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The Ore-forming Fluid and S-Pb Isotopic Characteristics of the Jijiawa Gold Deposit，Henan Province

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1 Deposit Geology

The Jijiawa gold deposit is located in the western part of the Xiong'er mountain gold polymetallic ore district, Henan Province. The mining stratas cropped out in the ore district are consisted of the Taihua Group of Neoarchean and the Mesoproterozoic Xiong'er Group. SN and NE trending fault segments are widespread developed in the deposit area, and they represent the major ore-controlling structures. Ore bodies occur within nearly SN- trending faults and display a shape “Y” for the ore distribution on the tendency. And they generally appear as thin veins, lenticular or irregular shapes. Two mineralization types could be distinguished: 1) Pyritization altered rocks with stringer-net vein structure and disseminated structure, which is the major mineralization type; 2) quartz vein mineralization. The ore-forming process can be divided into four stages as: pyrite-quartz vein stage (Ⅰ) , which forms the quartz vein with pyritization or K-feldspar; quartz-pyrite vein stage (Ⅱ) , which forms beresitization altered rock and quartz-pyrite vein; quartz–polymetallic sulfides stage (Ⅲ) , which forms polymetallic sulfides quartz vein and quartz-carbonate vein stage (Ⅳ). The gold mineralization mainly occurred at stage Ⅱand Ⅲ.

2 Microthermometry

According to the petrography and microthermometry behavior of fluid inclusions, the fluid inclusions can be divided into four types: three-phases CO_2 type inclusions (Ⅰ); aqueous-rich inclusions(Ⅱ); pure gas-phase type and pure liquid-phase type. The CO_2 type consists of vapor, liquid CO_2 and L_{H2O}. According to V_{CO2}+L_{CO2} volume, they are classified as $Ⅰ_a$ subtype (that V_{CO2}+L_{CO2} volumn greater than 50%) and $Ⅰ_b$ subtype (that V_{CO2}+L_{CO2} volumn less than 50%). Similarly, aqueous-rich type inclusions are classified as $Ⅱ_a$ type (that gas-phase volumn greater than 50%) and $Ⅱ_b$ type (that gas-phase volumn less than 50%). In this process, two types of fluid inclusions in stage Ⅰ and Ⅱ are indentified as CO_2 type and gas-liquid type; but stage Ⅲ and Ⅳ quartz contain exclusively gas-liquid type fluid inclusions.

The microthermometric results of fluid inclusion of the Jijiawa gold deposit display that the homogenization temperatures of ore-forming fluids from stage Ⅰ to stage Ⅳ are 232-333℃, 143-266℃, 135-227℃ and 106-166℃ respectively, with the corresponding salinities being 3.76%-16.05%, 1.74%-17.34%, 0.7%-17.26% and 0.35%-11.34%. The liquid phase compositions are mainly H_2O, CO_3^{2-} and OH^- and the vapor phase is dominated by H_2O and CO_2, along with minor componen

ts of CH_4, N_2 and H_2S. The minimum trapping pressures estimated from CO_2 type inclusions are 30-85MPa and 25-64MPa for stage Ⅰand Ⅱ, which correspond to the ore-forming depth of 1.1 to 3.2km and 0.9 to 2.4km, respectively. During the ore-forming process, the ore-forming fluid was evolved from CO_2-H_2O-NaCl system, which is characterized by medium-low temperature and medium-low salinity, to H_2O-NaCl system, with low temperature and low salinity.

3 Hydrogen and Oxygen Isotopes

The results of hydrogen and oxygen isotopes show that the $\delta^{18}O_{V\text{-}SMOW}$ range from 10.9‰ to 15.7‰, and the $\delta^{18}O_{H2O}$ range from -3.1 to 7.4‰. The variation range of $\delta^{18}O_{H2O}$ are 2.9‰ to 7.4‰, 0.2‰ to3.6‰, -3.1‰ to 1.0‰ and -2.9‰ from stage Ⅰto Ⅳ, and the variation range of $\delta D_{V\text{-}SMOW}$ -78‰ to -65‰, -78‰ to -59‰, -69‰ to -58‰ and -50%. The plot of $\delta D_{V\text{-}SMOW}$ versus $\delta^{18}O_{H2O}$ shows that samples from stage Ⅰ fall within the range of primary magmatic water, although some samples are slightly depleted in $\delta^{18}O_{H2O}$. Stage Ⅱ and Ⅲ isotopes plot in the

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diagram imply a mixture of magmatic and meteoric water, whereas stage Ⅳ fluids are exclusively meteoric water. Therefore, it is concluded that in the Jijiawa gold deposit, the hydrothermal system gradually transited from a magmatic-dominated fluid to a meteoric-dominated fluid.

4 Sulfer

The $\delta^{34}S$ values of the Jijiawa gold deposit range from -14.9% to -5.4%. The results show that the $\delta^{34}S$ values are basically negative. This wide $\delta^{34}S$ variation shows that the S isotope data reveals a characteristic of biogenic. But the $\delta^{34}S$ values of the Taihua Group and Xiong'er Group stratums, as well as the Yanshanian granite, are positive values. And only the Guandaokou and Luanchuan Groups contain organic material, which can be considered as a possible source of the biogenic of the Jijiawa hydrothermal system.

5 Lead

The Pb isopote ratios for the Jijiawa gold deposits show wide variation. The ratios of $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ are 17.042-18.647, 15.46-15.653 and 37.746-39.665, respectively. All the Pb isopote ratios fall on the region between mantle and orogenic belt, and it reveals that crust-mantle mixing maybe the source of the ore lead. Previous studies have shown that the Pb isopote ratios for the Taihua Group ranging widely from lower crust to orogenic belt, while the Pb isopote ratios for the Xiong'er Group mainly distribute near the upper mantle evolution line. And the ore lead all fall on the Taihua Group region.

6 Conclusions

The results of hydrogen and oxygen isotopes show that in the Jijiawa gold deposit, the hydrothermal system gradually transited from a magmatic-dominated fluid to a meteoric-dominated fluid. As the S isotope reveals a characteristic of biogenic, we propose that the Guandaokou and Luanchuan Groups may have been the sources of some ore-forming materials. Pb isotope reveals that crust-mantle mixing maybe the source of the ore lead, and the Taihua Group maybe an important fluid and metal source.

From stage Ⅰ to stage Ⅳ, the ore-forming fluid temperature reduced significantly, which was caused by the increase of meteoric water. This transition also prompted different complexes decomposition of gold, hence led to precipitation of gold. Meanwhile, during the main metallogenic stage (stage Ⅱ and Ⅲ), ore-forming fluid went through fluid immiscibility phase, which led to the change of the physical and chemical environment of ore-forming fluids. It also prompted different complexes of gold decomposition and gold precipitation. Therefore, we argue that fluid mixing action and fluid immiscibility are the most important factors that caused the gold precipitation and enrichment.

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