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The Occurrence Mode and Controlling Factors of Radial Molybdenite in Baimiaogou Molybdenum Deposit in The Southern Margin of North China Block

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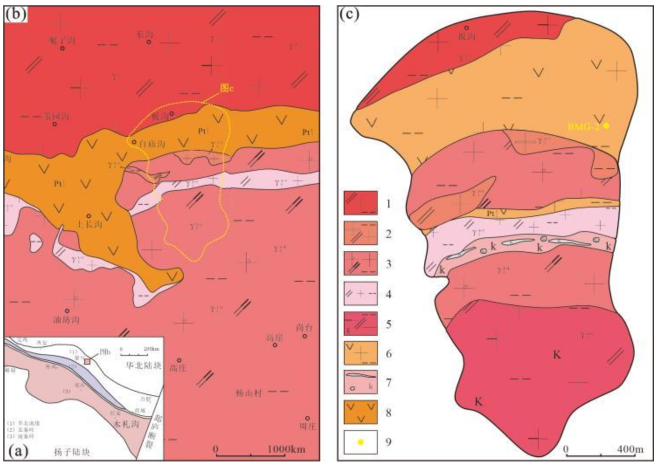
Abstract: The analysis of the occurrence mode and controlling factors of radial molybdenite in molybdenum deposits is of great significance for studying the formation mechanism of molybdenum deposits. In this paper, the radial molybdenite of Baimiaogou molybdenum deposit in the southern margin of North China block is taken as the research object. On the basis of field geological survey and petrographic observation, combined with laser Raman spectroscopy in situ test, the occurrence location, morphology, structure and symbiotic mineral assemblage of molybdenite are analyzed, and its controlling factors are discussed. Studies have shown that molybdenite mainly occurs in the micro-cracks of quartz minerals in medium and fine-grained monzonitic granite and altered andesite, mainly radial, and brittle tensile cracks related to overpressure are the main controlling factors.

Keywords: Molybdenite, Mode of occurrence, Overpressure, Baimiaogou, Southern Margin of North China Block.

1. Introduction

The Qinling orogenic belt is located in the central part of China. It is the intersection of the North China Craton and the Yangtze plate. It records the tectonic evolution history of the central and eastern regions of China from Proterozoic to Cenozoic.



1-giant porphyritic coarse-grained granite; 2-medium coarse-grained granite; 3-medium-grained granite; 4-fine-grained granite; 5-potassium medium-grained granite; 6-meta-andesite; 7-Potassium band of local silicified lump; 8-andesite; 9-Sample location and number

Figure 1. Geological map of Baimiaogou molybdenum deposit in East Qinling molybdenum metallogenic belt

In the evolution of geological structure, the Qinling orogenic belt has experienced many tectonic movements, magmatic activities and mineralization.

The Baimiaogou molybdenum deposit is located in Luanchuan County, Luoyang City, Henan Province. The tectonic position is located in the northwest side of the East Qinling orogenic belt. As a medium-large porphyry-skam type molybdenum deposit newly discovered in the East Qinling molybdenum metallogenic belt in recent years, the research on the deposit is very limited. Previous studies on the Baimiaogou molybdenum deposit focused on the geological characteristics and metallogenic regularity of the deposit [1-5], the research on the occurrence mode and control factors of molybdenite is still very lacking.

In this paper, the radial molybdenite in the Baimiaogou molybdenum deposit on the southern margin of the North China Block is taken as the research object. On the basis of systematic and detailed field geological survey and petrological and mineralogical observation, the occurrence mode and control factors of radial molybdenite are identified by using laser Raman spectroscopy in-situ test technology, which provides guidance for regional prospecting work.

2. Reginal Geology

The East Qinling area is mainly dominated by NWW-trending and NE-trending faults. The NWW-trending faults are long-term active regional structures, which control the spatial distribution of different types of geological bodies in different periods [4]. The NE-trending fault is a large-scale fault superimposed on the NW-trending fault, which has been affected by the circum-Pacific structure since the Yanshan period [5-9]. The Precambrian crystalline basement composed of Neoarchean and Paleoproterozoic intermediate-high grade metamorphic rocks is mainly exposed in this area, as well as the Mesoproterozoic-Paleozoic volcanic-clastic-carbonate rock assemblages with different degrees of deformation and metamorphism deposited on the upper part of these crystalline basements. The Caledonian granite and Yanshanian intracontinental granite related to subduction and collision are commonly invaded in the area, among which the Yanshanian magmatic activity is the most intense [10-12].

