The Genesis of the Jinchuan Cu-Ni-PGE Sulfide Deposit, NW China

Chengjiang Zhang[1], Yunliang Wang[2] and Guanghong Xie[2]
[1]Third Department, Chengdu University of Technology, Chengdu, 610059, P.R.China
[2]Guangzhou Institute of Geochemistry, Chinese Academy, Guanzhou, 510640, P.R. China
e-mail: xsong@hkusua.hku.hk

The Jinchuan Cu-Ni-PGE sulfide deposit, a world-class deposit, is contained in the Jinchuan intrusion, which is located in the southwest margin of the Alashan Block, NW China. The Jinchuan intrusion, dipping SW, is a mafic-ultramafic dike-like intrusion, with a length of 6500 m, thickness 20-530 m, and an exposed area of 1.34 km^2. Three separated large orebodies have been confirmed by extensively drilling. In the middle and western segments of the Jinchuan intrusion, the rocks from the center to margin are dunite, lherzolite and olivine websterite. The large, steep lens-shaped orebodies are contained in dunite. In contrast, the rock zones are dunite-lherzolite-plagioclase lherzolite- lherzolite from the bottom to top in the eastern segment, and the orebodies are located at the base of the intrusion. In summary, dunite is the major host rock of the orebodies in all of the three segments. Massive sulfide ores, mainly found within and around the layered orebodies, are irregularly shaped with length from a few meters to 300 m and in thickness from a few centimeters to 30 m.

Based on the diagrams of Th/Hf versus Ta/Hf, La/Yb versus La, and Pd/Ir versus Ni/Cu, Zhang and Wang (1996) indicated that the Jinchuan intrusion was formed in a continental margin rift and that the ultramafic rocks are the cumulate phase of an originally tholeiitic magma.

The PGE abundance of the rocks in the middle and western segments are more than 3 times higher than that of the rocks in the eastern segment in the Jinchuan intrusion. The rocks from central and western segments show similar PGE chondrite normalized patterns, which are different from that of the rocks of the eastern segment. Massive sulfide ores show the PGE abundance and chondrite normalized patterns similar to the ores in the layered orebody that imply the genetic links between them.

According to the geological and geochemical characteristics of the Jinchuan intrusion, Tang (1990) and Xie et al. (1998) suggested that the magmatic migration conduit is located in the middle and western segments. Tang's model proposed that the melts, experienced some degrees of crystallization fractionation in the depth, migrated upwards during the continental rifting. Because of the high pressure, the magma migrated upward very fast and resulted in severe flow differentiation. When the melts flowed into the eastern segment of the intrusion, which is relatively wide, the magma spread out laterally and experienced gravitational differentiation. The layered orebodies were found as the result of gravitational differentiation, while the other orebodies represented that they were the products of flow differentiation in a magma conduit. The massive sulfide ores solidified from the segregated sulfide melts, which transported over a short distance.

Sulfide segregation is the most important metallogenic process for the Cu-Ni-PGE sulfide deposits. The extent of sulfide segregation from a silicate magma will depend on a number of factors, such as 1) solubility of sulfide in the magma, 2) redox potential, and 3) viscosity and temperature of the magma. Wang and Zhang (1996) and Xie et al. (1998) indicated that Ce^0 (Ce^0=Ce2/(La*Nd)) and La/Nd ratio can be used as effective indicators for the extent of sulfide immisibility for the Jinchuan and the other giant magmatic Cu-Ni-PGE sulfide deposits in the world. The larger the amplitude of variation of Ce^0 values and La/ Nd ratios of the intrusion, the more possibly a giant Cu-Ni-PGE sulfide deposit occurs. The volatiles can be derived from the wall rocks, particularly those composed of carbonates.

References

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