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Genesis of the subduction-related Heishan magmatic Ni-Cu-(PGE) deposit at the southern margin of the Central Asian orogenic belt

Wei Xie* and Xie-Yan Song

College of Oceanography, Hohai University, Nanjing, Jiangsu, China, *e-mail, weixie@hhu.edu.cn

Most world class magmatic sulfide deposits are genetically linked with mantle plumes with magmatism close to craton margins. Examples include Noril'sk, Jinchuan and Voisey's Bay . However, many Ni-Cu-Co-(PGE) deposits with signifcant metal reserves have been also discovered in orogenic belts around the world, such as a series of deposits at the southern margin of the Central Asian orogenic belt (e.g., Kalatongke, Huangshan, and Pobei in NW China); the Aguablanca deposit in the Variscan collisional orogeny, Spain; the deposits in the Selebi-Phikwe belt, Botswana; the Santa Rita deposit in the Itabuna-Salvador-Curaca belt, Brazil; and the Xiarihamu deposit in the Kunlun orogenic belt. These discoveries indicate the potential of orogenic belts to host magmatic sulfide deposits. Yet the mechanisms of sulfide segregation and formation of the Ni-Cu-(PGE) sulfides are not fully understood.

The discovery of the Heishan Ni-Cu-(PGE) deposit hosted in a Late Devonian intrusion (357±4 Ma), Gansu Province, NW China, indicates that the magmatic sulfide mineralization along the southern margin of the CAOB can be formed in subduction-related environments, although most of the magmatic Ni-Cu-(PGE) deposits hosted in Permian mafic-ultramafic intrusions were long considered to be associated with post-subduction magmatism. The Heishan parental magma was derived from partial melting of the asthenosphere and mantle wedge triggered by upwelling of asthenosphere due to break-off of a subducted slab. Recent research supports this idea through studies of the ophiolitic mélange and intermediate dikes in the same area.

The two Heishan orebodies (No. 1 and No. 4) within the harzburgite and lherzolite at the lower part of the intrusion host ~35 million tonnes of disseminated sulfide mineralization with average grades of 0.6 wt. % Ni and 0.3 wt. % Cu. The sulfides of the No. 4 orebody were formed by settling of the mixtures of unfractionated sulfide liquids and previously fractionated MSS slurry at the base of the intrusion. The sulfide segregation was triggered by addition of crustal sulfur during contamination in a deep-seated magma chamber. The sulfides were upgraded in chalcophile elements by reaction of the sulfide droplets with the new pulses of S unsaturated magma in the deep-seated magma chamber that were brought to the Heishan intrusion and formed the No. 1 orebody and the mineralized harzburgites at higher levels. The low PGE grades of the Heishan sulfides indicate that the sulfides were segregated from PGE-depleted parental magmas.