LIU Yuan and JIANG Sihong, 2014. Ore Deposit Geology and Genesis of the Haobugao Zn–Fe Deposit, Inner Mongolia, NE China. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 18-19.

Ore Deposit Geology and Genesis of the Haobugao Zn–Fe Deposit, Inner Mongolia, NE China

LIU Yuan[1,2] and JIANG Sihong[2]

1 *China University of Geosciences, Wuhan 430074, China*
2 *MLR Key Laboratory of Metallogeney and Mineral Assessment, Institute of Mineral Resources, CAGS, Beijing 100037, China*

1 Introduction

Located in the eastern section of the Central Asian Orogenic Belt (CAOB), the Great Xing'an Range (GXR) area is not only an important polymetallic metallogenic province but also a region with strong superposition of the Paleozoic Paleo-Asian tectonic–metallogenic domain and the Mesozoic Western Pacific marginal tectonic–metallogenic domain (Chen et al., 2011; Li et al., 2012; Nie et al., 2002; Wu et al., 2011; Zhai et al., 2014). Since the 1970s, More than 10 large–sized Cu–Fe–Sn–Ag deposits and forty small–sized deposits have been discovered in the region (Sheng and Fu, 1999; Zeng et al., 2011). Generally, these deposits, including skarn–, porphyry–, and hydrothermal vein–type deposits, are spatially and temporally related to Yanshanian magmatic–hydrothermal activity (Zhai et al., 2014).

2 Ore Deposit Geology

The Haobugao skarn–type Zn–Fe deposit (about 6.76 Mt of zinc ores @ 4.24% Zn, and 7.53 Mt of iron ores @ 32.69% Fe) situated in southern segment of the GXR. The narrow banded NE–striking ore district is 5km long and 2.5km wide. NE–trending fracture is the main ore–controlling structure with a trend of 50–60°, and a dip of 70°. The strata in the ore district consist mainly of the Lower Permian Dashizhai Formation (P_1d). The Xiaohanshan pluton, related to mineralization, consists of quartz monzonite and a small amount of quartz–syenite. The Haobugao Zn–Fe district is principally composed of 5 ore zones, with the No.I zone in the northeastern–most part and the No.V zone in the southwestern–most part. The mineralization of these ore zones is quite different, with the Fe–Sn in No.I zone, Cu–Zn in No.Ⅱ zone, Zn–Fe in No.III zone, Pb–Ag in No.Ⅳ zone and Pb–Zn–Cu in No.Ⅴ zone. Among of these, the No.II and No.III ore zones are the focus of this paper. The main wall–rock alterations include skarnization, silicification, chloritization, carbonatization and fluoritization.

More than 50 minerals have been identified in Haobugao Zn–Fe deposit. The main ore minerals are composed of sphalerite, galena, chalcopyrite, magnetite, pyrite, and pyrrhotite, with a small amount of arsenopyrite, bismuth, bismuthinite, covellite, chalcocite, and gersdorffite. The main gangue minerals are andradite, grossular, hedenbergite, diopside, ilvaite, calcite, idocrase, chlorite, fluorite, and quartz. Skarn minerals can be divided into two metallogenic period as skarn period and quartz–sulfide period, and five metallogenic stages as early skarn, late skarn, oxide, early quartz–sulfide and late quartz–sulfide stages.

3 Genesis of Deposit

3.1 Source of hydrothermal component

Geology, mineralogy and geochronology of the Haobugao Zn–Fe deposit are all consistent with typical skarn–type deposit. The maximum $\delta^{34}S$ values of sulfides in Haobugao Zn–Fe deposit are close to zero, indicating a magmatic origin. Mixing between magmatic water and meteoric water may be a more plausible explanation for the negative $\delta^{18}O$ values. Previously published sulfur isotopic data for sulfides from the adjacent deposits, including Baiyinnuoer, Dajing, Bianjiadayuan, Bairendaba, Huanggangliang and Hashitu deposits generally yielded uniform $\delta^{34}S$ values of −2 to +2‰ (Zhai et al., 2012). These sulfur isotopic compositions encompasses igneous rocks and are interpreted as a magmatic source.

* Corresponding author. E-mail: liuyuandxy@163.com

3.2 Timing of mineralization

The molybdenite Re–Os isochron age is consistent with the zircon U–Pb age of the quartz monzonite within error, indicating that there is a genetic relationship between mineralization and quartz monzonite. The base–metal deposits in the southern GXR, including the Haobugao (141.5 Ma, this study), Baiyinnuoer (148.0 Ma, Zeng et al., 2009), Bairendaba (135.0 Ma, Chang and Lai, 2010), Huanggang (140.0 Ma, Zhai et al., 2014), Dajing (138.8 Ma, Liu et al., 2002) deposits, was formed around 140 Ma, related to late Mesozoic magmatic–hydrothermal activity.

3.3 Zn–Fe mineralization and geodynamic evolution

In the past ten years, more and more earth scientists agree with that the subduction of Paleo–Pacific plate during the period 120–140 Ma in the Mesozoic era played a key role in the tectonic movement, magmatic activity and metallogeny in eastern China (Ling et al., 2009; Mao et al., 2002, 2011; Zeng et al., 2011; Zhang et al., 2010). The subduction of the Paleo–Pacific plate changed its direction from west to north or northwest, which caused a transition in the tectonic regime from compression to extension in the Cretaceous period and subsequently induced large–scale delamination of the thickened lower crust and lithospheric mantle (Zhang et al., 2010). The crust delamination and consequent upwelling of the asthenosphere promoted the emplacement of Yanshanian granites (Wu et al., 2005; Zhang et al., 2010). The magmatic fluids originated from granitic magmas or the deep magma chambers during the Mesozoic era supplied significant amounts of sulfur and other base metals to form large–scale hydrothermal deposits in the GXR, such as the Haobugao Zn–Fe deposit.

