A Study on the Geological Characteristics and Metallogenic Laws of the Xilahe Copper Deposit in Yuanjiang County

Rongyong Xu *, Xiaoliu Wang, Ping Shi, Dianrui Liu, Wei Li

Kunming Geo-exploration Institute of China Metallurgical Geology Bureau, 702 Longquan Road, Ciba Street, Panlong District, Kunming, Yunnan

* Corresponding Author Email: 13629472352@163.com.

Abstract. The Xilahe copper deposit in Yuanjiang County, Yunnan Province, China, is a highly concerned copper mining area. The geological characteristics, structural characteristics, distribution of magmatic rocks, ore body characteristics, metamorphism and wall rock alteration, as well as the ore-forming horizon and mineralization characteristics of the deposit are described and analyzed in this article, revealing its mineralization laws. The strata of the ore deposit is mainly composed of the upper section of the Fei weihe Formation, and the structural characteristics show the development of multiple faults in the mining area, including magmatic rocks such as diabase. The characteristics of the ore body indicate the presence of five copper ore bodies, mainly sulfide ore, and the main metal mineral is Fool's Gold. Metamorphism and wall rock alteration are manifested as silicification, carbonization, and pyritization. The mineralization pattern is influenced by various geological factors, including geological structure, magnetic action, hydrothermal activity, and time factors. The deposit belongs to a sedimentary metamorphic copper deposit. Comprehensive analysis shows that the copper deposits in the study area have great potential for ore exploration, which has important theoretical and practical significance for subsequent exploration and application of ore exploration methods.

Keywords: Copper deposits, Geological characteristics, Metallogenic laws.

1. Introduction

The Xilahe Copper Mine is located at the southernmost end of the Eshan Platform Dome (I_2^{2d}) in the Yangtze Paraplatform (I), Sichuan Yunnan Platform Anticline (I_2), Wuding Shiping Uplift Fault Bundle (I_2^2), and the Yuanjiang Copper Mine area on the north side of the Honghe Deep Fault due to its tectonic location. The ore body, which is layered and lenticular, mainly occurs in the upper part of the Feiweihe Formation (Pt_1df^2) of the Dahongshan Group. At the bottom, there are fixed layers of light gray to grayish white medium to thick to massive quartzite and silicified dolomite. The ore deposit is controlled by strata, lithology, structure, and alteration intensity, among which the control characteristics of strata and lithology are particularly obvious.

2. Geological characteristics of copper deposits

2.1. Strata

The Triassic Ganhaizi Formation (T_3g) of the Mesozoic, the Feiweihe Formation (Pt_1df) of the Proterozoic Dahongshan Group, and the Feiweihe Formation (Pt_1df) of the Proterozoic Dahongshan Group are mainly exposed in the area (see Figure 1 for details). The ore bodies are mainly hosted in the Feiweihe Formation of the Dahongshan Group.

(1) The Mesozoic Triassic Ganhaizi Formation (T_3g) is characterized by gray to light gray argillaceous metamorphic feldspar quartz sandstone interbedded with black silty sericite slate and sandy slate, partially composed of black carbonaceous shale, mudstone, and coal seams. The exposed area in the region is relatively extensive, and it is in angular unconformity or fault contact with the underlying strata, with a thickness greater than 120m.

(2) The Proterozoic Dahongshan Group's Feiweihe Formation (Pt_1df) is divided into two sections. The upper section (Pt_1df^2) is composed of gray to greenish gray thin to medium thick layered dolomite

mixed with carbonaceous and sandy slate, as well as light gray to grayish white medium thick layered massive quartzite and silicified dolomite. The main ore bodies in the area occur in this section, which serves as the primary ore-bearing layer with a thickness ranging from 20-32m. On the other hand, the lower section (Pt_1df^1) is composed of thin to medium thick layered carbonaceous dolomite mixed with sandy slate and black carbonaceous slate. It has a small thickness and is in integrated contact with the underlying strata of the Hongshan Formation. This section is distributed in the central part of the research area, with a thickness ranging from 30-70m.

(3) The upper segment (Pt_1dh^3) of almond shaped and spherical hornblende sodium feldspar shallow grained rocks and the middle segment (Pt_1dh^2) of garnet hornblende green mud schists of the Proterozoic Dahongshan Group's Hongshan Formation are only exposed in the area. They are exposed in the central part of the research area, with a very small distribution area and unknown thickness. Additionally, they are in integrated contact with the overlying strata.

