Magmatic Ni-Cu sulfide deposit is one of the major types of deposit containing Ni, Cu and PGE, and is hosted by mafic-ultramafic intrusions occurring in cratons and orogenic belts. The geological settings and ore-forming mechanisms of magmatic Ni-Cu deposits have been well documented in previous studies (Naldrett, 2004; Barnes and Lightfoot, 2005). On the contrary, the Cu-rich ores in magmatic Ni-Cu sulfide deposit have received less attention possibly because of its fewer reserves and difficulties in distinguishing from Ni-rich or PGE-rich ores during exploration. Recently, some Cu-rich orebodies have attracted the interest of many Chinese geologists (i.e., Jinchuan; Jiao et al., 2012; Kalatongke; Gao et al., 2012; Chen et al., 2013; Xiarihamu; Gao, 2013, conference communication). The studies on the spatial distribution, ore structure, sulfide composition and PGE geochemistry of Cu-rich ores have shown much difference from the other ore types. Therefore, the research on ore-forming mechanism of Cu-rich ores can not only point out prospecting orientation, but also are important in understanding the diverse mineralization process of magmatic sulfide deposits.

1 The Present Genesis Theory of Cu-rich Ores Within Cratons

Magmatic sulfide ores are resulted from droplets of immiscible sulfide-oxide liquids within silicate magma, and then concentrating in particular processes (Naldrett, 2004). Barnes and Lightfoot (2005) proposed that the vein material from Noril’sk and Cape Smith in cratons probably represents Cu-rich fractionated liquid. The forming mechanism of Cu-rich ores in cratons can be summarized as follow: with decrease of temperature, the sulfide liquid fractionated to Fe-rich monosulfide solid-solution (MSS) cumulate and a Cu-rich sulfide liquid (Barnes and Lightfoot, 2005). Experimental and empirical research has implied that Os, Ir, Ru, and Rh are concentrated in the MSS, whereas Pt, Pd, Au and semimetals (Bi, Te, Sb and As) tended to partition into the residual Cu-rich sulfide liquid (Li et al., 1996; Mungall et al., 2005; Godel and Barnes, 2008; Helmy et al., 2010). The silicate magma solidified at or above 1,000°C, whereas the Cu-rich sulfide liquid solidified when the temperature decreases to below 900°C. Thus, the Cu-rich sulfide liquid can migrate into dilatent spaces in the footwall or the hanging wall or along the contact between the country rock and solid mafic-ultramafic intrusions to form veins even that extend into the country rock (Naldrett, 2004; Barnes and Lightfoot, 2005). Jiao et al. (2012) summarized the genesis of Cu-rich ores in the segment 1 exploration line 6-7 with altitude of 1120 m at Jinchuan: sulfide experiences MSS, and then the residual sulfide and Cu-, Pt-, Pd-rich concentrates are influenced by gravity and tectonic activities. This viewpoint shares many similar opinions with Chen et al. (2013). In these cases the Cu-rich veins should represent fractionated sulfide liquid.

2 The Studies on Cu-rich Ores from Some Typical Deposits Within Orogenic Belt

Many important magmatic Ni-Cu sulfide deposits are distributed in the southern margin of the Central Asian Orogenic Belt (CAOB), such as the Kalatongke, Tulargen in eastern Xinjiang, NW China. The Kalatongke Cu-Ni sulfide deposit appears to have formed from two different pulses of PGE-poor and Cu-rich magmas that underwent different degrees of assimilation and fractional crystallization (Gao et al., 2012). On basis of the intercalated relationship of the ore types in Tulargen (Fig. 1), we propose the sequence of the ores from early to late stages are as follow: disseminated Ni-rich ores → disseminated Ni-Cu-rich ores → weakly disseminated Cu ores → disseminated Cu-rich ores → Cu-rich ore vein.
In addition, the PGE characteristics suggest that Cu-rich ores and Ni-rich ores of Tulargen cannot form from the segregation and fractionation of the same sulfide melts. On the contrary, sulfide ores result from different silicate magma pulses. From the discussion above, we can see that the present theories based on cratons cannot summarize the unique mineralization mechanism of magmatic Ni-Cu sulfide deposit within orogenic belt.

3 Conclusion

The Cu-rich vein material of magmatic Ni-Cu sulfide deposit within cratons probably represents Cu-rich fractionated liquid. The Cu-rich ores and Ni-rich ores are from the segregation and fractionation of the same sulfide melts. On the contrary, the mechanism of Cu-rich ores occurring in orogenic belt is much more complex, and the sulfide ores may result from different magma pulses.

Acknowledgement

We thank Hui Weidong, Wu Jian, Yong Wenfu and Wang Huqiang of the Hexin mine for sharing their knowledge about the mining status of Tulargen and their assistance in our filed work. The manuscript benefited enthusiastic helps from Zhaoxiaobo of China University of Geosciences.

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