Acknowledgements

We thank Professor Jiang Sihong for his constructive comments and reviews, which have significantly improved the early version of this manuscript. We also appreciate Chen Chun Liang and Han Ning for their field assistance. This work was financially supported by the 973 program (2013CB429805)

References

Chang, Y., and Lai, Y., 2010. Study on characteristics of ore-forming fluid and chronology in the Yindu Ag–Pb–Zn polymetallic ore deposit, Inner Mongolia. *Acta Scientiarum Naturalium Universitatis Pekinensis*, 46: 581–593 (in Chinese with English abstract).

Chen, Z.G., Zhang, L.C., Wan, B., Wu, H.Y., and Cleven, N., 2011. Geochronology and geochemistry of the Wunugetushan porphyry Cu–Mo deposit in NE China, and their geological significance. *Ore Geol. Rev*., 43: 92–105.

Li, W.B., Zhong, R.C., Xu, C., Song, B., and Qu, W.J., 2012. U–Pb and Re–Os geochronology of the Bainaimiao Cu–Mo–Au deposit, on the northern margin of the North China Craton, Central Asia Orogenic Belt: implications for ore genesis and geodynamic setting. *Ore Geol. Rev*., 48: 139–150.

Ling, M.X., Wang, F.Y., Ding, X., Hu, Y.H., Zartman, R.E., Xiong, X.L., and Sun, W.D., 2009. Cretaceous ridge subduction along the lower Yangtze River belt, Eastern China. *Economic Geology,* 104: 303–321

Liu, W., Li, X.J., and Tan, J., 2002. Fluid mixing in the Dajing Cu–Sn–Ag–Pb–Zn deposits, Inner Mongolia: evidences from fluid inclusions and stable isotopes. *Sci. China Ser. D*, 32: 405–414 (in Chinese with English abstract).

Mao, J.W., Goldfarb, R.J., Zhang, Z.W., Xu, W.Y., Qiu, Y.M., and Deng, J., 2002. Gold deposits in the Xiaoqinling-Xiong'ershan region, Qinling Mountains, central China. *Mineral Deposita*, 37: 306–325.

Mao, J.W., Zhang, J.D., Pirajno, F., Ishiyama, D., Su, H.M., Guo, C.L., and Chen, Y.C., 2011. Porphyry Cu–Au–Mo-epithermal Ag–Pb–Zn-distal hydrothermal Au deposits in the Dexing area, Jiangxi province, East China-A linked ore system. *Ore Geology Reviews*, 43: 203–216.

Nie, F.J., Jiang, S.H., Su, X.X., and Wang, X.L., 2002.Geological features and origin of gold deposits occurring in the Baotou–Bayan Obo district, south-central Inner Mongolia, People's Republic of China. *Ore Geol. Rev*., 30: 1–29.

Sheng, J.F., and Fu, X.Z., 1999. Metallogenetic Environment and Geological Characteristics of Copper-Polymetallic Ore Deposits in Middle Part of Da Hinggan Mts. Beijing: Seismological Publishing House (in Chinese).

Wu, F.Y., Lin, J.Q., Wilde, S.A., Zhang, X.O., and Yang, J.H., 2005. Nature and significance of the Early Cretaceous giant igneous event in eastern China. *Earth Planet. Sci. Lett*., 233: 103–119.

Wu, H.Y., Zhang, L.C., Wan, B., Chen, Z.G., Xiang, P., Pirajno, F., Du, A.D., and Qu, W.J., 2011. Re–Os $^{40}Ar/^{39}Ar$ ages of the Jiguanshan porphyry Mo deposit, Xilamulun metallogenic belt, NE China, constraints on mineralization events. *Mineralium Deposita*, 46: 171–185.

Zeng, Q.D., Liu, J.M., Zhang, Z.L., Jia, C.S., Yu, C.M., Ye, J., and Liu, H.T., 2009. Geology and leadisotope study of the Baiyinnuoer Zn–Pb–Ag deposit, south segment of the Da Hinggan Mountains, northeastern China. *Resour. Geol.*, 59: 170–180.

Zeng, Q.D., Liu, J.M., Zhang, Z.L., Chen, W.J., and Zhang, W.Q., 2011. Geology geochronology of the Xilamulun molybdenum metallogenic belt in eastern Inner Mongolia, China. *International Journal of Earth Sciences*, 100: 1791–1809.

Zhai, D.G., Liu, J.J., Wang, J.P., Yang, Y.Q., Wang, G.W., Liu, X.W., Liu, Z.J., Wang, X.L., and Zhang, Q.B., 2012. Characteristics of melt–fluid inclusions and sulfur isotopic compositions of the Hashitu molybdenum deposit, Inner Mongolia. *Earth Sci. J. China Univ. Geosci*., 37: 1–12 (in Chinese with English abstract).

Zhai, D.G., Liu, J.J., Zhang, H.Y., Yao, M.J., Wang, J.P., and Yang, Y.Q., 2014. S–Pb isotopic geochemistry, U–Pb and Re–Os geochronology of the Huanggangliang Fe–Sn deposit, Inner Mongolia, NE China. *Ore Geology Reviews*, 59: 109–122.

Zhang, J.H., Gao, S., Ge, W.C., Wu, F.Y., Yang, J.H., Wide, S.A., and Li, M., 2010. Geochronology of the Mesozoic volcanic rocks in the Great Xing'an Range, northeastern China: implications for subduction-induced delamination. *Chem. Geol.*, 276: 144–165.