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# Isotope Geochemistry of the Dayingezhuang Gold Deposit, Jiaodong Peninsula, China: Insights for Gold Mineralization

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## 1 Geological Setting and Mineralization

The Jiaodong Peninsula defines the China's largest gold province with more than 150 known gold deposits and 4000t proved gold reserves (Goldfarb and Santosh, 2014; Yang et al., 2014a). The disseminated- and stockwork-style gold deposit, whose giant source of gold is a striking and key scientific issues, accounts for 90% of the proved gold reserves in the Peninsula. The Dayingezhuang gold deposit, a typical a disseminated- and stockwork-style gold deposit, whose proved reserves were about 125 t Au, located in the central part of Zhaoping metallogenic belt, the largest fault- metallogenic belt in the Jiaodong Peninsula (Deng et al., 2011) with proved gold reserves exceed 1500 t. The main ore-controlling structures are made up of NNE- trending Zhaoping and NNW- trending Dayingezhuang faults. The Zhaoping fault, which controls the occurrence of the gold orebodies in the gold deposit, separates two units: the Precambrian metamorphic rocks in the hangingwall and the Mesozoic Linglong granite in the footwall. The Linglong granite underwent pyrite-sericite- quartz alteration and hosts most part of the gold orebodies. The metamorphic rocks in the haningwall comprise biotite- plagioclase- granulite, carbonate schist and amphibolite of Archaean Jiaodong Group, and garnet-sillimanite- biotite schist and biotite schist of Paleoproterozoic Jingshan Group. The gold mineralization is closely related to sericitization, pyritization and silication. The gold orebodies occur in the pyrite-sericite-quartz altered rock and cataclasite in footwall of Zhaoping fault. The main metallic minerals are consist of pyrite, galena, sphalerite and chalcopyrite. The No. I and II orebodies, which account for 85% of the proved gold reserves in the gold deposit, are located in the footwall and hangingwall of the Dayingezhuang Fault respectively. More galena, sphalerite and silver minerals are developed in the No. I orebody than the No. II orebody and the orebodies in any other deposits in Jiaodong Peninsula. According to ore mineral assemblages, the mineralization can be divided into pyrite-quartz, gold-quartz-pyrite, gold-polymetallic sulfide, silver-polymetallic sulfide, and quartz-carbonate five metallogenic stages.

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## 2 Source of Ore-forming Material

Nine sulfide samples of No. I orebody yield $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$ of 17.2638–17.3585, 15.4663–15.6116 and 37.858–38.3328, respectively, while the other six sulfide samples of No. II orebodies are in range of 17.2157–17.3286, 15.4595–15.5084 and 37.8900–38.0004, respectively, which are slightly lower than that of No. I orebody. The meaningless single-stage model ages and high μ and ω values reveal that they're radiogenic and anomalous lead, who underwent three stages of evolution. The crust-mantle differentiation, intensive mixing of the lead isotope between the lower crust and upper mantle, occurred at about 3.4 Ga and formed the normal lead when the protolith of the metamorphic rock of the Jiaodong Group formed (3.4–2.6 Ga, Luo et al., 1999). The lead escaped from the reservoirs of the second stage and mixed with a certain amount of radiogenic lead at about 0.8 Ga. Finally, it was trapped in the gold- bearing sulfide during the period of mineralization. Furthermore, the sulfur and lead isotope components of sulfide samples are both consistent with the metamorphic rock of Jiaodong Group. All these reveal that source of ore-forming material may mainly derive from the metamorphic rock of the Jiaodong Group.

## 3 Mineralization Process

The white micas on the brittle planes of the Zhaoping Fault to the south of Dayingezhuang gold deposit, which are interpreted to be the synkinematic crystallizations, yielded $^{40}Ar/^{39}Ar$ ages of 128.19±1.36 Ma and 127.7±1.34 Ma (Charles et al., 2013), while the hydrothermal sericite and muscovite in gold ore from the Dayingezhuang deposit yield $^{40}Ar/^{39}Ar$ plateau age of 130 ± 4 Ma (Yang et al., 2014a). These $^{40}Ar/^{39}Ar$ ages reveal that the large scale alteration and gold mineralization was controlled by the synchronous activities of the Zhaoping fault. The initial ore-forming fluids mainly derived from the metamorphic dehydration of the subducting plate (Yang et al., 2014b). The Zhaoping Fault was both the pathway for ore-forming fluids and ore depositing structures. The loss of $CO_2$ and $H_2S$ as well as the sulfidation resulted in the gold deposition from the metamorphic water at appropriate T-P conditions (Yang et al., 2014b). The evolving tendency of $\delta D$-$\delta^{18}O$ isotope towards the meteoric water (Yang et al., 2009) indicates that meteoric water took an important role in the ore-forming processes of the silver mineralization stage. Higher $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ values of the No. I orebody reveals that the No. I orebody underwent intense water-rock reaction with the mixing of more components from the upper crust into the ore-forming fluids in the silver mineralization stage, and keeps less information about the initial ore-forming fluids and material. The reason caused the difference of lead isotope between the two orebodies may be the activities of the Dayingezhuang Fault who resulted in the mixing the initial ore-forming and meteoric water and separated the two orebodies. Then the mixing of the meteoric water which brought more substance from the upper crust induced the later silver mineralization.

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