SEG 2017 Conference

A new ore genesis model for the Jinchuan Ni-Cu-PGE deposit: Constraints from the multiple S isotopes and the spatial variation of PGE tenors

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The Jinchuan Ni-Cu-PGE sulfide deposit is one of the three largest magmatic sulfide deposit camps and the largest single magmatic sulfide deposit in the world. The host intrusion is located in southern Alxa, which has the Archean basement. The still debated questions for the Jinchuan deposit are (1) the key factors for the sulfide segregation; (2) the ore genesis model, including the emplacement of multiple sulfide liquids or multiple pulses of sulfide-charged magma with different R-factors at depth. We use new data for the lower parts of the deposit that are now accessible for sampling due to on-going underground mining operations, together with the existing data for its upper parts, to show a more complete picture of the deposit in PGE tenor variation. The fundamental controls on such variations are then discussed. Some of the new samples have also been analyzed for multiple sulfur isotopes which will evaluate the role of addition crustal sulfur in triggering sulfide saturation in the Jinchuan magma.

Four of ninemultiple sulfur isotope analyses for the Jinchuan deposit show anomalous $\Delta^{33}S$ values varying from 0.12 to 2.67 ‰. These results, together with elevated $d^{34}S$ values (>2 ‰) for some of the samples analyzed previously by other researchers, indicates the involvement of external sulfur from Archean and Proterozoic sedimentary rocks. Previously reported Re-Os isotope data for the Jinchuan deposit (gOs from 30 to 320) are consistent with the S isotope data. All these isotopic data indicate that the parental magma of Jinchuan deposit has experienced previous sulfide segregation during ascent or in staging chambers.

New PGE data from this study, together with previous results, indicate that PGE tenors in the bulk sulfide ores of the deposit increase eastward, except for two fault-offset ore zones which occur together within the western part of the deposit. Generally, these two ore zones show depletions in IPGE (Ir, Ru, Rh) but not in PPGE (Pt, Pd) and Cu, and more fractionated olivine and Cr-spinel compositions than the rest of the deposit. These differences can be explained by a more evolved parental magma for the IPGE-depleted ore zones. The eastward increase of PGE tenors in the rest of the deposit can be explained by upgrading of pre-existing sulfide liquid in a sub-horizontal conduit by a new surge of magma moving through the conduit from west to east, which took place before the formation of the IPGE-depleted ore zones.