3. Sample Collection and Test Methods

3.1. Sample Collection

The sample collected in this paper is located in the middle and fine-grained granite sample number BMG-2, which is exposed in the south of the Baimiaogou molybdenum deposit. Molybdenite is radial under the microscope, which is produced in medium and fine grained monzonitic granite, and the granite is strongly silicified.

3.2. Sample Collection

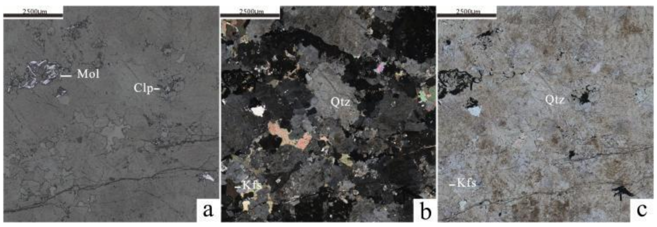
In order to analyze the mineralogical characteristics, genesis, and the relationship with the structure and structure, this paper grinds 2.5cm×5cm rock slices of molybdenite-bearing quartz veinlets, and under 2.5×10 times of single polarized light, orthogonal polarized light and reflected light, automatic scanning and photo splicing are carried out respectively to generate high-resolution images. The research-level translucent reflective polarizing microscope model is Axio Imager M2, equipped with ICCS optical system and automatic scanning stage, which can realize multi-field automatic scanning.

Raman analysis was completed in the Analysis and Testing Center of Henan Polytechnic University. The instrument is a high-resolution microscope confocal laser Raman spectroscopic imager (WITec alpha300R, Germany). The laser wavelength is 532 nm, the laser power adjustment accuracy is 0.1 mW, the minimum laser beam spot is 1 μm, the spectral resolution (full spectrum) is less than 1.5 cm-1, and the spectral range is 10 cm^{-1}~ 3900 cm^{-1}.

4. Results

4.1. Petrology and Mineralogy

In medium and fine grained granites, the main mineral components are quartz and potassium feldspar. It is grade I gray to grade I yellow, with a content of about 70 % and a particle size of about 5mm-20mm.There are residual K-feldspar cleavage and scattered argillization materials in the interior. There is a small amount of strongly argillized K-feldspar between quartz minerals. Obviously, these quartz minerals are the products of strong silicification of feldspar, and with the enhancement of silicification, the particle size of quartz minerals tends to increase gradually. K-feldspar is grade I ash, with a particle size of about 5mm and a content of 20 %. It is residual between quartz particles with different degrees of silicification. Brown mud particles are common in K-feldspar particles. The secondary mineral is molybdenite, which is bright lead gray under the reflected light. It is radially developed in the quartz mineral particles formed by silicification of potassium feldspar, and some of them have potassium feldspar skeleton crystals (Fig.2a ~ f).



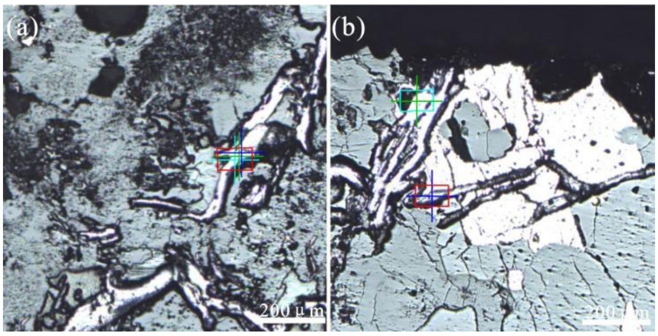
a-the characteristics of a-nonmetallic minerals under single polarization; b-nonmetallic mineral characteristics under orthogonal polarized light; characteristics of c-metallic minerals under reflected light Qtz-quartz; Kfs-potassium feldspar; Mol-molybdenite; clp-chalcopyrite

Figure 2. Mineralogical and petrographic characteristics of fine-grained granites and altered andesite from the Baimiaogou Mo deposit in the southern margin of the North China Block (Sample No. BMG-2)

In the altered andesite, the main mineral is sericite, and the interference color is bright and bright, which is grade II blue-III red. The irregular granular content is about 90 %, and the particle size is about 2mm-4mm, with certain directional arrangement characteristics. In the late stage, sericitization was strong, accompanied by chloritization and epidotization (Fig.2d ~ f).

