

Modeling of the compositional variations of metal tenors in the Aguablanca Ni-Cu-(PGE) sulfide deposit, SW Spain

Rubén Piña*, Fernando Gervilla, Lorena Ortega, and Rosario Lunar

University Complutense of Madrid, Madrid, Spain, *e-mail, rpinagar@ucm.es

Ni-Cu-(PGE) sulfide deposits are the result of fractionation and crystallization of sulfide melts previously segregated by immiscibility from silicate magmas. The metal composition of the mineralized bodies depends on the initial metal content of the silicate magma, the partitioning behavior of metals during the sulfide segregation and fractionation, and the silicate to sulfide ratio (*i.e.*, R-factor). Modeling of the compositional variations of metal tenor has led to establish the origin and fractionation of the sulfides in the Aguablanca Ni-Cu sulfide ore deposit (SW Spain). Two main ore-types with distinct metal tenors occur in this deposit: semi-massive and disseminated ores. In addition, there are also locally chalcopyrite-rich veinlets but this ore-type is much less abundant.

In Aguablanca, the high modal abundance of pyrrhotite in the semi-massive ore, the predominance of pentlandite over chalcopyrite and the enrichment in Ni, Os, Ir, Ru and Rh and depletion in Cu, Au, Pt and Pd relative to disseminated ore indicate that the semi-massive ore represents MSS-enriched cumulates. The disseminated ore likely represents the *in-situ* crystallization of an original, unfractionated sulphide melt. Os, Ir, Ru and Rh are enriched in pyrrhotite and pentlandite from the semi-massive ore by a factor of 3 to 15 relative to the disseminated ore, and Pt and Au are depleted by factors of 0.1 and 0.01, respectively. Considering that these values are within the range of the partition coefficients between MSS and sulfide melt, it seems probable that the disseminated ore represents an original sulphide liquid from which MSS crystallized. Modeling of the composition of disseminated sulfides indicates that they may be segregated from a relatively Cu-rich silicate magma containing ~ 250 ppm Cu, ~ 250 ppm Ni and ~ 6 ppb Pd, under R-factors ranging from 200 to 1000. The Cu content is higher than the upper limit for a mantle-derived melt, ~ 120 ppm, suggesting that the high Cu content could well be due to the assimilation of crustal components from the country rocks characterized in the surrounding area by hosting small stratabound concentrations of chalcopyrite and bornite.

Only 1-2 vol. % of the sulfide ores in Aguablanca consists of chalcopyrite-rich veinlets. The high Cu, Pd, Pt and Au tenors suggest that these veinlets likely represent the crystallization of a Cu-rich fractionated sulfide liquid after MSS fractionation. However, the abundance of chalcopyrite-rich veinlets is very low considering the high amount of semi-massive ore (*i.e.*, MSS cumulates) present in Aguablanca. It is thus probable that the emplacement of the sulfide melts in shallow crustal levels and the subsequent rapid cooling of the melt prevented extensive fractionation of the sulfide melts and only small amounts of Cu-rich residual sulfide melt generated. This melt was then likely retained with the MSS cumulates or percolated away the mineralized breccia, and uniquely in some places, this liquid precipitated as Cu-Pd-Pt-Au-rich chalcopyrite veinlets.