Geochemical Characteristics and Tectonic Setting of the Granites in Sanmianjing Pb-Zn (Ag) Deposit, Inner Mongolia

WEI Hantao1,2, SHAO Yongjun1,2, LIU Zhongfa1,2, YE Zhou1,2 and QUAN Wei1,2

1 Key Laboratory of Metallogenic Prediction of Nonferrous Metals, Ministry of Education, Central South University, Changsha 410083, China
2 School of Geosciences and Info-Physics, Central South University, Changsha 410083, China

1 Regional Geological Conditions

Sanmianjing Pb-Zn (Ag) deposit is located on the north of Zhengxiangbaiqi Area, and the east of Inner Mongolia–Daxinganling metallogenic province, belongs to epicontinental accretionary belt in the north of North China Plate. In the mining area, exposure strata are mainly Pliocene and Quaternary. Dominant structures are faults, which could be divided into two groups: NW-trending group and NE-trending group. The NW-trending faults are host structures, and the NE-trending faults are post tectonic, which cuts through the early NW-trending faults. Magmatism is strong and is dominated by Yanshanian magmatism, which is represented by porphyraceous biotite granite and granite porphyry. The formation of the orebodies are associated with the activities of magma with the orebodies obviously being controlled by fractures.

2 Geological and Petrological Characteristics of the Granites

The porphyrraceous biotite granites are light salmon with porphyritic-like texture and block structure. Weathered surfaces are light yellow to fleshy red, while fresh surface range from gray-white to shallow red meat. Phenocrysts (40% ~ 45%) are mainly composed of quartz and potassium feldspar, plagioclase, biotites, and occasionally hornblende phenocrysts. Groundmass (45% ~ 60%) with particulates/fine texture are mainly composed of quartz, feldspar and a small amount of biotite. The contacts of the porphyrraceous biotite granites and the granite porphyry are not clear because of the development of Quaternary. Ore-bearing rocks are mainly the porphyrraceous biotite granite and partly granite porphyry.

3 Geochemical Characteristics of the Granites

3.1 Major elements characteristics

Porphyrraceous biotite granite and granite porphyry have the same major elements characteristics. The SiO2 contents of the granites are 61.28~71.78 wt.% (average of 67.41 wt.%). The total alkali contents (w(Na2O+K2O)) are 8.04~10.89 wt.% (average of 9.06 wt.%), which are higher than those of A-type granites worldwild (8.42~8.72 wt%; Wu et al., 2007). The contents of K2O are 3.80~5.37 wt.%, and the average ratio of w(K2O)/w(Na2O) is 1.15, showing high -K characteristics. AR is 2.46~4.11 (average of 3.45). Rittmann combination indexs (σ) are 3.03~3.94 (average of 3.40). In the AR-SiO2 diagram, sample points fall in alkalic rocks category. All of them indicate that the granites belong to alkalic rocks. The average of A/CKN is 0.95, less than 1.1. In A/CKN-A/NK diagram, most of the sample points fall in the metaluminous scope. In the K2O-Na2O and MgO-SiO2 diagrams (Eby, 1992), sample points fall in A-type granite scope. In summary, the granites belong to A-type granites with high-K alkalic and metaluminous characteristics.
3.2 Trace elements characteristics

The trace elements characteristics, both of porphyroclastic biotite granite and granite porphyry are similar. Trace elements abundance shows that Sr, Ba, Nb, Ta, P, and Ti are of negative anomalies while Rb, Th, U, Zr, and Hf are of obvious positive anomalies. The values of characteristic parameters Nb*, Sr* and Ti* are less than 1, while the values of Zr*, Hf* and K* are greater than 1, implying that rock-forming substances came from lower crust or upper mantle (Wilson, 1989). In the K$_2$O/MgO-104Ga/Al, (K$_2$O+Na$_2$O)/CaO-104Ga/Al, FeO*/MgO-104Ga/Al, Zr-104Ga/Al, Y-104Ga/Al and Ce-104Ga/Al diagrams, sample points all fell in A-type granites field (Whalen et al., 1987).

The contents of REE are $\Sigma$w(REE)=310.73×10$^{-6}$~379.80×10$^{-6}$ (average of 346.38×10$^{-6}$), which are significantly higher than those of I-type granites (114.71×10$^{-6}$) and S-type granites (173.14×10$^{-6}$), with $\Sigma$w (LREE)=263.87×10$^{-6}$~321.07×10$^{-6}$ (average of 292.51×10$^{-6}$), and $\Sigma$w(HREE)=46.86×10$^{-6}$~61.59×10$^{-6}$ (average of 53.87×10$^{-6}$). The ratios of $\Sigma$w(LREE)/$\Sigma$w (HREE) (5.17~5.63; average of 5.44), are much greater than 1, suggesting evident fractional crystallization. The differential degrees of LREE are higher than HREE’s, with (Ce/Yb)N=8.90~10.44 (average of 9.61), (La/Sm)N=4.24~5.34 (average of 4.92), and (Gd/Yb)N=1.22~1.69 (average of 1.43). Eu show obvious negative anomalies with $\delta$Eu of 0.36~0.88 (average of 0.62), and Ce have weak negative anomalies with $\delta$Ce of 0.85~0.86 (average of 0.85).

Chondrite-normalized rare earth element (REE) patterns show rightward incline and obvious negative Eu anomalies, which are similar with the REE patterns of A-type granites. And the distribution plots of porphyroclastic biotite granite and granite porphyry are almost coincident in REE diagram, which imply that both the two granite have similar sources.

4 Tectonic Setting

In the Rb - Y + Nb and Nb – Y diagrams, sample points fall in the scope of intracontinental granites (WPG). Intraplate environment can be divided into oceanic rift and continental rift, but oceanic rift relatively concentrates Nb and Ta. In Sanmianjing ore district, granite is depleted in Nb and Ta, and there are no ophiolites, so the tectonic environment must be continental rift. In the Nb-Y-3Ga and Nb-Y-Ce diagrams, the sample points all fall in the area of A1 granite, which further support that the granites were formed in a continental rift environment (Zhao, 2007).

5 Conclusion

In summary, the granites in Sanmianjing Pb-Zn (Ag) deposit belong to A-type granite with high-K alkaline and metaluminous characteristics. The rock-forming substances came from lower crust or upper mantle and the granites were formed in a continental rift environment.

References