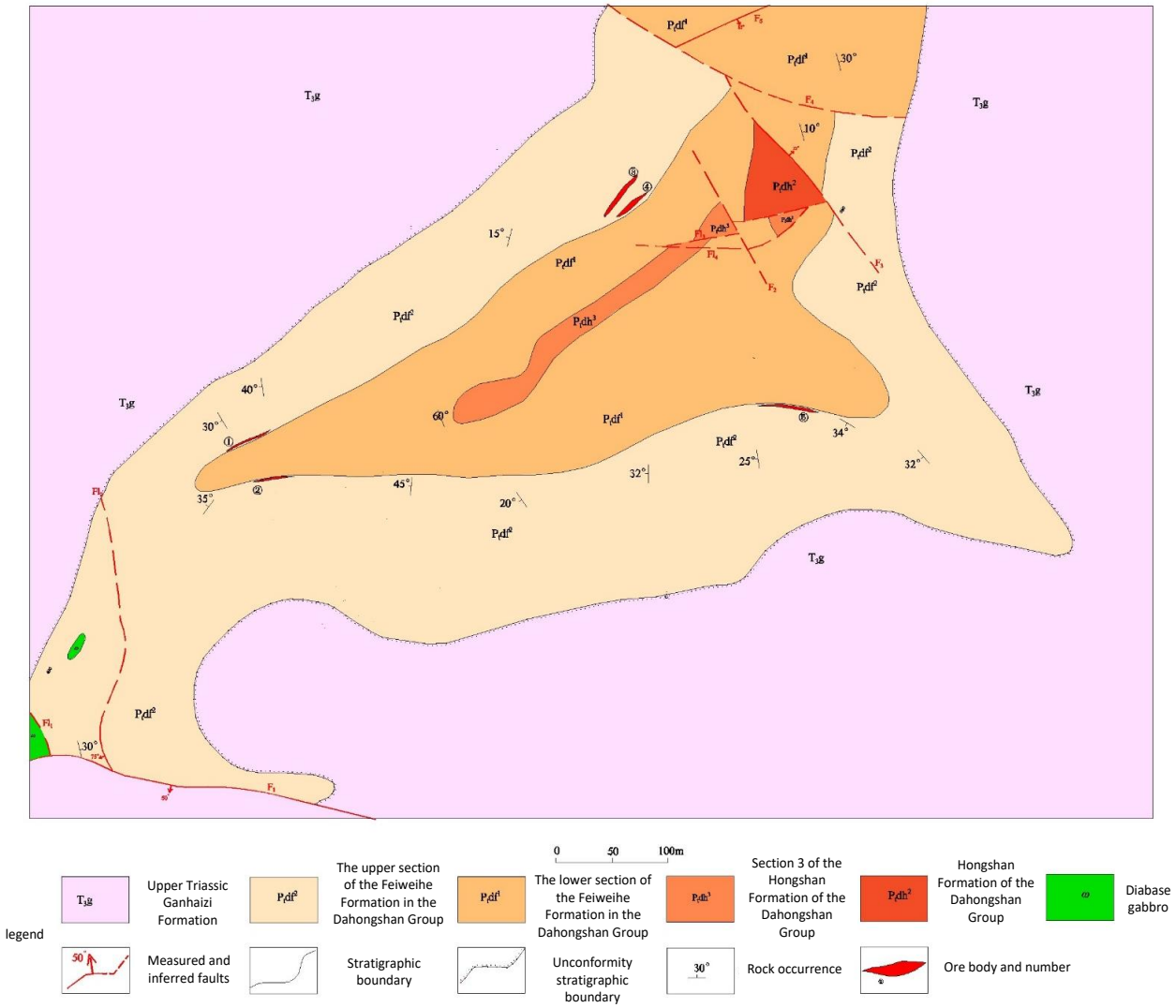


Figure 1. Geological schematic map of the study area

2.2. Structural characteristics

Fault development in the research area is distributed in the northeast and southwest of the mining area. In the southwest, there are three longitudinal faults, FL_1, FL_2, and a transverse fault layer F1. The two longitudinal faults, FL_1 and FL_2, are close to the north-south direction and dip westward with an inclination angle of 75°. They extend southward and are cut off by the nearly east-west transverse fault layer F_1. The east-west fault runs approximately 370m in length and dips southward with an inclination angle of 50-65°. In the northeast, the fault is composed of two sets of faults, namely the

northwest transverse fault layers F_2, F_3, F_4, F_5, and the northeast longitudinal fault FL_3 and FL_4. Among them, F3 leans towards the northeast at 75° and F_5 leans towards the southeast at 85°. The occurrence of other inferred faults is unclear. The vertical and horizontal faults intersect and cut each other in a block-like manner, with obvious fault breccia and occasional copper ore fragments, indicating post-mineralization faults. Additionally, there is a fault gouge with a thickness of 0.2-1.3m between the plate-like dolomite and mineralized dolomite on the upper wall of the ① ore body, which is an interlayer fault with the same occurrence as the rock layer. The saddle of the Xila River anticline has developed feather-like cracks, often serving as a site for ore fluid precipitation.

