

# Discussion on the Minerogentic Series of Gold Deposit in Qinghai

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## Abstract

Gold is one of the most important strategic minerals in Qinghai province. Based on the metallogenic characteristics, types, ore control factors and spatial distribution of gold deposits, the metallogenic regularities of gold deposits were put forward. It's divided the pre-Cambrian, Early Paleozoic, Late Paleozoic, Mesozoic and Cenozoic the metallogenic series assemblages, and also their distribution features are discussed which focus on five metallogenic periods. According to the theory of metallogenic series of ore deposits, combining with characteristics of typical gold deposits, twenty metallogenic series are preliminarily divided in Qinghai province. It is pointed out some suggestions about prospecting and exploration of gold deposits in Qinghai.

## Keywords

Gold Deposits, Metallogenic Background, Gold Deposit Types, Mineralization Epoch, Minerogentic Series, Qinghai Province

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## 1. Overview of Gold Deposit Resources in Qinghai Province

As of the end of 2015 (Report on Mineral Reserves Statistics in Qinghai Province in 2015, 2016), 354 gold deposit in Qinghai province, 208 mineral deposits with reserves. Among them, there are 11 large-scale, 22 medium-scale and 71 small-scale. At present, the province has a total of 782.56 tons of gold reserves. Rock gold accounted for 94.24%, shallow into medium-low temperature hydrothermal type accounted for 82.10%, marine volcanic rocks accounted for 3.19%, 5.21% skarn rock type, superposition type accounted for 3.74%, and Placer gold accounted for 5.76%. Placer gold deposits are found throughout the province, and are concentrated in the northern baiyenhara Metallogenic Belt, the southern baiyenhara Metallogenic Belt, and the northern Qilian Metallogenic Belt. The gold-bearing reserves of the three ore-forming zones are close to 90% of the

gold-bearing reserves of the whole province.

In Qinghai province except Xining city, other 7 states (City) have different scale of gold distribution. Identified gold reserves in the top two is Haixi, yushuzhou, accounting for 75.13% of the total.

## 2. Types of Gold

Due to the stable geochemical properties of the gold elements, the gold is rich in integrated ore in different geotectonic backgrounds, different geological eras and different rocks. It makes the classification scheme of the type of gold deposit is also varied (Wang et al., 2014).

In this paper, according to the “China Geological and mineral records provincial mineral geology and technical requirements” in the deposit (Genesis/industry) type table. Qinghai province endogenic gold ore is mainly composed of shallow-medium-low temperature hydrothermal type (Pan et al., 2009), followed by marine volcanic rock type and contact-metasomatic type.

