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## Fluid Inclusion Study of Zhengguang Gold Deposit in Heilongjiang Province and Its Ore Genesis Discussion

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### 1 Introduction

Zhengguang gold deposit in Heilongjiang province, located in the Duobaoshan metallogenic belt in the Northeastern Da Hinggan Mountains, is a newfound large scale ore deposit in recent years. Although much work about the geological characteristics of the deposit has been done, the deposit genesis is controversial. The origin of this gold deposit is tectonic alteration type based on the geological characteristics (Zhao Guangjiang, 2006). Through the isotopic tracing including H, O, Pb and the study of fluid inclusion, Zhengguang gold deposit is a low temperature hydrothermal deposit (Wu Ziyu, 2006). On the basis of previous studies, combining with the geological background of mineralization and the geological feature, the deposit belongs to the type of epithermal gold deposit (Fu Yanli et al, 2011). This paper presents fluid inclusion data of hydrothermal quartz and calcite in all ore-forming stages. The aim of the study was to constrain the physico-chemical conditions of mineralization and discuss the genesis of the ore deposit.

### 2 Geological Setting

Zhengguang gold deposit is produced in Duobaoshan volcanism and Yanshan invasion, and occurs in NWW-NNW tectonic belt. The ore veins occur in the contact zone between Yanshanian diorite pluton and the Middle Ordovician Duobaoshan Formation, and are controlled by NW faults, NE faults and near SN faults. The wall rock alteration near the ore such as silicification, sericitization, chloritization, epidotization, pyritization, kaolinization, limonitization, carbonatization and potassic are well developed. The field geological survey shows that the

characteristics of ore-formation are of multistage and multiphase. The ore-forming process can be divided into hydrothermal phase and epidiagenetic phase two phases. There are four mineralizing stages in the hydrothermal period, including quartz-pyrite stage, quartz-polymetallic sulfide stage, carbonate-polymetallic sulfide stage and quartz-carbonate stage.

### 3 Characteristic of Fluid Inclusion

#### 3.1 Petrographic features of fluid inclusion

Fluid inclusions are widely present in some hydrothermal minerals such as quartz and calcite of all the ore-forming stages. Primary inclusions have been found mostly while secondary inclusions have been found rarely. Most of primary inclusions morphology is with irregular shape, round-based, oval shape and negative form, rarely showing rectangular, triangular and other shapes. They differ in sizes ranging from 2μm to 20μm, mostly between 3μm and 8μm. The vapor-liquid ratio is usually less than 20%, showing the beating black spots or shaking bubbles. All the fluid inclusions belong to the type of gas-liquid inclusion at room temperature.

#### 3.2 Fluid inclusion data

Fluid inclusions in all the ore-forming stages homogenized into a liquid phase. The homogenization temperatures of all the inclusions in different stages range from 100.7°C to 252.1°C, with a dominant range from 130°C to 170°C and the temperatures for the initial ice melting range from -6.9°C to -0.3°C, which correspond to the salinity from 0.53 to 9.60 wt% NaCl equivalent.

In quartz-pyrite stage, the  $T_{\text{mice}}$  values range from -0.5°C to -6.2°C and the salinities are estimated to be 0.88-9.47wt.% NaCl equivalent, with a dominant range from

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4% to 7%. The  $T_h$  values range from 126.7°C to 252.1°C, mostly ranging from 150°C to 180°C. Trapping pressure ranges from 8.02 to 18.3Mpa.

In quartz-polymetallic sulfide stage, the  $T_{mice}$  values range from -0.6°C to -6.3°C and the salinities are estimated to be 1.05-9.60wt.% NaCl equivalent, with a dominant range from 4% to 7%. The  $T_h$  values range from 112.8°C to 188.7°C, mostly ranging from 130°C to 160°C. Trapping pressure ranges from 8.87 to 14.9Mpa.

