XU Jiuhua, ZHANG Hui, GUO Xuji, CHENG Xihui, BIAN Chunjing, 2014. Overprints of Gold Mineralization in the Tiemurte VMS Deposit, Altay: Evidences from Geology and Fluid Inclusions . *Acta Geologica Sinica* (English Edition), 88(supp. 2): 1186-1187.

Overprints of Gold Mineralization in the Tiemurte VMS Deposit, Altay: Evidences from Geology and Fluid Inclusions

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1 Introduction

A majority of Lead-Zinc （Copper） deposits in the Kelan Volcano-sedimentary Basin of Altay are hosted in the Lower Devonian Kangbutiebao Formation, in which ore bodies occur as banded and lenticular layers, such as the Talate .in the Lower Sub-Formation ($D_1k_1^2$), the Daqiao in bottom of the Upper Sub-Formation ($D_1k_2^1$), and the Tiemurte and Dadonggou in the middle of the Upper Sub-Formation ($D_1k_2^2$). Mineralization epoch of bedded Pb-Zn deposits can be determined by volcanic country rocks. The ages of the Kangbutiebao Formation were reported in several recent papers, such as 388.9±3.2Ma and 400.7±1.6Ma of magmatic zircon LA-ICP-MS ages of metamorphic rhyolite in the Dadonggou deposit (Geng et al., 2012）, 396~405±5Ma of zircon LA-ICP-MS ages of metamorphic volcanic rocks in the Tiemurte deposit（Zheng et al., 2013）, and 412±3.5Ma of SHRIMP zircon U-Pb age of metamorphic rhyolite in the Abagong deposit（Chai et al., 2009）. Many geologists believe that bedded Pb-Zn (Cu) deposits are belong to VMS or SEDEX (Niu et al., 2006). Zhang et al (2012) argued that the Tiemurte deposit could not be VMS, but be a orogenic. Here we present overprints of gold mineralization newly found in the Tiemurte deposit.

2 Gold Mineralization

Gold and copper occurrances are widely found in the Volcano-sedimentary Basin of the southern Altaides. Some progresses were made on chronology of Au-Cu mineralization in recent years., such as 213.5Ma±2.3Ma of biotite Ar-Ar age in altered rocks of the Sarekoubu gold deposit (Qin et al., 2012), 219.73±2.17Ma of muscovite in copper-bearing ore of the Wulasigou deposit (Zheng et al., 2013). Gold (copper)-bearing ores occur as two types: 1) lentoid or streaked quartz veins (QI) which are parallel to the foliated structure of the biotite-chlorite or garnet-chlorite schist; 2) gold-chalcopyrite-bearing quartz veins (QII) which cut across metamorphic volcanic rocks at small angles.

The Tiemurte Pb-Zn (Cu) deposit, a main VMS deposit in the Kelan Volcano-sedimentary Basin, is controlled by the upper thrust-nappe of the NW-striking Abagong-Kurti fault. The ore bodies occur in chlorite quartz schist, marble, and garnet-biotite schist of the Lower Devonian Kangbutiebao Formation. Vein gold mineralization has been found recently in shear zones above Pb-Zn ore bodies. Gold ore bodies occur in brittle-ductile shear zones where intensive silicification and pyritization are developed in biotite-quartz schist. Two types of ores can be seen in mining tunnel: pyrite veinlets occurring along or cutting the foliated structure of schist (Fig.1A), and disseminated and massive pyrite associated with tiny vein quartz in altered schist (Fig. 1B). These vein gold systems must be related with later orogenic and metamorphic events.

3 Fluid Inclusions

Fluid inclusions in vein quartz from gold ore bodies in the Tiemurte are mainly characterized by CO_2-rich inclusions, including two phase H_2O-CO_2 inclusions (L_{CO2}-L_{H2O}) and mono-phase carbonic inclusions (L_{CO2}, $L_{CO2-CH4}$ or L_{CO2-N2}) (Fig.2). L_{CO2}-L_{H2O} inclusions consist of liquid H_2O phase and liquid CO_2 phase, with CO_2 volume percent from 80% to 20%. Carbonic inclusions may occur as one direction (Fig.2B), or associated with L_{CO2}-L_{H2O} inclusions.

