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Platinum-Group Elements Constraint on the Origin Mechanism of the Hetaoshu Rich-PGE Deposit in the Xiaoguanhe Region, Panxi Area

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1 Geological Background

The Pan-xi area is located in middle of the Pan-xi Great Rift Valley, which witnessed multiple complicated geological events and remains lots of geological phenomenon and bodies. Influenced by the tectonic-magmatic activity in the ELIP, a lot of mafic-ultramafic layered intrusions hosting Fe-Ti oxide deposits and Cu-Ni-(PGE) magmatic sulfide mineralization occur close to the S-N-trending fractures. The Hetaoshu just represents a magmatic sulfide deposit with rich-PGE, which located in tectonic intersectant place on the sub-fractures of An-Ning River-Yimen deep fault and Hekou duplex anticline.

The Hetaoshu deposit is composed of west and east dykes, controlled by the north-east and south-north compressor-shear structure, the ore-bearing intrusion intruded the Lower Proterozoic Hekou Formation and Upper Proterozoic, which are quartzite, quartz breccia, garnet muscovite schist, gabbro and gabbro diabase, respectively.

2 Ni, Cu, and Platinum-group Elements

The concentrations of PGE, Cu and Ni in whole rock samples show that the ore forming elements consists of Ni primarily and Cu secondly with the character of higher contents of Pt and Pd than Os, Ir, Ru and Rh. For most of samples from Hetaoshu intrusion, the ratios of Cu/Pd vary in the ranges of 6000~20000, which is similar to those observed for the mantle.

The primitive mantle-normalized patterns of Ni-Cu-PGE in recalculated 100% sulfides show that all samples from the Hetaoshu intrusion are enriched in PPGE relative to IPGE, which is similar to that of Jinbaoshan Pt-Pd deposit. Differences between them lie in that the contents of PGE, Cu and Ni from Hetaoshu intrusion are lower than Jinbaoshan. In addition, the ratios of Pd/Ir are lower (Pd/Ir=1.5-13.1) and close to primitive mantle value, suggesting that the primary magma of the Hetaoshu intrusion formed by high degree of mantle partial melting.

3 Discussion

Experimental and theoretical studies suggest that PGE can be strongly concentrated in sulfide, owing to the much larger sulfide liquid-silicate liquid partition coefficient (10^4-10^5) relative to Cu and Ni. Even though minor sulfide (0.01%) removed from parental magma, this process can result in strong PGE depletion in the basaltic magma. Therefore, PGE are the most effective and sensitive indicator for sulfide segregation (Fleet et al., 1996).

In order to quantitatively evaluate the impact of sulfide segregation on the ore-forming process of Hetaoshu deposit, it is necessary to do the model calculation via the following equation of Campbell and Naldrett (1979): CSul i=CSil i×DSul/Sil i×(R+1)/(R+DSul/Sil i), where CSil i and CSul i represent the concentrations of element i in the parental silicate magma and in the sulfide melt, respectively; DSul/Sil i is the sulfide melt/silicate liquid partition coefficient of element i; and R is the R-factor.

By model analyzing (Fig. 1), it is concluded that the Limahe and Qingkuangshan intrusions had undergone two sulfide segregations. But, the ratios between silicate magma and immiscible sulfide melt are very different. The Hetaoshu deposit was generated by concentration of sulfide droplets in a dynamic conduit. The sulfide droplets were directly segregated at depth (R=2000-50000) and

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transported by ascending magmas. Reaction between the sulfide liquid in the Hetaoshu conduit and new magma passing through the conduit increased PGE tenors in the sulfide ores.

4 Conclusions

(1)The ore forming elements of Hetaoshu consists of Ni primarily and Cu secondly characterized by PGE undepletion. The ratios of Cu/Pd vary in the ranges of 6000~20000, which is similar to those observed for the mantle. The primitive mantle-normalized patterns of Ni-Cu-PGE in recalculated 100% sulfides have Positive slopes, and similar with that of Jinbaoshan Pt-Pd deposit, which indicates the similar metallogenic model.

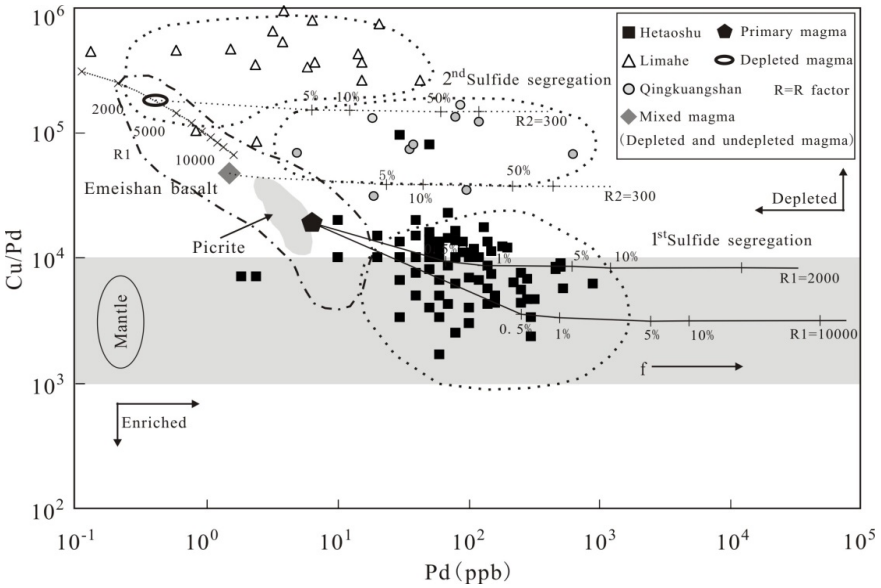

Fig. 1 Pd vs Cu/Pd diagram of typical Ni-Cu-PGE magmatic sulfide deposits in ELIP.
Primitive mantle values after Sun and McDonough, 1989; Emeishan picrites and basalts from Zhong et al.,2006; Limahe from Tao et al.,2008; Qingkuangshan from Zhu et al., 2012; Partial Hetaoshu sulfide ore from 601 Geological Brigade of Sichuan company of Metallurgical Geology & Exploration, 1974; f, content of segregated sulfide.

(2)The immiscible sulfide liquids of Hetaoshu deposit were segregated (R=2000-50000) at depth from PGE-undepleted magmas directly and new magma passing through the conduit increased PGE tenors in the sulfide ores.

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