Ore Features and Gold Occurrence of the Manlonggou Gold Deposit, Southeast Yunnan Province, China

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Abstract. The Yunnan-Guizhou-Guangxi “Golden Triangle” is one of the famous Carlin-type gold deposits in China and even in the world [1]. There are nearly 100 deposits and ore spots discovered in the area, and the total resources and reserves that have been identified now exceed 500 t [2]. Manlonggou gold deposit is a new gold deposit discovered in the “Golden Triangle” in recent years, which is a successful case of geochemical prospecting. The deposit can be a fine grain hydrothermal altered gold deposit with the origin of tectonic-medium-low temperature hydrothermal percolation.

1. Introduction

The Yunnan-Guizhou-Guangxi “Golden Triangle” is one of the famous Carlin-type gold deposits in China and even in the world [1]. There are nearly 100 deposits and ore spots discovered in the area, and the total resources and reserves that have been identified now exceed 500 t [2]. Manlonggou gold deposit is a new gold deposit discovered in the “Golden Triangle” in recent years, which is a successful case of geochemical prospecting. The deposit can be a fine grain hydrothermal altered gold deposit with the origin of tectonic-medium-low temperature hydrothermal percolation.

2. Mining area geological condition and deposit characteristics

The lithology in the mining area is mainly mudstone and silty mudstone of the Lower Devonian Pojiao Formation (D₁p), basal conglomerate, silty mudstone, mudstone and lithic quartz sandstone of the Posongchong Formation (D₁ps), crystal powder limestone of the lower Ordovician Nanjinguan Formation (O₁n), and crystal powder dolomite of the Cambrian Bocaitian Formation (Є₁b). The upper Ordovician and Silurian systems are missing. The upper Paleozoic strata are in unconformable contact with the lower strata, forming the Caledonian unconformable surface. The unconformity is an
important ore-bearing region in the “Golden Triangle”.

The ore bodies occur in the interbedded fractures and fractures of the top lithic quartz sandstone, medium-fine grained sandstone and mudstone in the Posongchong Formation of lower Devonian. The ore bodies are mostly lenticular and strike close to the east and west, distributed on the two wings of the Dabao syncline. The ore bodies are mostly lamellar and quasi-lamellar, which are strictly controlled by the shear fracture caused by the nearly EW direction fault and the F18 sliding overburden fault. The main wall rock alteration in the mining area includes silicification, pyritization, limonite and clayization, which are closely related to gold mineralization.

3. Ore quality
It can be seen from the geological characteristics that the Manlonggou gold deposit is controlled by the lithology and structure of a certain horizon and the hydrothermal activity in the later period. The host rocks are mainly lithic quartz sandstone, silty sandstone and silty mudstone.

3.1. Texture and structure of ores
The gold bearing rocks are mainly fine sand texture, fine medium sand texture, sandy texture and argillaceous texture. The ore minerals are mainly fine grain - fine grain unequal grain texture, allochthous fine grain texture and granular allochthous texture, while the metal minerals are mainly allochthous grain and crystalline grain. The ore-bearing rocks are mainly fragmentary structure, disseminated structure and shell-like structure. The main ore minerals in the ore are natural gold, limonite, hematite and pyrite (see occasionally), while the main gangue minerals are quartz, mica, kaolinite, calcite and a small amount of feldspar.

(1) Natural gold
The natural gold in the mining area is in the form of fine particles, and its morphological characteristics can only be accurately identified by laboratory means (figure 1).

![Figure 1. Gl- Natural gold (plane-polarized light)](image1)

![Figure 2. Lm-limonite (plane-polarized light)](image2)

(2) Limonite
Limonite is the main indicator mineral of gold mineralization in this area. It is unevenly distributed among the ores in the shape of yellowish-brown and brown shells. It is distributed along the joints and cracks. When distributed uniformly in the shallow part, it is usually the product of the oxidation of rock forming minerals, with a content of 3%-5%. Through the sample analysis and verification, the
higher gold grade position, the higher limonite content. It is proved that limonite is closely related to gold mineralization (figure 2).

(3) Pyrite
Occasionally deposited pyrite that is evenly distributed among ores in the form of particles and stars (figure 3).

(4) Magnetite
Magnetite is granular, locally concentrated, unevenly distributed (figure 4).

(5) Quartz
As the main gangue mineral of ores, quartz has three distribution forms. First, it is distributed in a discrete and uneven form, and the single particle is in the shape of sugar grain. It is the product of late silicification, and its particle size is generally less than 0.2mm. The second type is produced in the form of quartz veins. This kind of quartz changes from white to colorless and is related to gold mineralization. When it is associated with limonite and pyrite, there is generally gold mineralization. The third type is sedimentary quartz in the shape of sand or silty sand. This type of quartz has nothing to do with gold mineralization. The content is about 50%.

(6) Mica
White mica, microscopic flake shape, part slightly metamorphosed into sericite. The content is about 6%.

(7) Kaolinite
Kaolinite is distributed in microscopic scales, and is partly distributed with quartz in ore fissures, with a content of about 10%.

There is no primary ore in the mining area.