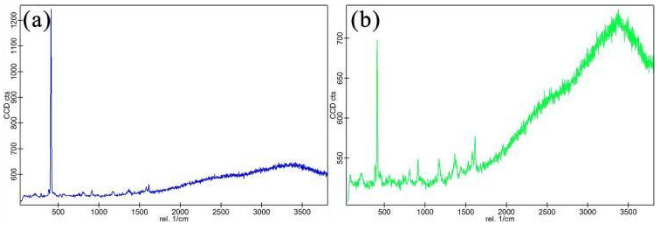
4.2. Laser Raman Spectrometry

In order to further determine the mineral type, laser Raman analysis was performed on metal and non-metal minerals with different optical characteristics in ore-bearing quartz veins (Fig.3, Fig.4).



(a)-Radiated molybdenite in medium-fine grained granite; (b) Radial molybdenite in altered andesite

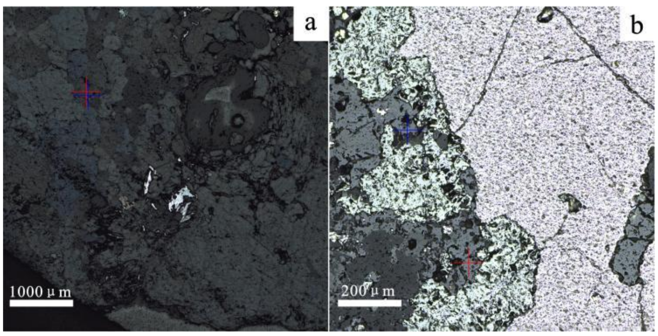
Figure 3. Laser Raman Spectroscopic Points of Radial Molybdenite in Baimiaogou Molybdenum Deposit, Southern Margin of North China Block (sample No. BMG-2)



(a)-Albite Raman shift; (b) Raman shift of chlorite

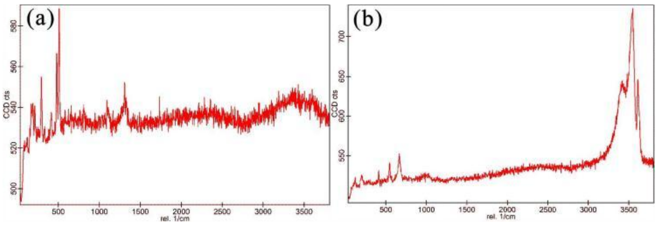
Figure 4. Laser Raman Spectroscopic Points of Nonmetallic Minerals in Fine Granite of Baimiaogou Molybdenum Deposit in the Southern Margin of North China Block (Sample No. BMG-2)

In addition to quartz, potassium feldspar, sericite, epidote, chlorite, non-metallic minerals also have orthoclase and grossular (Fig.5, Fig.6).



a-syenite; b Calcium aluminum garnet

Figure 5. Laser Raman spectroscopy test points of non-metallic minerals in molybdenite-bearing quartz veins of the Baimiaogou molybdenum deposit in the East Qinling molybdenum metallogenic belt (sample No. BMG-2)



a. b-Laser Raman spectral shift of syenite

Figure 6. Laser Raman shift of non-metallic minerals in fine-grained monzonitic granite and altered andesite in the Baimiaogou molybdenum deposit on the southern margin of the North China block (Sample No.: BMG-2)

5. Discussion

5.1. Overpressure Factor

There are a large number of molybdenum deposits related to overpressure in the southern margin of the North China Block. Overpressure can lead to a large number of tensile fractures in molybdenum deposits, which are filled with ore-forming hydrothermal fluids, rapid mineral precipitation, and closure of tensile fractures. Subsequently, overpressure can crack in the original place or re-generate tensile cracks, and the ore-bearing hydrothermal solution invades again, resulting in pulsation of overpressure and accompanying mineralization.

