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The Characteristics and Its Geological Significance of Fluid Inclusions in Yingchengzi Gold Deposit, Heilongjiang Province

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1 Regional Geology

The Yingchengzi gold deposit is located in Shalai town, Ning'an county, Mudanjiang City, Southeast Heilongjiang Province, in the continental margin of NE China (Sun *et al.* 2013), tectonically on the east end of the Central Asia Orogenic Belt (CAOB), so called Zhangguangcai Range, adjacent to the Jiamusi Massifs in the northeast, the North China Plate in the south, and the Songliao basin in the west. This region underwent not only the evolution of the Paleo-Asian oceanic tectonic system in the Paleozoic, but was later overprinted and modified in the Mesozoic–Cenozoic by events related to the circum-Pacific tectonic system. Zhangguangcai Range are characterized by voluminous Phanerozoic granitoids, with rare Paleozoic strata and late Mesozoic volcanic and sedimentary strata occurring as remnants in a “sea” of granitoids (Wu *et al.*, 2000, 2002).

2 Ore Deposit Geology

The Yingchengzi gold deposit hosted in the eastwest trend ductile-brittle shear zone (Figure 1). There was 18 strip orebody, the most shape of the orebody is lenticular, besides there was layered and stratiform-like. The most mineralization of the deposit is sulfide altered mylonite type, a small quantity of the orebody was sulfide quartz vein type. Ore body is generally hosted by mylonitized monzogranite, although minor amounts of mineralization are hosted by metamorphosed pyroclastic rocks. By the field and laboratory study, the most ore minerals were pyrite, chalcopyrite, sphalerite and pyrrhotite, the lesser ore minerals were arsenopyrite, bornite, hematite and galena; the gangue mineral were quartz, goethite, chalcocite, covellite and malachite *et al.*. The ores show euhedral-subhedral crushed, dissolution metasomatism residual and allotriomorphic interstitial textures, and

veinlet-disseminated, vein like, brecciated and massive structures. Base on the correlation of the minerals and ore fabric, we divided the mineralization stage as: quartz–pyrite veins in the early stage, sulfide–quartz veins in the middle stage, and quartz–carbonate veins or veinlets in the late stage.

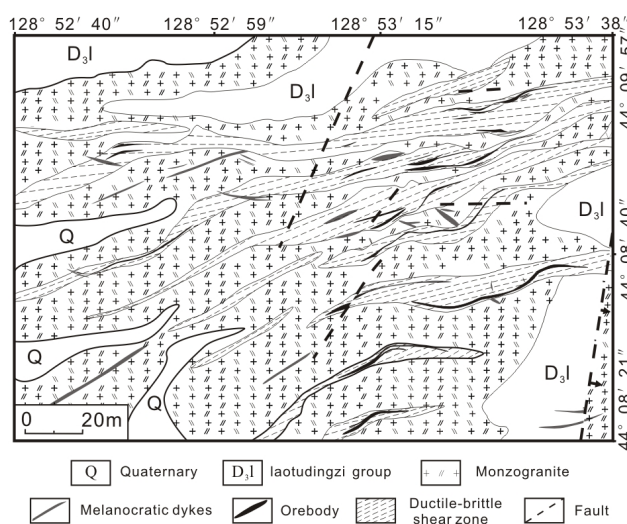


Fig. 1. Geological of sketch map of Yingchengzi gold deposit.

3 Characteristic of Fluid Inclusions

Four types of fluid inclusions were identified based on petrography and laser Raman spectroscopy: CO₂–H₂O inclusions, pure CO₂ inclusions, NaCl–H₂O inclusions, and daughter mineral-bearing inclusions. The early-stage quartz contains CO₂–H₂O fluid inclusions, NaCl–H₂O inclusions pure CO₂ inclusions and with salinities of 3.15 to 7.70wt.% NaCl equivalent, bulk densities of 0.65 to 0.87 g/cm³, and homogenization temperatures of 247.9 ~ 400.0°C, with vapor bubbles composed of CO₂, CH₄, and HS₂. The middle-stage quartz contains all four types of fluid inclusions, of which the CO₂–H₂O and NaCl–H₂O types yield homogenization temperatures of 214.5 °C–

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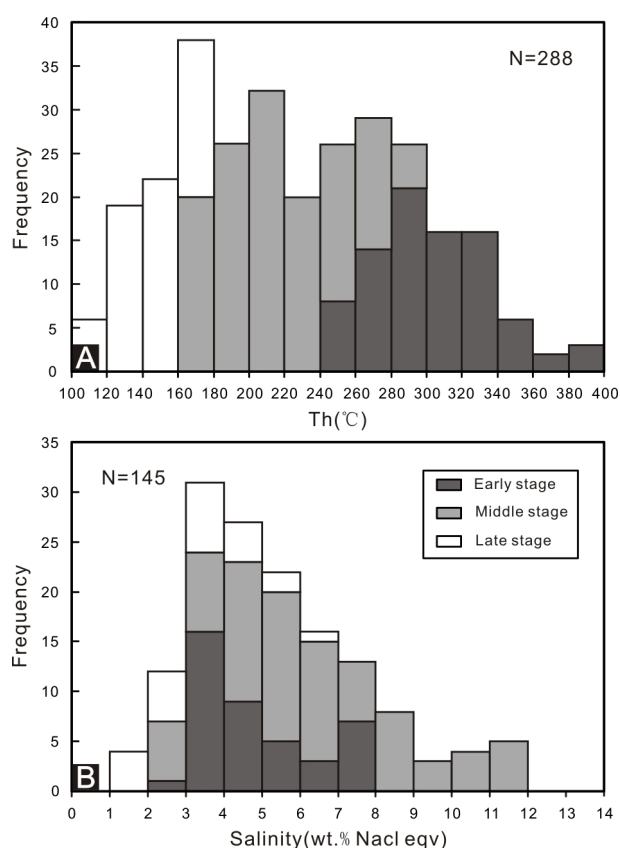


Fig. 2. Histograms of homogenization temperatures (A) and salinities (B) of fluid inclusions of the Yingchengzi deposit.

290.0 °C and 160.5°C–265.0°C, respectively. The CO₂–H₂O fluid inclusions have salinities of 2.20 to 8.35 wt.% NaCl equivalent and bulk densities of 0.64 to 0.90 g/cm³, with vapor bubbles composed of CO₂, CH₄ and C₂H₆. The NaCl–H₂O fluid inclusions have salinities of 2.73 to 11.95 wt.% NaCl equivalent and bulk densities of 0.81 to 0.96 g/cm³. Fluid inclusions in the late-stage quartz are NaCl–H₂O solution with low homogenization temperatures (99.0 °C–180.6 °C) and low salinities (1.39–6.14 wt.% NaCl equivalent), bulk densities of 0.93 to 0.97 g/cm³ (Figure 2 A and B).

The coexistence of all four types of fluid inclusions can only be observed in the middle-stage minerals, even in the microscopic domain of a crystal, representing an association trapped from a unmixing or boiling fluid system (Shepherd et al. 1985; Fan et al. 2003). It is

proposed that the onset of gold deposition in Yingchengzi deposit is related to the onset of fluid unmixing or boiling with the decreasing of fluid pressure.

4 Conclusions

Four types of fluid inclusions were identified in Yingchengzi deposit: CO₂–H₂O inclusions, pure CO₂ inclusions, NaCl–H₂O inclusions, and daughter mineral-bearing inclusions.

The coexistence of inclusions of these four types in middle-stage quartz suggests that fluid unmixing or boiling occurred in the middle-stage mineralization.

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