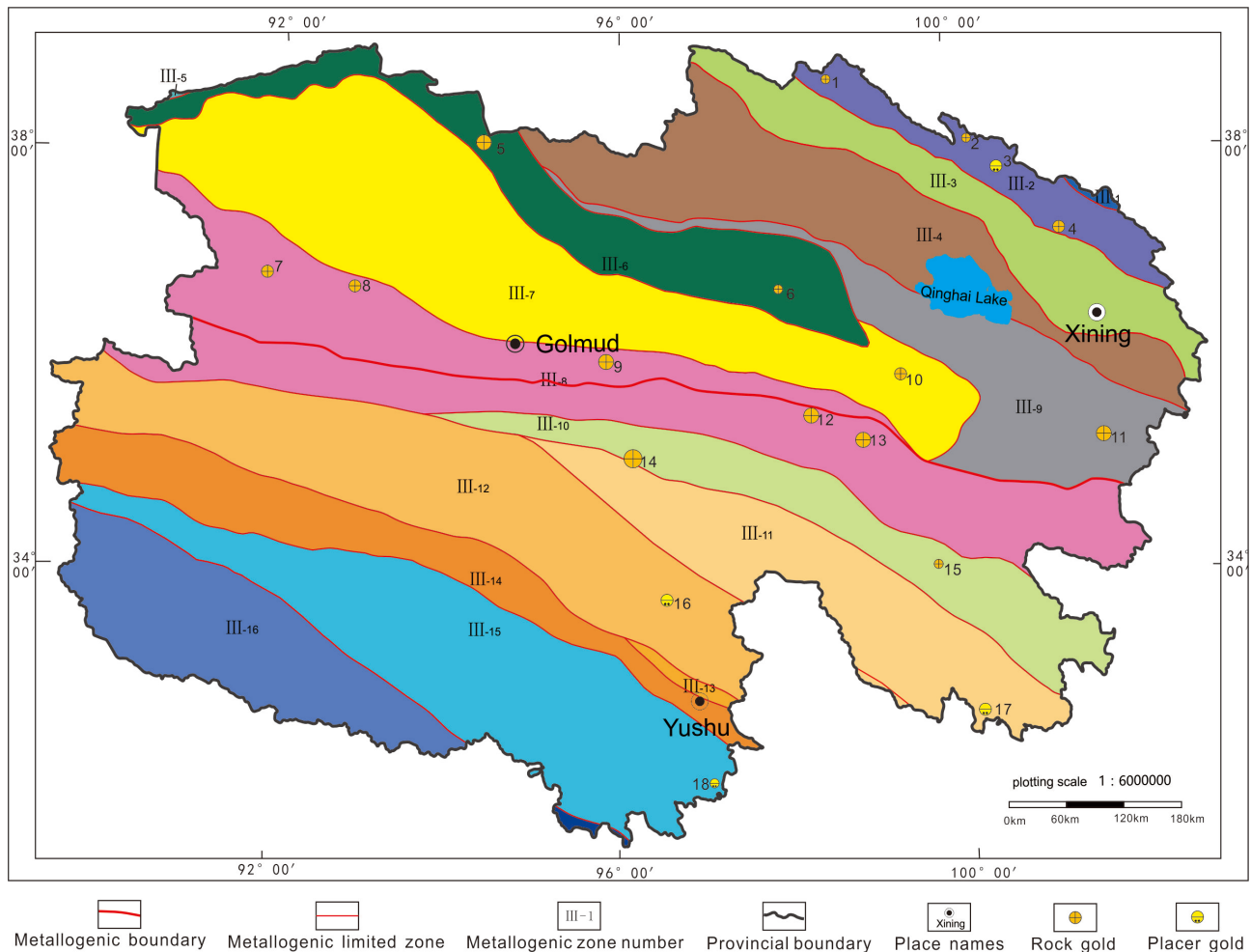
## 3. Gold Ore Formation

### 3.1. The Tectonic Background of Gold Mineralization

Qinghai is located in the northeastern part of the Qinghai-Tibet Plateau. The mineralization unit in Qinghai province is divided as follows, according to the principle of China's mineralization Zone (Xu et al., 2008) potential evaluation and the latest material and chemical exploration data results. We have Six ore-forming provinces (II), 16 ore-forming zones (III), namely North Qilian, North Qaidam, East Kunlun, West Qinling, kaohexili-ba yan Qala, three North West Yan, etc. (Pan, 2017) (**Figure 1**).

The strata from Proterozoic to the new era in Qinghai province are present. From the era, the distribution has the most extensive Cenozoic. On the space, al Jinshan South Slope, Qilian Mountains, Qaidam Basin, east Kunlun to widely distributed yuan ancient circles, the Paleozoic characteristics, it is widely distributed in the Cenozoic strata of the Republic Basin of KE Xili mountain, Anima Qing mountain, Tanggula mountain, xigang mountain and Xinghai. Qinghai is the most widely deposited Triassic, accounting for about 1/2 of the province's area, Carboniferous, Permian and Proterozoic strata also occupies an important position.

Qinghai magma is frequent and intense. From the Times, Caledonian magma activities focused on the North Qilian Mountains, qimantag, North Chai—Dulan area. The most intense magmatic activity in the Western phase of Hualien, in other parts of the province outside the North Qilian Mountains, tongtuo—Zuo, West jinulan—Yushu, Bukta Daban peak—Anima Qing and other areas are particularly evident. During the Indo-Chinese period, the magmatic activity was concentrated in the East Kunlun, erlash mountain and West jinulan—Yushu area. Yanshan period magmatic activity scattered in the eastern Qinghai area. The magmatic activity of the Xishan period develops in the various parts of



**Figure 1.** Distribution of III Metallogenic Units of gold deposits in Qinghai.

1. Red sichuan gold deposit; 2. Xishanliang gold-polymetallic deposit; 3. Tianpenghe placer gold deposit; 4. Songsongnangou gold deposit; 5. Tanjian hill gold deposit; 6. Saibaigou gold deposit; 7. Kendekeke iron - gold-polymetallic deposit; 8. Tawenchahanxi- iron-gold-polymetallic deposit; 9. Wulonggou gold deposit; 10. Man zhanggang gold deposit; 11. Warragon gold deposit; 12. Guolongwa gold deposit; 13. Kangde-shenong gold-polymetallic deposit; 14. Big gold deposit; 15. Dongcheng gongma gold deposit; 16. Zado gravel mine; 17. Jika sand gravel mine; 18. Caoqu downstream gravel mine

