

## **Compositional Characteristics, Petrogenesis, and Metallogenic Significance of Biotite from Granodiorite in the Laba Porphyry Mo-Polymetallic Deposit, Northwestern Yunnan, SW China**

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The Laba Mo-polymetallic deposit lies in the western margin depression belt of the Yangtze landmass, and is adjacent to the Yidun island arc and Garze-Litang suture zone. The investigation confirmed that there is a superlarge porphyry-skarn hydrothermal-type Mo-polymetallic metallogenic system with resource reserves of 63.5 Mt Mo at 0.11%, associated with 33.7 kt Cu at 0.22%, and Au 14.7 t at 0.65 ppm. Based on systematic fieldwork, the authors investigate the petrographic and mineralogical composition of the biotites in the granodiorite porphyry, place constraints on the physical-chemical conditions information of the host rocks and their metallogenic potential, and provide important insights into understanding the rock- and ore-forming process on the mineral scale. Electron microprobe analysis (EMPA) shows that the biotites in the Laba granodiorite porphyry belong to Mg biotites. The contents of  $\text{FeO}^{\text{Tot}}$  are 15.47% to ~17.09%,  $\omega(\text{Al}_2\text{O}_3)$  are 13.81% to ~14.29%,  $\omega(\text{TiO}_2)$  are 3.47% to ~4.03%, and  $\omega(\text{MgO})$  are 12.77% to ~13.83%. Biotites are manganese poor ( $\omega(\text{MnO})$  are 0.38% ~ 0.60%), showing that the substitution among  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$  maybe occurred during the solidification of biotite. The biotites display no CaO content and the  $\text{Fe}^{2+}/(\text{Mg} + \text{Fe}^{2+})$  ratios are 0.36 to ~0.40, which is consistent with those of magmatic biotites. The  $\text{Fe}^{2+}/(\text{Mg} + \text{Fe}^{2+})$  ratios are less extensive, indicating that biotites are protosomatic biotites, although they have undergone alteration to some extent. The coefficients of oxidation from biotites are about 0.11. The values of  $\text{Mg}/(\text{Mg} + \text{Mn} + \text{Fe}_{2+})$  are 0.59 to ~0.63. These characteristics suggest that the Laba granodiorite porphyry derives from a mantle-crust mixed source. The biotites are rich in volatiles (fluorine, chlorine), showing that the magma has obviously undergone a high degree of crystallization differentiation. The increasing fluorine contents can decrease the temperature between solidus and liquidus of magma and prolong the time of magma-hydrothermal interaction. The molybdenum content increases from the magma to liquid in the magmatic-hydrothermal systems. Mineral chemistry analysis reveals that the crystallization temperature for biotite is 720° to ~747°C and the solidification pressure is 84 to ~117 MPa, corresponding to a solidification depth of 3.2 to ~4.4 km. The oxygen fugacity is -11.12 to ~-11.89. These results suggest the Laba granodiorite porphyry formed under the conditions of relatively high temperature, high oxygen fugacity, and shallow environments. High oxygen fugacity is favorable for copper and molybdenum mineralization, but high temperature and high content of fluorine are favorable for molybdenum mineralization rather than copper. This is why the ore-forming elements are rich in molybdenum mainly in the Laba deposit.