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Zircon U-Pb Dating and Geological Significance of Granitoids in the Jinchang Copper-Gold Deposit, Heilongjiang Province

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1 Ore Deposit Geology

The Jinchang copper-gold deposit is located in the Jilin-Heilongjiang folding belt, Jiamusi and Xingkai Plate to the north, and north margin of North China Plate to the south. So far, a number of deposits have been discovered in the region, including a large-scale gold-copper deposit (Xiaoxi'nancha); four medium-scale gold deposits (Wufeng, Naozhi, Nongping and Ciweigou) and four small-sized gold deposits (Jiusangou, Wuxingshan and Duhuangling). These discoveries indicate the high potential of the area to host epithermal gold–copper deposits.

The Indosinian-Yanshanian intermediate-acid intrusive rocks are largely distributed in the mining area. However, strata exposion of strata is relatively less, and Upper Proterozoic Huangsong Group metamorphic series and Midddle-Upper Jurassic Tianying Group volcanics are sporadic developed in the southwest of mining area .

The intrusive boies can be divided into five periods by diagenetic age: (1) Late Triassic dioritoid magmatic activity: rock types mainly include black medium and micro-fine grain biotite diorite, and mainly distribute in the Bahaodong-Xingjiagou-Qiongbangzigou-Banjiegou and northern area of the Jinchang country. (2) Early Jurassic granitoid magmatic activity: rock types mainly contain biotite granite, plagiogranite, coarse grain graphicgranite, potassium granite and granodiorite, which are ore-bearing wall and mainly distribute in the Heixiazigou-Xingjiagou and estern area of the Jinchang country. (3) Late Jurassic granitic magmatic activity: rock types mainly contains fine grain porphyric granite and medium-coarse grain granite, and mainly distribute in the Bahaodong-Heixiazigou and southern area of the Jinchang country. (4) Early Cretaceous granite porphyry magmatic activity: rock types mainly include granite porphyry and quartz porphyry, which are closely associated with time-space distribution of orebody and mainly distribute in the Bahaodong-Gaoligou. (5) Late Cretaceous dioritic magmatic activity: rock types mainly contain diorite and diorite porphyry occur as small stock or small apophysis. These kinds of intrusive bodies with different epoch and lithology constitute main ore-bearing wall within mining area.

2 Zircon U-Pb Dating

We selected typical granitoids from area around the mineral deposit for whole-rock geochemistry. Sample code GLG, JC, BHD and HXZ is representative of samples selected from Gaoligou, Banjiegou, Bahaodong and Heixiazigou area in the mining area respectively.

Sample BHD-1 (Granite) was collected from the southwestern Bahaodong, yielding an average $^{206}Pb/^{238}U$ age of 184.69 ± 0.98 Ma with MSWD = 4.6. Sample GLG-1 (Granite) was collected from the southwestern Gaoligou, yielding an average $^{206}Pb/^{238}U$ age of 203.62 ± 0.86 Ma (MSWD = 1.13). Sample GLGN (Granite porphyry) was selected from the southwestern Gaoligou. The 9 analytical spots gave a concordia age of 190.4 ± 4.7 Ma (MSWD = 4.6). Sample JC-20 (Granite) was selected from area around No. I orebody, yielding an average $^{206}Pb/^{238}U$ age of 205.88 ± 0.95 Ma (MSWD = 1.12). Sample JC-1 (Diorite) was selected from area around No. I orebody, yielding concordia ages range from 101 to 118 with a weighted mean age of 109.0 ± 2.4 Ma (MSWD = 1.8).

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3 Diagenetic and Metallogenic Epoch

The ore-bearing wall for the Jinchang copper-gold deposit is product of magmatic activity from Indosinian to Yanshanian, and metallogenesis is close associated with the Yanshanian granitoids. Therefore, it is an effective restriction for metallogenetic epoch that determinates ages for each period of granitoids in the mining area. The diagenetic epoch for granitoids is mainly focus on two epochs by dating results from predecessors: ~110 Ma and ~200 Ma. According to new research by Wu et al. (2011), the ages of granites developed in the periphery of the mining area are concentrated in the Early Jurassic-Late Triassic (175–240 Ma) and Early Triassic-Late Permian (245–260 Ma), minority in the Early Cretaceous (100–130 Ma).

We selected samples from the No. I orebody, Bahaodong and Gaoligou to prepare them for zircon dating, and obtained precise ages of 205.88 ± 0.95 Ma (JC-20), 109.0 ± 2.4 Ma (JCN), 190.4 ± 4.7 Ma (GLGN), 203.62 ± 0.86 Ma (GLG-1) and 184.69 ± 0.98 Ma (BHD-1) by LA-ICP-MS dating, which is consistent with ages obtained by predecessor. Therefore, we verified that there are two-phase important magmatic acitivities (~110 Ma and ~200 Ma) in the mining area at least, which provide essential conditions for forming of the Jinchang copper-gold deposit.

The authors think that magmatic activity around 200 Ma formed a series of molybdenum and copper-polymetallic deposits, and induced enrichment of copper in the Jinchang copper-gold deposit at the same time. However, magmatic activity around 110 Ma formed a series of gold deposits, and prompted enrichment of gold in the Jinchang copper-gold deposit. The superposition of two-phase magmatic activities (~200 Ma and ~110 Ma) in the Jinchang copper-gold deposit manifest as complex metallogenic system with superposition of magmatic fluid, which caused different opinions in discrimination of genetic type of ore deposit. Therefore, the metallogenic age of the Jinchang copper-gold deposit is around 110 Ma.

4 Metallogenic Dynamic Setting

We think that the Jinchang copper-gold deposit is located in the superposition of the Paleo-Asian Ocean tectonic domain and Marginal Pacific Ocean tectonic domain. The closing of Paleo-Asian Ocean occurred in Late Paleozoic-Early Triassic, and collisional orogenesis occurred around the Triassic-Jurassic boundary. A large number of granitoids developed in the Jinchang mining area since collisional regime of magma-fluid led to peak. Meanwhile, this period of magma-fluid activity induced large-scale molybdenum, copper-polymetallic mineralization in the Early Jurassic, such as Dashihe molybdenum deposit, Liushengdian molybdenum deposit, Yanghuidongzi copper deposit, Jiufogou and Dongzigou polymetallic deposits, and moreover this period of magma-fluid activity caused enrichment of copper in the Jinchang copper-gold deposit.

Since the Late Jurassic, tectonic setting in study area was transformed into Marginal Pacific Ocean tectonic domain. The Izanagi Plate subducted towards Paleo-Asian Ocean Plate and subduction-released fluids metasomated mantle wedge and happened partial melting. Magma, generated from partial melting, injected or contaminated by the Lower Crust in the process of upwelling, which is important to formation of the Jinchang copper-gold deposit.

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