the eastern region of La Dandong, at the source of the Changjiang River and in the region of koukaxil (Pan Tong, et al., 2006) There are 18 major large-scale deformation tectonic belts in the province, among which there are 2 large-scale deformation tectonic belts of North Qilian thrust-strike-slip structure and Dang-Henan Shan-pull-back thrust structure in the Qilian orogenic belt. The eastern Kunlun—Qaidam orogenic belt mainly has 8 large-scale deformation structures. It includes, Alkin left strike-slip structure, zongwu Longshan—ia he Kan Jia strike-slip structure, North Chai edge inverse north edge inverse thrust—strike-slip structure, kunnanbei reverse thrust—strike-slip structure, erashan left strike-slip structure, Xinghai—Kuo Hai reverse thrust—strike-slip structure, kunnanbei reverse thrust—strike-slip structure MNZ, etc. The baiyanga orogenic belt has three large deformed structures: the Kunlun Mountain mouth-Gander thrust—strike-slip structure, the lower red-left strike-slip

structure, and the Mado-Machen hyperplastic wedge thrust pile structure. The second river orogenic belt has Ganz—Zi—Litang thrust—strike-slip structure, West of the Golden grey mullet Blue Lake—the Jinsha River reverse punch—strike-slip structure, Ulan-Ude-Lake—the Mekong reverse punch—strike-slip structure, long wooden Kai—Twin Lakes thrusting—strike-slip structure and Chamdo-lanping-way before the land stays Wrinkle washed off with 5 large deformation of the structure (Yang & Pan, 2013).

The reverse thrust—strike-slip structure on the north edge of chai, the reverse thrust—strike-slip structure on the north edge of Kunlun and the gander thrust—strike-slip structure on the north edge of Kunlun are prominent in the control of the gold deposit. Gold-related Metallogenic evolution is: from the relatively quiet tectonic period of the ancient Proterozoic, through the movement of lüliang, regional dynamic heat rheological properties, the invasion of the Granite in the orogeny, consolidation to form a crystalline basement, become part of the supercontinent of Colombia, the formation of this stage gold ore to provide a rich material base. From Nanhua Ji, Qin Qi Kun and its North area are the northern active land margin of Tethys Ocean, and Caledonian forms Qin-Qi-Kun Yang form. Then the multi-Island Arc Basin system was formed, forming the gold and polymetallic ore and rare earth ore related to marine volcanic activity, and the western ocean was closed. Qin, Qi and Kun entered into a collision between the mountains, which resulted in a large concentration of gold and polymetallic elements in the East Kunlun Region (Pan Tong, Ma Meisheng, 1999). The ore-forming region of Sanjiang is still the active continental margin of the ancient Tethys Ocean, and the Island-Arc Basin system forms the non-ferrous polymetallic deposit associated with marine volcanic activity. The Indochinese movement at the end of the Triassic closed the Tethys Ocean and formed three major orogeny belts of East Kunlun, ba yan Qala and Tanggula, providing a material source for orogeny gold deposits. Sedimentary deposits of placer—gold deposits were formed during the Oligocene-Pliocene in the epigenetic geology.

### **3.2. Gold Mineralization Ore Control Conditions**

The formation and distribution of rock gold deposits in Qinghai province are mainly controlled by Metallogenic tectonic background, fold fracture activity, strata and strata (rock facies) distribution, magmatic action and surface enrichment.

The details are as follows:

- 1) Tectonic conditions on the control of gold ore tectonic factors are an important factor in controlling the formation and distribution of gold deposits. The discovered gold deposits in Qinghai province are mainly located in and near the edge and tectonic band (subduction zone) of the Paleo-land and the inter-continental (Valley) subsidence zone. In particular, the fault zone that cuts through the lithosphere or the deep mantle, they control the distribution of the

stratum, magmatic rocks and the secondary faults without direction, which are important conditions for the material source, migration and enrichment of the gold ore belt. Part of the deep fracture is a direct guide ore structure, which controls the spatial distribution of the gold deposit. Such as Kun break, along the East Kunlun Mountain Main Ridge spread, for the main fracture of the thrust-go slip structure in kunzhong. It is a long-term active super-lithospheric fracture which directly controls the spatial distribution of the main gold deposits in the wulonggou Gold Fields and ditchy Gold Fields.

