchuan area. They started by exploring the Yinmin, Luoxue, Tangdan, and other large-scale copper deposits. However, there are few reports of the discovery of independent gold deposits, only reports on gold deposits associated with copper deposits. As of 1988, the total reserve of gold-associated copper ores was 21.07 tons.

(2) During a period from the 1990s to 2000s, the Boka and Xiaoliukou gold mines were discovered in the area. In 2003, No. 807 geological brigade submitted its Dongchuan Area Gold Mine Research Report, showing D and E class geological reserves of more than 20 tons and an average gold ore grade of 7.95g/t.

(3) From 2003 to 2007, Yunnan Jinshan Mining Co. Ltd. initiated gold exploration research work in the Boka gold mine. Soil investigation detected 26 geochemical gold and copper anomalies and high-precision magnetic surveys detected 6 anomaly areas and 53 individual anomalies. The main gold and copper anomaly areas detected usually consisted of valuable gold and copper mineralized spots. Geochemical anomalies often become direct indicators for gold prospecting, whereas magnetic anomalies may be used as indirect prospect indicators.

(4) From December 2008 to August 2009, No. 809 geological brigade initiated a large-scale geological survey of gold deposits in the northern section, copper deposits in southern section, and multiple ore and mineralized spots found throughout the Boka mine.

(5) In 2011, Beijing Zhongxing Research Technology Co. Ltd. conducted research in the Yuanbaoshan District. They have completed a 1:2000 geological survey of 1.60 km², and through trenching and drilling, acquired an estimated total of 715,200 tons of ore and 5390.84 tons of copper metal.

As of 2005, related geological researches and prospecting analyses of the Dongchuan area have been published in academic journals, therefore strengthening the exploration prospect potential of the area. Previous researchers have had issues regarding the genesis type and occurrence conditions of gold deposits found in the area. The lack of a complete understanding of the genesis, ore-forming horizons, and metallogenic age of these deposits has restricted prospecting of the area.

4. Existing issues

The degree of exploration and research of gold deposits found in the Dongchuan area is relatively low. Gold exploration in the area still faces problems, such as understanding the area's basic geology, ore deposits, and metallogenic theory, as well as finding suitable research methods.

(1) The stratigraphic system and distribution of ore deposits remains unclear. The Dongchuan and Tangdan groups exposed in the Dongchuan area are barren strata with similar lithology types and changes. They are generally characterized by low-grade metamorphism with complex structural changes, thus there are many differences views on the stratigraphic horizons and distributions of reach area. Therefore, stratigraphic determination and generalization of its distributions are important steps for effective mineralization forecasting and ore prospecting.

(2) The formation period, degree of maturity, mechanical properties, and distribution pattern of structurally deformed by-products and the relationship between gold and copper mineralization found in the area have not been effectively determined. The Dongchuan area is situated in a structural unit with strong structural deformation and a complicated distribution. At present, gold mineralization found in the Dongchuan area is structurally controlled. Multi-group and multi-type faults and fractures

are important direct ore-hosting spaces. Therefore, studying the history of tectonic deformation, the period of deformation, and the deformation dynamic background is an important way to understand the ore-controlling structure pattern and for ore prospecting.

(3) There is a lack of effective research on the magmatic activity period, genetic type, diagenesis mechanism, and depositional pattern and their relationships with gold and copper mineralization. Investigation results show that gold mineralization in the area is associated with the distribution of multi-stage and multi-type magmatic activities. The lithofacies type and distribution of in-situ forms are complicated. They are mostly subjected to complex metamorphism and have undergone superficial changes. Most of the characteristics of magmatic rocks became undefined, affecting the correct determination of genesis, period of mineralization, material source, and pattern of in-situ mineralization.