3.2. Material composition of ores
The spectral analysis of ores was shown in table 1. It is observed that main harmful components are Pb, Sn, Zn, As, Cr, and their content are 0.01-0.03%, 0.001-0.003%, 0.01%, 0.03-0.1%, 0.001-0.003%
respectively. Low levels of harmful components are harmless to human health. However, the accumulation of harmful elements on the surface may lead to the accumulation of harmful elements, which may have a certain impact on the environment. The grade of iron, silver and other elements is generally very low, and no independent silver minerals have been found.

Table 1. The spectral analysis of ores

| Sample No. | Pb   | Zn   | As   | Sb   | Ti  | V   | Ca  | Mg  | Al  | Si  | Fe  | Mn  |
|------------|------|------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|
| GP001      | 0.01 | 0.01 | 0.03 | 0.01 | 0.1 | 0.01| 0.03| 0.3 | >1  | >10 | >3  | 0.01|
| GP002      | 0.01 | 0.01 | 0.03 | 0.03 | 0.1 | 0.01| 0.03| 0.3 | >1  | >10 | >5  | 0.01|
| GP003      | 0.01 | 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03| 0.1 | ≥3  | >10 | >3  | 0.03|
| GP004      | 0.03 | 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03| 0.3 | >1  | >10 | >3  | 0.01|
| GP005      | 0.01 | 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03| 0.1 | >1  | >10 | >3  | 0.01|

Continued table 1. The spectral analysis of ores

| Sample No. | Ni  | Sn   | Mo   | B    | Cr  | Cd  | Ag  |
|------------|-----|------|------|------|-----|-----|-----|
| GP001      | 0.01| 0.01 | 0.03 | 0.01 | 0.1 | 0.01| 0.03|
| GP002      | 0.01| 0.01 | 0.03 | 0.03 | 0.1 | 0.01| 0.03|
| GP003      | 0.01| 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03|
| GP004      | 0.03| 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03|
| GP005      | 0.01| 0.01 | 0.1  | --   | 0.1 | 0.01| 0.03|

4. Occurrence state of gold

According to the results of phase analysis, exposed and semi-exposed natural gold are the main occurrence in the ores, while the contents of limonite wrapped gold, quartz and silicate wrapped gold and carbonate wrapped gold are relatively high, while the contents of copper-lead-zinc sulfide wrapped gold and pyrite wrapped gold are extremely low (table 2). Therefore, the natural type of ores is fine grain gold deposit in fine clastic rock.

Table 2. The result of phase analysis

| No. | lithology     | Total content of gold | exposed and semi-exposed natural gold | carbonate wrapped gold | copper-lead-zinc sulfide ore wrapped gold | limonite wrapped gold | Pyrite wrapped gold | Quartz and silicate wrapped gold |
|------|---------------|-----------------------|---------------------------------------|------------------------|------------------------------------------|----------------------|-------------------|-------------------------------|
| 1    | mudstone      | 0.58                  | 0.42                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 2    | mudstone      | 0.92                  | 0.87                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 3    | silty mudstone| 1.55                  | 1.37                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 4    | silty mudstone| 1.62                  | 1.48                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 5    | sandstone     | 1.18                  | 1.01                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 6    | sandstone     | 3.84                  | 3.03                                  | 0.11                   | 0.081                                    | 0.27                 | 0.069            | 0.17                          |
| 7    | mudstone      | 1.15                  | 0.99                                  | <0.050                 | <0.050                                   | <0.050               | <0.050            | <0.050                        |
| 8    | sandstone     | 1.35                  | 1.21                                  | <0.050                 | 0.077                                    | <0.050               | <0.050            | <0.050                        |
| 9    | mudstone      | 3.14                  | 2.89                                  | 0.082                  | 0.063                                    | 0.050                | <0.050            | <0.050                        |
| 10   | mudstone      | 1.59                  | 1.24                                  | 0.13                   | 0.070                                    | 0.057                | <0.050            | <0.050                        |
5. Conclusions
The main ore minerals of are natural gold, limonite, hematite and pyrite. The occurrence states of gold are exposed and semi-exposed natural gold, limonite wrapped gold, quartz and silicate wrapped gold, carbonate wrapped gold. The the natural type of ores is fine grain gold deposit in fine clastic rock. The deposit can be a fine grain hydrothermal altered gold deposit with the origin of tectonic-medium-low temperature hydrothermal percolation.

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References
[1] X. Yang, Q. H. Pi, G. Li, J. B. Wu, H. D. Yu, and D. Lu, Tracing of detrital provenance of Late Triassic Strata in the “Golden Triangle” area of Yunnan, Guizhou and Guangxi. Geological Bulletin of China, vol. 39(2/3), pp. 253-266, 2020.
[2] C. Maohong, M. Jingwen, C. ZhenYu, and Z. Wei. Mineralogy of arsenian pyrites and arsenopyrites of Carlin-type gold deposits in Yunnan-Guizhou-Guangxi “golden triangle” area, Southwestern China. Mineral Deposits, vol. 28(5), pp. 539-557, 2009.
[3] T. Kun, F. Zhihong, L. Mingjian, and Y. Ca. Genesis and Metallgenic Regularity of Manlonggou Gold Deposit Xichou County, SoutheastYunnan Province. Modern Mining, vol. 4, pp. 42-45, 2019.