XU Jiuhua, LIN Longhua, WEI Hao, WU Xiaogui and XIAN Defeng, 2013. Fluid Inclusion Study on the Dongtongyu gold deposit in Xiaoqinling Mt area, China. *Acta Geologica Sinica* (English Edition), 87(supp.): 808-810.

Fluid Inclusion Study on the Dongtongyu gold deposit in Xiaoqinling Mt area, China

XU Jiuhua[1*], LIN Longhua[1], WEI Hao[1], WU Xiaogui[1] and XIAN Defeng[2]

1 *University of Science and Technology Beijing, Beijing 100083, China*
2 *Tongguan Gold Mine, Gold Co.,Ltd.of China, Shanxi 714300, China*

The Xiaoqingling Mt. area, extending from east Shaanxi province to west Henan province, is one of the most productive gold districts in China. The Archean Taihua Group, mainly composed of amphibolite, plagioclase gneiss and migmatites, underlines much of the area. It forms an east-west trending folded structure comprising the Laoyacha anticline and the Jinluobei syncline, bounded by two regional scale faults—the Taiyao fault on the north side and the Xiaohe fault on the south side (Fig.1). Yanshanian granites occur along the Taiyao fault. Gold mineralization occurred at about 132Ma according Ar-Ar dating of sericite in mineralizing stage (Xu et al., 1998).

Like the Dongchuang and Wenyu gold deposits (Xu et al., 1993; Fan et al., 2003), the gold-bearing quartz veins in the Dongtongyu gold deposit are controlled by a series of east-west shear zones within the Archean Taihua Group, and related to the late Yanshanian (Cretaceous) granite. Principal alterations around shear zones are sericitization, silicification, pyritization and carbonization. Four structural stages of mineralization can be distinguished (Fig.2): I) pyrite-quartz stage forming the main bodies of the veins, which is characterized by large amounts of white quartz and disseminated cubic pyrite; II) quartz-pyrite stage, which is characterized by abundant pyrite and minor amounts of gray quartz. Sometimes pyrite occurs as nearly monomineralic bands along the vein margin and in the fractures within the veins; III) polymetallic sulfide stage, including chalcopyrite, galena, sphalerite, pyrrhotite and fine pyrite, associated with siderite, quartz and ankerite. This mineral assemblage was commonly developed in portions where quartz vein is relatively thick and stage II pyrite abundant; and IV) quartz-calcite stage, which is composed of fine-grained quartz and calcite crystals. Stage II and III are the main gold mineralization stages.

Fluid inclusions are abundant in various stages of vein quartz. Three types of primary fluid inclusions can be observed under room temperatures, that is, CO_2-H_2O inclusions, carbonic inclusions (Van den Kerkhof and Thiery, 2001), and aqueous inclusions. CO_2-H_2O inclusions are commonly seen in stages I, II, and III, which are two-phase inclusions of an aqueous liquid with 20 to 90 vol. % of CO_2 phase with size of 5 to 20 μm. CO_2-H_2O inclusions usually appear three-phase inclusions of an aqueous liquid phase, gas CO_2 phase of 10-40 vol. %, and liquid CO_2 phase of 30 to 50 vol.% (Fig.3). Carbonic inclusions are one-phase inclusions of a dense liquid CO_2 which occupies almost 100% of the whole inclusion cavity, and are associated with CO_2-H_2O inclusions. Aqueous inclusions are seen in late stage.

A microthermometry study shows that solid CO_2 melting temperatures ($T_{m,CO2}$) for CO_2-H_2O inclusions in quartz of stage I range from -60.5℃ to -57.3℃, indicating that there are some CH_4 or N_2 in CO_2 phase. The CO_2 partial homogenization temperatures ($T_{h,CO2}$) of stage I range from +8.2℃ to +28.5℃. The $T_{m,CO2}$s for CO_2-H_2O inclusions of stage II range from -60.3℃ to -56.7℃, and $T_{h,CO2}$s range from 1.1~28.5℃. CO_2-H_2O inclusions in poly-metallic sulfide quartz veins (stage III) have $T_{m,CO2}$ of -60.0~-58.5℃, and with $T_{h,CO2}$s of 7.1~24.1℃. CH_4 contents (X_{CH4}) can be calculated from the phase diagram of Thiery et al(1994). They are 0.04~0.11、0.05~0.07and 0.04~0.06 for stage I, II, and III, respectively.