2) The control effect of formation on mineralization is mainly reflected in two aspects. One is that the formation controls some of the material sources of the deposit, which plays a role in the ore blastocyst. The second is the specific lithology and structural structure control the occurrence of ore body space, provide a channel for the mineralization of fluid migration, provide a place for the precipitation of minerals. There are ancient jinshuikou rock group, Zhongyuan ancient Wan dong ditch group, early Paleozoic Beach Mountain Group, in the Cambrian system of heizi ditch group, on the Cambrian system of six ditch group, on the Ordovician system buckle Menzi group, the female ditch group, the Triassic ba yan qinglashan group, the flood Sichuan group, long service River Group, the fourth Department. The high content of gold element in the formation is the basis of the material source of Metallogenic, such as the Cambrian heitgou group in the North Qilian area, the upper Ordovician buckle Menzie group is an important ore-bearing layer, the upper rock group of heitgou group in the basic-acidic volcanic rock to build gold element content is high, the And produced in the upper Ordovician buckle Menzi Group fine bijiao porphyry construction of pine nanogou ore with high content of gold elements.

3) The control effect of magmatic activity on gold mineralization is reflected in the formation and enrichment of gold deposit, whether it is basal rock, mid-acidic intrusive rock, basal rock or medium acidic volcanic rock. Gold metallization is basically consistent with the distribution of magmatic activities or intrusive rocks in the province. In the province from the North Qilian-East Kunlun-ba yan Qala mountain, all kinds of intrusive rock body from the Cali east period → Huali West period → Indo-Persian period → Yanshan successive new. Goldmine from North to South in the era, also shows the characteristics of change from the Caledonian period → Huali West period → late Huali West period → Indo-Chinese period → Yanshan period.

The distribution of magmatic rocks is the most extensive in Qinghai province. Magma activity at the same time is bound to be accompanied by a large number of magma hydrothermal activity, these hydrothermal from deep often carry deep into the mineral, while the high temperature of the magma hydrothermal determines its activity. This active hydrothermal material exchange occurs easily with the surrounding rock, further increasing the mineral concentration of hydrothermal, magmatic hydrothermal carrying a large number of minerals in the appropriate space position on the discharge precipitation mineralization. Such as

the beach between the Mountain gold mine, five longgou gold deposit, gologory Valley gold deposit, valgen gold deposit, etc., are formed in the West and the Indo-prostration period. This is consistent with the large-scale magmatic activity in this period. The formation of gold deposits and magmatic activity in the time there is a significant coupling relationship.

4) The control of gold deposit by surface enrichment shows that the gold deposit has secondary enrichment, such as Iron-Cap type gold deposit. In most gold deposits, only in the Iron hat to see the gold, the original ore is difficult to see, indicating that the size of the gold in the table under the conditions of life becomes large. In some deposits, gold content is low, only the associated components; but in the oxidation zone, but see the rapid increase in gold grade, up to the Independent gold requirements, or the emergence of “upper gold and lower copper” phenomenon. Almost all of the Metallogenic sulphide deposits of various Genesis types have a metal-bearing Iron Cap formed in the oxidation zone. Such as red ditch, shuangbencai, xiekeng, delney, hegeleng, copper ditch and other deposits, are available for mining of oxidized ore (Yang & Wen, 1999).

### 3.3. Temporal and Spatial Distribution of Gold Ore

#### 1) Time law of gold deposits

Qinghai province, the earliest formation of rock gold ore Precambrian, its industrial significance is not. Caledonian formation in volcanic activity related to the North Qilian Pine Nan ditch gold deposit (Pan et al., 2016). In the West phase of Huali gold deposit, the ore-forming intensity increased, and the formation of tanjian Gold Field on the north edge of chai, the Indo-Chinese period reached its peak. It also forms the Gold Fields of the East Kunlun wulonggou gold deposit, the Gold Fields of the ditch, the gold deposits of the manzhang gang, the gold deposits of the West Qinling wulegong gold deposit, and the Gold Fields of the North ba yan Qala Dabang gold deposit. Exogenous gold: the age of placer-gold mineralization is the Xishan period. The mineralization of Caledonian is mainly distributed in the ore-forming belt of Qilian and laji mountain in the North. The ore-forming effects of Huali West or late Huali West-early Indo-Chinese dynasties are mainly distributed in the gold Metallogenic Belt on the northern edge of chai. The main mineralization period of gold deposits in the East Kunlun region is the late Huali West-Indochina period. The south slope of Kunlun and the North Baiyun Mountain and the Republic-tongde area of gold mining mainly indosinian-yanshanian period.