2.3. Magmatic rock distribution

Volcanoes and magnetic activities are frequent in the area, resulting in a range of basic to moderately acidic magmatic rocks that are products of multiple stages of activity. These rocks are mainly composed of diabase, basic diorite, and plagioclase lamprophyre, occurring as dikes, dikes, and rock plates. The formation period of these rocks is mainly during the Jinning period and the Indosinian Yanshan period.

2.4. Characteristics of ore body

Currently, 5 copper ore bodies, namely ore bodies ①, ②, ③, ④, and ⑤, are present in this area. They are produced in a layered or lenticular manner.

① No. ore body: The ore body is located in the upper part of the Feiweihe Formation (Pt_1df^2), beneath which is light gray to grayish white medium thickness to massive quartzite and silicified dolomite. It measures 70m in length, 130m in width, with a thickness ranging from 0.30-3.71m and an average thickness of 1.698m. The average grade is 1.99%.

② No. ore body: The ore body is located at the bottom of the upper section of the Feiweihe Formation (Pt_1df^2), which is characterized by light gray to grayish white medium thickness to massive quartzite and silicified dolomite. It measures 220m in length and 180m in width, and the ore body is layered with local expansion and contraction, without branching or compositing. The thickness ranges from 1.01-5.76m, with an average of 2.14m and an average grade of 0.86%.

③ No. ore body: The ore body is found in the light gray to grayish white medium to massive quartzite and silicified dolomite located at the bottom of the upper section of the Feiweihe Formation (Pt_1df^2). It is produced in a lenticular shape, measuring 120m in length, 80m in width, and with a thickness ranging from 1.00-14.07m. The average thickness is 4.02m, and the average grade is 2.77%.

④ No. ore body: The ore body is found in the bottom of the upper section of the Feiweihe Formation (Pt_1df^2), which is characterized by light gray to gray white medium thickness to massive quartzite and silicified dolomite. It is produced in a lenticular shape, with an average thickness of 5.91m and an average grade of 0.78%.

⑤ No. ore body: The ore body is found in the light gray to gray white medium thick to massive quartzite and silicified dolomite located at the bottom of the upper section of the Feiweihe Formation (Pt_1df^2). It appears as a lens, with an average thickness of 2.36m and an average grade of 0.59%.

The ore is mainly sulfide ore, with some oxidized ore on the shallow surface. The metal minerals are mainly Fool's Gold, followed by Cu5FeS4, copper ore, Malachite, and a small amount of Chalcolite, pyrite, and sphalerite; Gangue minerals mainly include Quartz, dolomite, and a small amount of chlorite.

3. Metallogenic regularity

3.1. Genesis of deposit

The ore deposits in this area are controlled by strata, lithology, structure, and alteration intensity, among which the control characteristics of strata and lithology are particularly obvious. The ore body is layered and mainly occurs in the upper part of the Feiweihe Formation (Pt_1df^2) of the Dahongshan

Group, with a light gray to grayish white medium to thick to massive quartzite and silicified dolomite at the bottom, with fixed layers. The occurrence state of copper minerals reflects a clear sedimentary origin. The two sets of faults and secondary structural fractures in the northeast and northwest directions of the mining area are favorable conditions for the rise, diffusion, and occurrence of hydrothermal fluids, controlling the formation and occurrence of epigenetic vein like ore bodies; The alteration of the surrounding rock near the mine includes silicification, carbonization, pyritization, and a small amount of chlorination, graphitization, etc; Among them, silicification is closely related to mineralization and often coexists with mineralization, with strong silicification and mineralization being better. Mineralization is distributed in silicified dolomite. In summary, the formation of the deposit in this area is closely related to the initial source layer, lithology, structural fractures, and alteration intensity, which are favorable conditions for the formation of the deposit. This deposit belongs to the sedimentary metamorphic copper deposit.

3.2. Metamorphism and surrounding rock alteration

The metamorphism in the area is strong, and the strata of the Middle Proterozoic Dahongshan Group exposed in the area have undergone varying degrees of metamorphism.

The alteration of the surrounding rock near the mine includes silicification, carbonization, pyritization, and a small amount of chlorination, graphitization, etc; Among them, silicification is closely related to mineralization and often coexists with mineralization, with strong silicification and mineralization being better. Mineralization is distributed in silicified dolomite.

Silicification: The alteration of the surrounding rock near the mine results in varying degrees of fading and recrystallization of the blue-grey dolomite, with a wide range of alteration and a milky white color of the rock.

Pyritization: Pyrite staining is widely distributed in the surrounding rocks of ore deposits.