(4) There is comparatively little research regarding the geological and mineralization characteristics of gold deposits. There are no reliable conclusions on mineralization theory and ore prospecting basic information, such as ore-formation age, genetic types, ore-controlling factors, and in-situ mineralization patterns. In the Dongchuan area, only the Xinshan-Majiagou gold mine has reached a detailed investigation and exploration stage. However, the geological mineralization environment, morphology and occurrence of ore deposits, and in-situ distribution patterns are not fully understood. It is difficult to effectively compare different parts of the mining area with ore deposits found in adjacent areas, in terms of their geological conditions, to establish a conceptual model of mineralization and a geological exploration model.

5. Prospecting potential

Good and effective prospecting work requires that we have a comprehensive understanding of the metallogenic elements of the study area. In addition to regional fault zones, development of volcanic rock mass, gold anomaly mineralization, and other geological evidence, this paper also focuses on the following:

(1) Stratigraphic position

In the Dongchuan area, gold and ore deposits are close to the bottom of the Yinmin Formation and its underlying strata. For example, the Xinma-Majiagou mining area has ore deposits in the Tangdan Group of the upper-middle section of the Pingdingshan Formation and in the Dongchuan Group of the lower Yinmin Formation. The Sichuan Huidong Xintian gold deposit, which is adjacent to the Xinshan-Majiagou mine, is also found in the Tangdan Group of the Pingdingshan Formation. Xiaoliukou gold deposits are found within the Dongchuan Luoxue-Yinmin area, with ore-hosting horizons in the underlying strata of the Yinmin Formation. Mineralization analysis of ore-hosting strata in the Boka gold deposit also supports this conclusion.

(2) Lithological structure

The Dongchuan and Tangdan groups are barren strata with similar lithology and changing patterns. They are generally characterized by low-grade metamorphism with complex structural changes, thus there are more differences in terms of stratigraphic horizons and distributions. Ore-hosting strata, such as those of the upper-middle section of the Pingdingshan Formation, have complex lithology, composition, and rock structure. Low-rigidity shale and silty shale, which are chemically inert and have low permeability, act as chemical barriers. The strata also contain lenticular crystalized sandy limestone and dolomitic sandstone that have high porosity and fracture connectivity, a high degree of rigidity, good permeability, and are chemically active. Additionally, the contact between the Yinmin and Pingdingshan formations is a small-angled unconformity. The Pingdingshan Formation is an important source of fluid/rock reaction-extraction for ore-forming material and acts as an ore-forming fluid transport channel, allowing physiochemical property exchange and aggregation precipitation to occur.

The mid-upper part of the Pingdingshan Formation to the lower part of the Yinmin Formation is the main ore-hosting horizon for gold deposits and is important for prospecting indicators of the gold deposits. The higher the degree of development of related rock strata, the more complete the lithologic assemblage types and the more conducive it is for the enrichment of gold mineralization. It is also an

important reference index for identifying the degree of enrichment of gold mineralization. At the same time, the development of the core of the anticline complex and the near N–S compression-shear fracture zone is also a necessary condition for the spatial location of gold deposits. Intersections between fault zones and the interface layers between the Dongchuan and Tangdan groups are the most favorable structural sites for mineralization enrichment of gold deposits. In these areas, sodium diorite magma intruding along the fracture zone is the basic condition of hydrothermal gold mineralization. Small rock-body or larger-scale dike development sites are central for hydrothermal gold mineralization activity and are the sites of gold mineralized enrichment.

6. Conclusion

The Dongchuan area is one of the most important copper deposit areas in China. It is also a part of the Yunguichuan polymetallic metallogenic province. Since the discovery of gold in the 1990s, geologists have been working in this area, gathering a substantial amount of geological information and producing large amounts of literature. However, most of the ore (chemical) sites have not been subjected to systematic evaluation work, thus the presence of deeply-hosted or potentially-hosted ore deposits remain unclear. Gold mineralization in the Dongchuan area is related to the intrusive action and development of sodium diorite and is controlled by complex anticlines and faults. Gold-deposit prospecting should be carried out around the N–S compressive shear zone. Sites with the characteristics mentioned in this study and that are accompanied by high degrees of rock formation and complete assemblages of lithological composition will be locations conducive to prospecting gold deposits.

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