The total homogenization temperatures (Th_{tot}) of CO_2-H_2O inclusions are from 221 to 392℃ for stage I, from 205 to 350℃ for stage II, and from 224 to 271℃ for stage III, whereas those of aqueous inclusions for stage IV are from 175 to 185℃. The salinities of CO_2-H_2O inclusions are from 5.5 to 7.9wt%NaCleqv for stage I, and from 5.1 to 7.1wt% NaCleqv for stage II and III, according to melting temperatures of clathrate. The minimum ore-forming pressures of gold-rich stage in the Xiaoqinling gold deposits are estimated to be 270-290MPa (Roedder,

* Corresponding author. E-mail: jiuhuaxu@ces.ustb.edu.cn

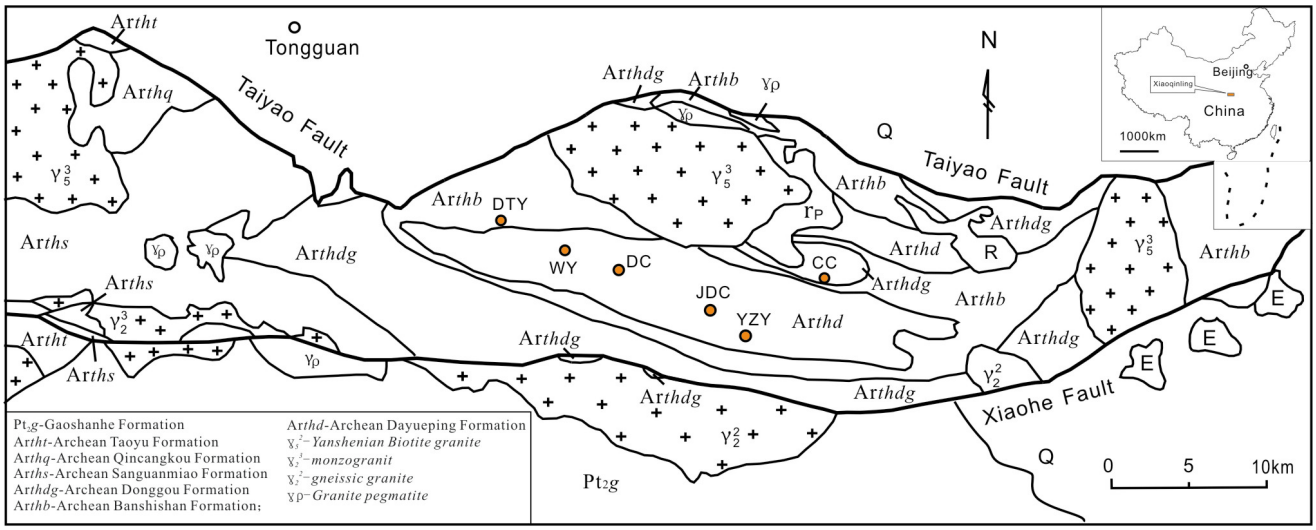

Fig. 1. Regional map of the Xiaoqinling gold provice (modified from Jiang et al., 1999)