Chlorite and sericitization: can be seen in carbonaceous slate or dolomite, which are products of hydrothermal alteration and are not significantly related to mineralization.

3.3. Ore bearing horizon and mineralization characteristics

The copper ore bodies in the area mainly occur in the upper section of the Feiweihe Formation (Pt_1df^2) of the Dahongshan Group, with a thickness of 1.5-7m, ranging from light gray to grayish white to medium thick to massive quartzite and silicified dolomite at the bottom; Mainly distributed along the layer in a layered and lenticular manner. The ore body mainly occurs in small lentils of quartzitized dolomite, composed of copper bearing quartz veins filled along interlayer fractures, distributed in an irregular vein or lentil shape along the layers, and exhibits significant expansion and contraction along the strike and dip. The ore body is mostly consistent with the occurrence of the surrounding rock, occurring in a gently inclined or horizontal manner, with a general inclination of 210-345 º and an inclination of 12-48 º. In addition, there are also copper bearing quartz vein ore bodies with small scales and significant changes, with a dip angle of 50 º and a dip angle of 75 º; In the strongly silicified dolomite near the edge of the quartz vein, there are still scattered disseminated and small veins composed of fine veins, but the scale is very small. The ore bearing strata in the area have undergone a long period of tectonic activity, with strong wall rock alteration. The copper ore body occurs in quartzite dolomite lentils, with a relatively rich grade but uneven mineralization. The metal minerals in the ore are mainly chalcopyrite, bornite, and pyrite, and the secondary minerals are mainly Malachite, Brochantite, etc. The deposit belongs to sedimentary metamorphic rock copper deposit.

3.4. Prospecting criteria

(1) Layer marker: The ore bodies in this area mainly occur at the bottom of the upper section of the Feiweihe Formation (Pt_1df^2) in the Dahongshan Group.

(2) Lithological indicators: light gray to grayish white, medium thick to massive quartzite, silicified dolomite.

(3) Erosion markers: with silicification and carbonization sites.

(4) Mark of mining relics: old mining caves near the ore bearing strata.

4. Conclusion

After the previous research, the following conclusions have been drawn.

(1) The copper ore bodies in the area mainly occur in the light gray to gray white medium thick to massive quartzite and silicified dolomite at the bottom of the upper section of the Feiweihe Formation (Pt_1df^2) in the Dahongshan Group.

(2) The metamorphism in the area is strong, and the alteration of the surrounding rocks is mainly silicification, carbonization, pyritization, and a small amount of chlorization, graphitization, etc; Among them, silicification is most closely related to mineralization, often coexisting with mineralization.

(3) Civilian mining sites can serve as direct indicators for mineral exploration.

(4) Through systematic comprehensive research and analysis, it is found that this deposit belongs to a sedimentary metamorphic copper deposit, with a relatively stable thickness and grade of the ore body. There is still a large exploration space in its direction and inclination.

References

[1] YU Guofei; CAI Hengan; SHANG Shichao, et al. The geological characteristics, metallogenic regularity and prospecting direction of skarn copper deposits in Zhaojiawan-Ouyangshan area, central south of Yangxin rock mass in Hebei [J]. Mineral Resources and Geology, 2023, 37 (02): 209 - 219.

[2] FU Rong-rong; WENG Wang-fei. Geological Characteristics and Metallogenic Regularity of Shuizhukeng Copper Deposit in Southern Anhui [J]. Gansu Metallurgy, 2023, 45 (01): 127 - 131.

[3] Hu Xingwang; Zhu Manhuai; Zhao Can, et al. Study on Geological Characteristics and Prospecting Regularity of Copper Deposits in Liuinggou Area of South Qinling Mountains [J]. Scientific and Technological Innovation, 2022, (14): 13 - 16.

[4] YU Xiuyan, ZHANG Xiang, HUANG Ziqiang, et al. Analysis of Geological Geophysical Characteristics and Metallogenic Laws of Copper Deposits [J]. China Metal Bulletin, 2021, (09): 46 - 47.

[5] MAO Yi; LIU Ya-lan; DU Jin-rui, et al. Geological Features and Structural Ore-Control of the Guanfang Cu Deposit in Yunnan [J]. Acta Geologica Sichuan, 2019, 39 (01): 75 - 78.

[6] YU Can, LI Feng, CHEN Minggui, et al.Geological Characteristics and Ore-contorlling Factors of Damingcao Copper Deposit in Yuanjiang of Yunnan[J].Nonferrous Metals Engineering, 2016, 6 (03): 73 - 76.

[7] XU You-zhi; HU Xing-tao. Analysis on ore controlling factors of Jiguanshan copper mine in Yuanjiang County, Yunnan Province [J]. World Nonferrous Metals, 2022 (04): 93 - 95.