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Re-Os Dating of Molybdenite from Hadamengou Gold Ore Field in Inner Mongolia and Its Geological Significance

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The Hadamengou gold ore field is located in the Agarutai town, about thirty kilometers west of Baotou City, Inner Mongolia. Since the first ore vein was discovered by Gold Branch of the Chinese Armed Police Force in 1986, hundreds of mineralized quartz-potassium feldspar veins have been discovered, with a proven reserve of 100 t gold. However, timing of gold mineralization of this ore field remains controversial due to the lack of precise radiometric dating, significantly hampering a comprehensive understanding in the temporal-spatial distribution and genesis of the gold deposits. Here we present the result of Re-Os isotopic dating of molybdenite sampled from auriferous quartz vein in the Hadamengou gold ore field in an attempt to tightly constrain the timing of gold mineralization and the tectonic setting under which the ore field was formed.

1 Deposit Geology

The ore field lies in the central portion of the northern margin of the North China Craton. In the research area, the exposed stratum is the lower Proterozoic Wulashan Group consisting of the amphibolites and granulites. The entire ore field is located in the south limb of the Wulashan anticline. Most of gold veins are hosted in the EW-striking fault zones. The magmatic activities in the region are mainly represented by the Hercynian Dahuabei intrusion in the west as well as the Indosinian Shadegai and Xishadegai intrusion in the north.

Gold mineralization occur as veins, pods, and lens mostly in EW-striking faults and dip 40° to 80° to southeast to southwest. In addition to Au mineralization, economic Mo mineralization has also been discovered recently.

The ores can be divided into the quartz-potassium feldspar vein-type, quartz vein-type and potassium feldspar alteration rock-type. Pyrite is the dominant metal mineral and is accompanied by chalcopyrite, sphalerite, galena and molybdenite, with minor amounts of chalcocite, pyrrhotite, marcasite, and specularite. Quartz and potassium feldspar are the dominant gangue minerals, with subordinate sericite, chlorite, epidote and calcite. Ore textures mainly include hypidiomorphic-granular texture, crushed texture, poikilitic texture and metasomatic relict texture. Ores have massive structure, sparse disseminated structure, vein structure and brecciated structure. The ore-related alteration consists mainly of potassium feldspathization, silicification, sericitization, epidotization, chloritization, and carbonatization.

2 Molybdenite Re-Os age

One molybdenite sample was collected from the borehole penetrating the No.313 ore vein. Molybdenite consists of euhedral to hypidiomorphic granules and occurs as small flakes in fissures of auriferous veins. The sample yields a model age of 354.9 ± 5.7 Ma. Due to the intergrowth of molybdenite and gold-bearing pyrite, the molybdenite Re-Os model age is interpreted as the age of Mo and Au mineralization.

3 Geological Significance

Numerous geochronological work using K-Ar, Rb-Sr, Ar-Ar and U-Pb methods has been undertaken in the Hadamengou gold orefield (Lang et al., 1990; Li et al., 1993; Zhang et al., 1999; Miao et al., 2000; Nie et al., 2005), and the isotopic ages range from 477 to 132 Ma. The large scatter of the ages either reflect prolonged and repeated mineralization in the area in the Hadamengou

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gold ore field or indicate their low quality and less reliability.

The K-Ar isotopic system is prone to be affected by late tectonic – magmatic thermal events due to its lower closure temperature. Therefore, the K-Ar age may possibly record the age of late thermal disturbances and cannot record true mineralization age. Rb-Sr isotope system is more thermally sensitive; the Rb-Sr isochron ages may tend to have uncertain geological significances. The sericite ^{40}Ar - ^{39}Ar isochron age of 239.76 ± 3.04 Ma (Nie et al., 2005) and the weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 132 ± 2 Ma obtained by U-Pb dating of hydrothermal zircon from potassium feldspar alteration rock (Miao et al., 2000) are considered as reliable and geologically meaningful.

Combined with the molybdenite Re-Os model age of obtained in this study, it is inferred that there are at least three metallogenic events in the ore field, which can be well linked to the main tectonic evolution of the northern margin of the North China Craton. All three metallogenic events occurred under a transitional tectonic regime from compression to extension. The 354-Ma metallogenic event occurred during the extension regime induced by the arc-continent collision between Bainaimiao arc and the northern margin of the North China craton. The 239-Ma metallogenic event occurred during the extension setting after continent-continent collision between the North China Craton and Siberian Plate. The metallogenic event of 132 Ma occurred during the extension background caused by lithospheric thinning of the North Craton

craton.

The tectonic transition from compression to extension caused upwelling of asthenosphere and extensive crust-mantle interaction, triggering large magmatic activities. The ore-forming fluid from the magma interacted with the wall rock and mixed with meteoric water and metamorphic hydrothermal fluid when ascending. Eventually, the ore-forming fluid was concentrated at the shallow position along favorable structures to form ore veins.

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