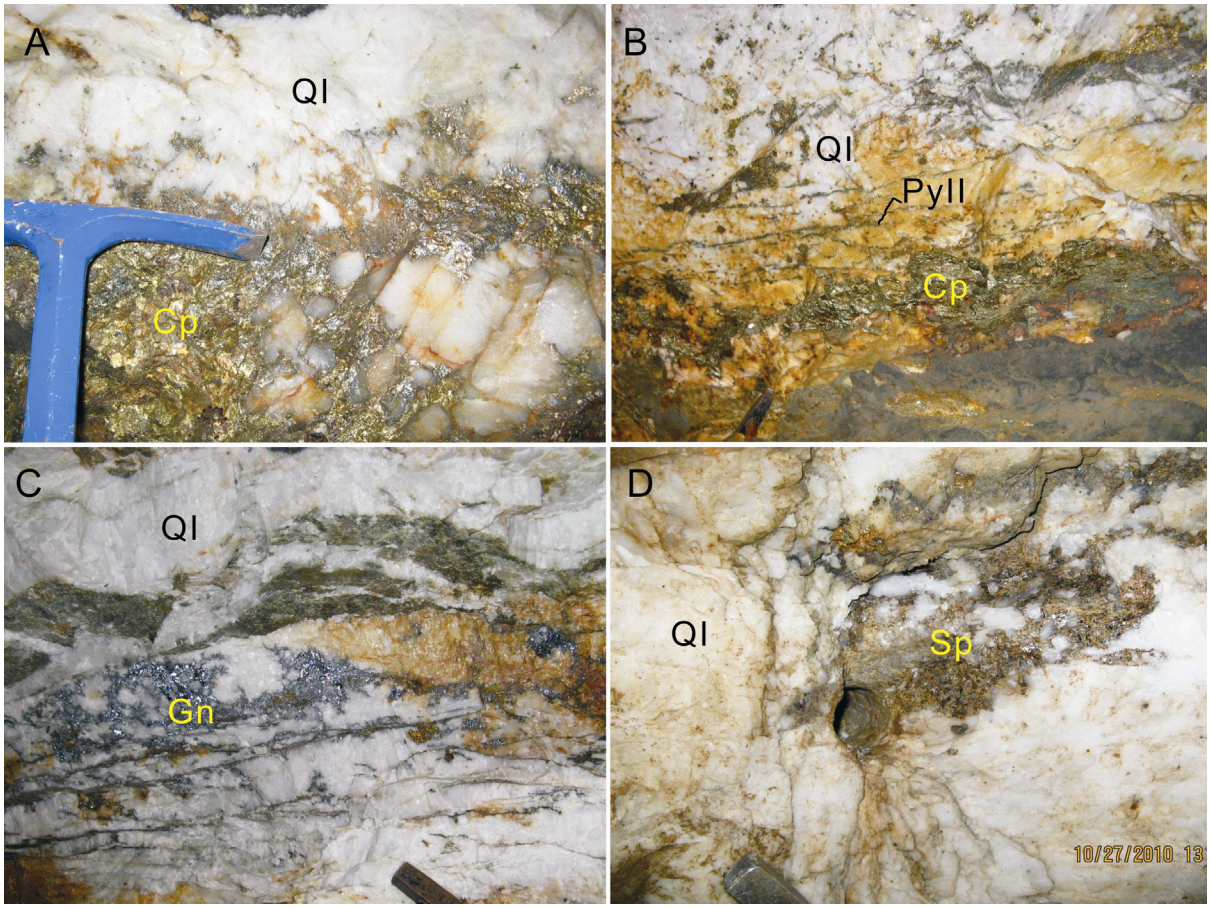

Fig.2 Characteristics of gold-bearing quartz veins in the Dongtongyu gold deposit

A- Chalcopyrite (Cp) of stage III in gold-bearing quartz veins, cements white quartz vein (QI) in early stage I, Q531 vein in Dongtongyu, at 1300m level; B- Stringer chalcopyrite (Cp) of stage III and stockwork pyrite (PyII) of stage II fills in footwall of stage I quartz vein (QI), Q8501 vein in Dongtongyu, at 600m level; C- Stockwork- stringer galena (Gn) of stage III fills in quartz vein (QI) of stage I, Q8501 vein in Dongtongyu, at 600m level; D- Stockwork- stringer sphalerite (Sp) of Stage III fills in stage I quartz vein (QI), Q8501 vein in Dongtongyu, at 600m level

1983; Bodnar, 2003).

The δD values of fluid inclusions in vein quartz from the Dongtongyu and neighbour Wenyu gold deposits are high, which range from –78.1 to -29.5 per mil for stage I, and from -50.8 to -43.8 per mil for stage II and III, indicating a metamorphic origin. The $\delta^{18}O$ values of vein