In carbonate-polymetallic sulfide stage, the  $T_{mice}$  values range from -1.1°C to -5.6°C and the salinities are estimated to be 1.91-8.68wt.% NaCl equivalent, with a dominant range from 4% to 7%. The  $T_h$  values range from 100.7°C to 224.2°C, mostly ranging from 130°C to 160°C. Trapping pressure ranges from 9.20 to 16.2Mpa.

In quartz-carbonate stage, the  $T_{mice}$  values range from -0.3°C to -4.7°C and the salinities are estimated to be 0.53-7.45wt.% NaCl equivalent, mostly range from 1% to 5%. The  $T_h$  values range from 100.7°C to 196.5°C, mostly ranging from 100°C to 140°C. Trapping pressure ranges from 7.35 to 15.3Mpa.

Laser Raman analysis showed that the composition of fluid inclusions in all stages presents a low and wide water peak without other components in liquid and gas phases. Compositional analyses of fluid inclusions indicated that  $Na^+$  and  $K^+$  are the key components of cation while  $Cl^-$  and  $SO_4^{2-}$  are the key components of anion in the liquid phase. Meanwhile, the most important part of gas phase is  $H_2O$ , which abounds in  $CO_2$ .

## 4 Discussion

The temperature and salinity of fluid inclusions in all ore-forming stages is low, which have the trend of decreasing from quartz-pyrite stage to quartz-carbonate stage. That maybe caused by the addition of external meteoric water. The metallogenic depth corresponding to ore-forming pressure ranges from 0.735 to 1.83 km. Overall, the ore-forming temperature, pressure and depth are all revealing the epithermal feature.

In order to reflect the degree of oxidation and reduction in the metallogenic environment, we can divide the gas phase except  $H_2O$  into three groups including the oxide gas ( $CO_2$ ), reducing gas ( $CO$ ,  $H_2S$ ,  $CH_4$ ,  $C_2H_6$ ,  $H_2$ ) and inert gas ( $N_2$ , Ar). By contrasting with the high-sulfidation epithermal deposit(Zijinshan) and the low-sulfidation epithermal deposits(Tuanjieou, Wufeng), we can see that

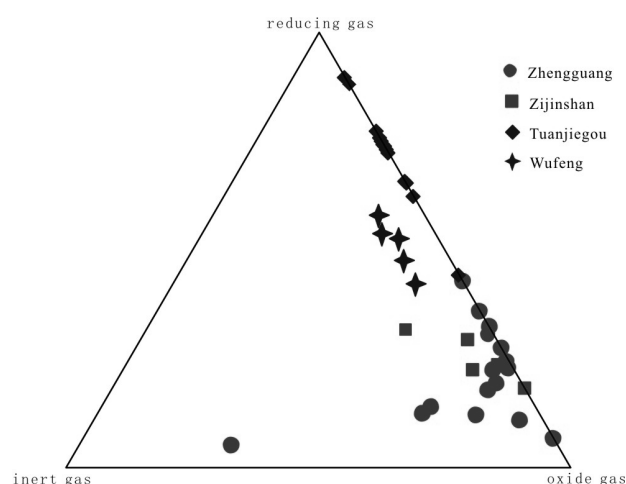


Fig. 1. Reducing gas-oxide gas-inert gas ternary plots

Zhengguang and Zijinshan both have high content in the oxide gas while Tuanjieou and Wufeng have high content in reducing gas(Fig.1). It indicates metallogenic environment of Zhengguang is rather oxidized. Considering geological characteristics such as vuggy quartz, Zhengguang gold deposit is regard as a high-sulfidation epithermal deposit.

## 5 Conclusion

Fluid inclusions in hydrothermal quartz and calcite define a temperature of formation from 130°C to 170°C and a meteoric water origin (very low salinity). The estimated metallogenic depth ranges from 0.735 to 1.83km. The metallogenic environment is oxidized through compositional analyses. Considering the geological characteristics, Zhengguang gold deposit belongs to the high-sulfidation epithermal type.

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