#### 2) The spatial distribution of gold deposit

Among the 16 tertiary ore-forming zones in Qinghai province, the rock-gold deposits are mainly distributed in the East Kunlun (III-8), the North baiyenhara ore-forming Zone (III-11) and the North Qaidam ore-forming Zone (III-6) (**Figure 1**). Each mineralization zone is according to the number of mineral and resource statistics. Among them, the East Kunlun Metallogenic Belt in the central part of Qinghai province and the North ba yan Qala Metallogenic Belt ac-

counted for 60% of the gold resources in the province, and it is called “golden belt” in Qinghai province. From the type, shallow into the middle-low temperature hydrothermal concentrated in North Qilian, north edge of chai, East Kunlun, West Qinling and North Pakistan ore-forming Zone, mineralization than a single, mainly gold. The marine volcanic rocks are mainly distributed in North Qilian, and The Associated gold is mainly distributed in North chai and East Kunlun. The contact type is mainly distributed in West Qinling, and The Associated gold ore is mainly distributed in the East Kunlun Metallogenic Belt to the west of Golmud.

#### 4. Minerogenic Series of Gold Deposit in Qinghai

The definition of Metallogenic series of deposits refers to the natural combination of deposits with intrinsic causative links, in a certain period of geological history, in a certain geological structure unit and tectonic parts, and a certain geological Metallogenic effects related to a group of (Chen, Wang, & Lin, 1998; Chen, Pei, & Wang, 2007). That is, when the ore-forming series of a regional deposit is divided, the four elements of the main ore types should be considered first, including the time, space, and Metallogenic effects of the ore-forming series and the formation of the ore-forming combination. That is a certain period of geological history, Geological tectonic units constitute a certain geological environment, a certain geological mineralization and a group of deposits with a certain causal link. On the basis of the gold characteristics formed in different tectonic environments during different periods of Earth's evolution, etc. (Chen et al., 2007), the results were evaluated according to the potential of Qinghai province (Yang & Pan, 2013). It starts from the north to the south system to collect Hongchuan gold (small), xishanliang gold ore (small), Tianpeng River Sand Gold (Medium), Pine south ditch gold (medium), beach between the Mountain Gold (large), Saiba ditch gold (small), kende iron gold polymetallic deposit (medium), it Wen chahanxi iron gold polymetallic deposit (medium), wulonggou Gold (large), Manchang gang gold (medium), valgen Gold (large), goluo long WA gold gold ore (large), large field gold (large), dongshenggongma gold ore (small), zaduo placer gold (medium), jika placer gold (medium), grass song downstream placer gold (small) data. We use the deposit Metallogenic series (Group) to divide, that is, the deposit Metallogenic series Group to geological mineralization to further division, and it is known that there is no controversy is the magmatic, sedimentary, metamorphic Metallogenic effects. Also, we separated three combinations, considering the existence of independent geological mineralization of geologic fluid mineralization. Based on the characteristics of mineralization evolution and regional gold mineralization, the mineralization process in Qinghai province is divided into five major mineralization stages, including Cambrian, early Paleozoic, late Paleozoic-early Mesozoic, late Mesozoic and Cenozoic. Qinghai province preliminary division (determination) for 20 Metallogenic series (Group), which Precambrian 2, early Paleozoic 5, late Paleo-

zoic-early Mesozoic 5, late Mesozoic 2, Cenozoic 6.

## 5. Conclusion

1) Through the geological prospecting work in recent years, gold prospecting has made important progress, on the one hand shows the great potential of gold resources in Qinghai province. On the other hand also requires us to continue to strengthen the study of Metallogenic laws, in order to effectively guide the gold ore prospecting and exploration work, in order to achieve greater breakthroughs.

2) In accordance with the deposit (Genesis/industry) type division, can be divided into five types of gold in Qinghai province, including contact type, marine volcanic rocks, shallow into medium-low temperature hydrothermal type, superposition (compound) ore deposits, ore type gold ore. Among them, the shallow medium-low temperature hydrothermal type is the main, followed by marine volcanic rock type and contact type. Shallow into medium-low temperature hydrothermal type should be the focus of Future Work type.

3) According to the Metallogenic facts, combined with the understanding of the ore-forming law, the mineralization of gold in Qinghai province is divided into five periods, including the middle-Neoproterozoic, early Paleozoic, late Paleozoic-Mesozoic and Cenozoic. Meanwhile, the late Paleozoic-Mesozoic is the most important Metallogenic stage.

4) From a spatial point of view, the northern margin of chaidamu ore-forming belt, east Kunlun ore-forming belt, north ba yan North ba yan Kara ore-forming belt is the main gold ore distribution area. Considering the requirements of ecological protection, the Metallogenic Belt and the East Kunlun Metallogenic Belt of North Qaidam should be the breakthrough areas for gold prospecting.

5) The preliminary plan in Qinghai province gold ore-forming series is divided into a series (Group) 20, and enhances the theoretical understanding. The goal is to continue to improve in the future work practice, have better technical guidance to find gold deposit.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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