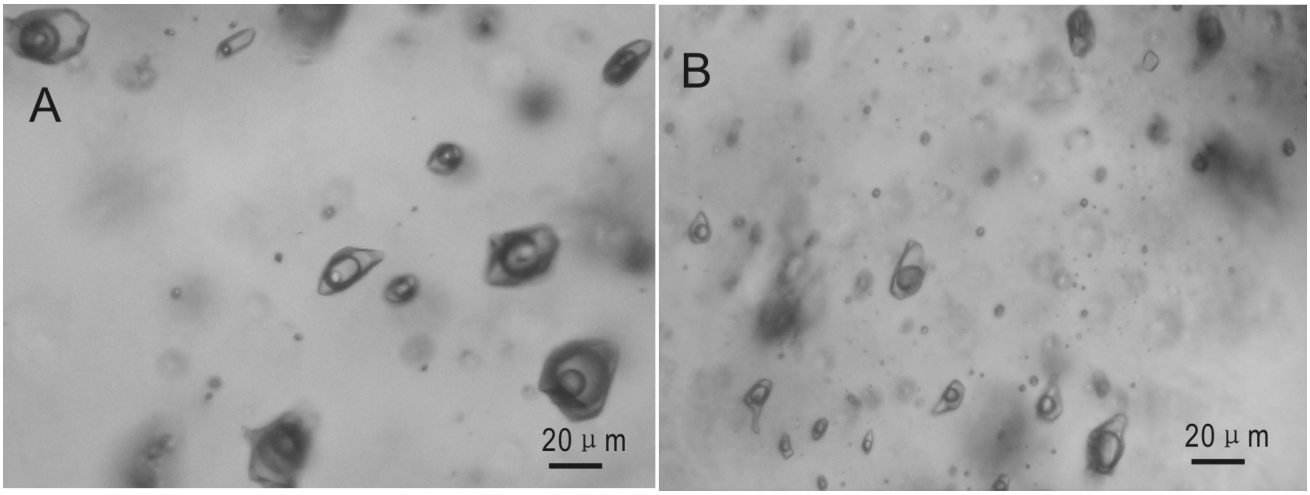

Figure 3 Fluid inclusions in quartz veins of gold deposits in the Dongtongyu gold deposit
A-Three-phase CO_2-H_2O inclusions in weakly deformed quartz veins, Dongtongyu V531, Ty010(1300m); B- CO_2-H_2O inclusions in quartz vein (QII+III) near a chalcopyrite grain,, Dongtongyu Q8, TY028(550m)

quartz are from 10.9 to 14.3 per mil for stage I, and from 7.9 to 9.7 per mil for stage II. The calculated $\delta^{18}O_{H2O}$ values of fluid inclusions vary from 7.2 to 10.2 per mil for stage I, and from 4.1 to 5.9 per mil for stage II and III, when using the quartz-H_2O fractionation equation. It is concluded that the hydrothermal fluids precipitating ores could have been mainly of metamorphic nature, according to the field of magmatic and metamorphic waters suggested by Taylor (1979). The $\delta^{34}S$ values for pyrite of the ores range from 2.5 to 8.2 per mil for stage I, and from 3.7 to 7.1 per mil for stage II. Those of other sulfides (chalcopyrite, galena, and sphalerite) range from -3.7 to 3.4 per mil, which proximate those from metamorphic rocks of Taihua group. In summary, the Dongtongyu gold deposit is an orogenic gold deposit related to regional metamorphic event.

Key words: Fluid inclusions, Stable isotopes, Gold deposits, Dongtongyu, Xiaoqinling,

References

Bodnar, R.J., 2003. Introduction to fluid inclusions. *In* Samson, I., Anderson, A. and. Marshall, D., eds., Fluid Inclusions: Analysis and Interpretation. Mineralogical Association of Canada, Vancouver, Canada*, Short Course Series,* 32:1-8.

Fan, H.R.，Xie, Y.H.，Zhai, M.G., and Jin, C.W.. 2003. A three stage fluid flow model for Xiaoqinling lode gold metallogenesis in the He nan and Shaanxi provinces, central China. *Acta Petrologica Sinica*，19(2):260-266 (in Chinese with English Abstract).

Jiang, N., Xu, J.H., and Song, M.X., 1999. Fluid inclusion characteristics of mesothermal gold deposits in the Xiaoqinling district, Shaanxi and Henan Provinces, People's Republic of China. *Mineralium Deposita*, 34:150-162.

Roedder, E., 1984. Fluid Inclusions. Mineralogical Society of America, Michigan, USA, *Reviews in Mineralogy*, 12, 644p.

Van den Kerkhof, A.M., and Thiery, R., 2001. Carbonic inclusions. *Lithos*，55：49-68.

Xu, J.H.，Ni, W. and Zhao, Y.S., 1993. A study on wall rock alteration at Dongchuang gold deposit in Xiaoqinling MT. Area, west Henan. *Contributions to Geology and Mineral Resources Research*，5(1):18-32 (in Chinese with English Abstract).

Xu, Q.D., Zhong, Z.Q., Zhou, H.W., Yang, F.C., and Tang, X. C., 1998. $^{40}Ar/^{39}Ar$ Dating of the Xiaoqinling gold area in Henan province. *Geological Review*, 44(3):323-327