Primary microthermometry has been done. The temperatures of CO_2 triple points ($T\text{m}_{,CO2}$) of L_{CO2}-L_{H2O} inclusions of the gold-bearing sulfide-quartz vein (Q1) and

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late grey vein (Q2) are -58.6~-57.1℃ and -61.9~-57.2℃ respectively, and the CO_2 partial homogenization temperatures ($T_{h,CO2,}$ homogenized to liquid CO_2) are 5.4~11.4℃ (Q1) and -11.4~14.0℃ (Q2), which are corresponding to 0.06~0.02 and 0.20~0.03 of X_{CH4} (After Theiry et al., 1994). Considering X_{CH4}, the densities of carbonic phases are 0.85~0.80g/cm^3(Q1) and 0.70~0.80g/cm^3 (Q2) (After Swanenberg, 1979). The melting temperatures of CO_2 clathrates are 3.4~4.6℃(Q1) and 3.0~7.4℃(Q2), corresponding to 9.6~11.3wt%NaCleqv and 5.0~11.9 wt%NaCleqv of salinities (After Collins, 1979). Only a few final homogenization temperatures ($T_{h,TOT,}$ 250~343℃) of CO_2-H_2O inclusions were obtained because of decrepitating for majority of inclusions.

Carbonic phases of fluid inclusions in above samples were analyzed by laser Raman microprobe. Most of them are CO_2-N_2-CH_4 inclusions, some are CH_4-N_2 inclusions, and some show very strong CH_4 peak and weak SO_2 peak (at Raman shift 1160cm^{-1}) (Fig.3). CO_2 spectra peaks are clearly present near Raman shift 1384 cm-1 and 1278 cm-1, and CH_4 and N_2 spectra peaks are present around Raman shift 2915cm^{-1} and 2327cm^{-1}, respectively. These data are consistent with, and support the microthermometric data.

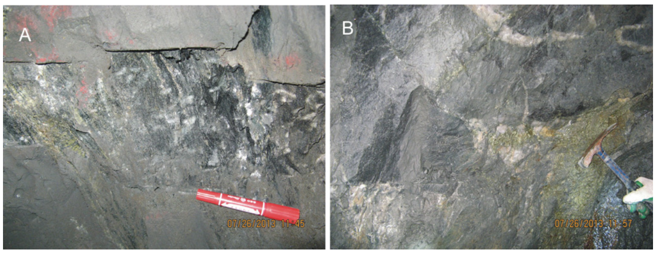

Fig. 1 Gold mineralization at the Tiemurte-Sarekoubu area
A-Pyrite veinlets occurring along or cutting the foliated structure of schist, 1552m level, Tiemurte; B-Pyrite-quartz veins in biotite schist over Pb-Zn ore bodies, 1483m level, Tiemurte

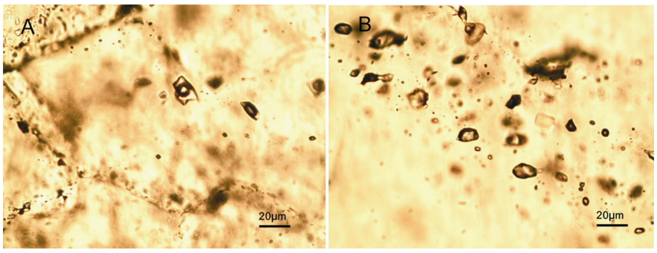

Fig.2 Fluid inclusions in quartz of gold ores from the Tiemurte
A-Primary L_{H2O}-L_{CO2} inclusions in quartz associated with chalcopyrite, TM905c; B-Carbonic inclusions in quartz associated with chalcopyrite, TM906b

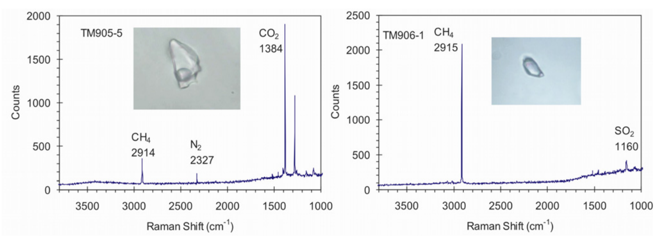

Fig.3 Raman spectra of carbonic phases in various inclusions (Conducted at Fluid Inclusion Lab of IGG-CAS)

4 Conclusion

Carbonic-rich inclusions of vein gold system in the Tiemurte deposit do not represent parts of VMS ore systems but represent a much younger orogenic-metamorphic event that may have contributed to gold mineralization and modified VMS deposits. Widespread occurrences of vein gold-copper mineralization in the southern Altay can be found not only in the Tiemurte but also in other VMS deposits, such as the Dadonggou and the Talate.

Acknowledgements

This work is funded by National Nature Science Foundation of China (41372096, 40972066). Thanks also to Prof. Fan HR of IGG-CAS for Raman analysis.

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