Molybdenite mineralization related to overpressure is more common in the Baimiaogou molybdenum deposit, which is mainly manifested in two aspects. One is related to the tensile fissures formed by minerals and rocks due to overpressure. The minerals are mainly quartz, magnetite and pyrite formed before molybdenite mineralization. These minerals have strong rock mechanical properties relative to the same period of potassium feldspar and other minerals, it is easy to form radial, reticular or single cracks under overpressure, and produce molybdenite precipitation in them, but these cracks are strictly limited by mineral boundaries. Overpressure related to rocks mainly occurs in medium-fine-grained granites, because medium-fine-grained granites are formed in the transitional stage from magmatism to mineralization, especially in the hydrothermal mineralization stage, the overpressure is strong, and a large number of tensile cracks with small extension length can be generated inside them, filling quartz or / and molybdenite. After the overpressure is released, these quartz or / and molybdenite veins can produce plastic deformation and are earthworm-like ; the second is related to the overpressure caused by the local extension formed during the mineralization period, which mainly occurs at the tip of the wedge-shaped tensile fracture (Fig.2) or in the intestinal-shaped deformed quartz vein obliquely intersecting with the andesite foliation.

5.2. Structural Factors

The lithospheric evolution of the Mesozoic North China Craton is active, and it has experienced three major geodynamic events: collisional orogeny, tectonic system transition and lithospheric delamination. The NWW-trending faults in the southern margin of the North China block were formed early, with large scale and long duration, which controlled the distribution of the main granitic batholith, medium-acid small rock mass and molybdenum metallogenic belt in Yanshan period. The NE-trending faults were mainly formed in the late Mesozoic, and also played an important role in controlling the molybdenum deposits. As a result, the molybdenum deposits in the southern margin of the North China Block were distributed along the above two groups of faults in a beaded shape.

Studies have shown that brittle deformation can occur under overpressure in the shear zone dominated by ductile deformation in the deep crust. However, when the overpressure is released and the strain rate is reduced, the ductile deformation is carried out again, and the formed brittle structure is reformed. For example, intermittent seismic slip processes are common in the deep crust, and the transition from brittle deformation to plastic deformation corresponds to a semi-brittle region throughout the seismogenic zone, where brittle fracture and plastic flow can coexist and transform each other under high strength conditions (confining pressure 45-180 MPa).

The ore-bearing quartz veins obliquely intersected with andesite foliation should be veins in a series of tension fissures (T faults) produced by the ore-forming hydrothermal fluid filling in the strike-slip process under overpressure. Microscopically, the tension fissures produced by this strike-slip effect are also obvious. The sericite formed at the same time with molybdenite mineralization is distributed along the contact boundary between granite and andesite. The wedge-shaped space and its tip at the boundary are filled with larger-sized sericite minerals and associated with molybdenite. This part should obviously be the tension fissures (T faults) caused by strike-slip action, and the sharp angle between these tension fissures and the strike-slip boundary indicates the nature of left-lateral strike-slip.

The minerals filled in the above-mentioned tension fissures can produce rapid crystallization due to the sudden decrease of pressure, which leads to the veins filled in the tension fissures have higher rock mechanical strength than the surrounding rock [18-20]. After the overpressure is released, the stress property is transformed into compression and torsion. Under the action of progressive deformation and shear, these ore-bearing veins with high rock mechanical strength obliquely intersecting with andesite foliation can be transformed into intestines.

6. Conclusion

In the micro-cracks of quartz minerals in medium and fine-grained monzonitic granite and altered andesite, molybdenite is radial or veinlet-like in the radial micro-cracks or single micro-cracks of quartz. At the contact between quartz vein and altered andesite, there are agglomerated or wedge-shaped sericite mineral aggregates penetrating into quartz vein, and radial molybdenite is developed near the tip of quartz vein in these sericite mineral aggregates. The genesis and occurrence of this radial molybdenite are controlled by overpressure and tectonic factors.

Acknowledgements

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