The Distribution Patterns of Platinum Group and Chalcophile Elements in Zoned Sulfide Blebs: Example from the Rudniy Intrusion, NW Mongolia

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Platinum-group elements (PGE), Au, Ag, and other chalcophile elements partition preferentially into sulfide melts and sulfide blebs collect them from silicate magma. Experiments show that Os, Ir, Ru, Rh, Co, and Re partition mainly in the Fe-Ni monosulfide solid solution (MSS), whereas Pd, Rh, Pt, Au, and many other chalcophile elements accumulate in the residual Cu-rich sulfide melt, subsequently forming an intermediate solid solution (ISS). With further cooling, subsolidus exsolution of MSS and ISS takes place, leading to the formation of pyrrhotite-pentlandite (from MSS) and chalcopyrite-cubanite (from ISS) mineral associations called base metal sulfides (BMS). Understanding the distribution of the chalcophile and PGE among the BMS phases is important to establish petrogenetic models and for the efficient extraction of these elements in Cu-Ni-sulfide ore-deposits.

We are investigating the distribution of PGE and other chalcophile elements on representative sulfide blebs from the base of the ultramafic-mafic Rudniy intrusion (located in the Tsagaan-Shiveet Ridge, NW Mongolia). These blebs are ideal to investigate the behavior of PGE during the crystallization of a sulfide melt because the system can be considered as closed. The PGE, Ag, Au, Cd, Co, Re, and Zn distribution were determined by laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) at Laurentian University, Sudbury, Ontario, Canada. Additional work is planned to characterize the samples in more detail. However, several major observations can be made from the obtained preliminary element distribution maps. Ni and Co are compatible with MSS and, as expected, are mostly concentrated in pyrrhotite and pentlandite. In contrast, Cd, Zn, and Sn partition preferentially into ISS and are hosted in chalcopyrite and cubanite. Regarding the PGE, the behavior is more complex. Little can be said about Ru and Rh at this point because argide interferences ($^{40}Ar^{61}Ni$ on ^{101}Ru and $^{40}Ar^{63}Cu$ on ^{103}Rh) mask the behavior of those elements. However, there are clear correlations among Pt, Ir, Bi, and Te. These elements form small areas of high concentration that indicate micronuggets of PGE are largely hosted in chalcopyrite-cubanite aggregate and may have formed by exsolution during subsolidus re-equilibration. More important and noticeable is the clearly visible difference in the distribution of Os, which emphasizes the presence of two generations of pyrrhotite (MSS)—one, relatively rich in Os (and with some Re) and another, where the Os content is below detection limit. The distinctions in concentrations of Os in between two nearby pyrrhotite grains can support the model of MSS segregation to MSS1 and MSS2 during crystallization. There are also observed enrichment of Pd in coarse-grained pentlandite specifically in the central part of grains. Gold is essentially below detection limits and As shows a very unusual distribution with no correlation with the BMS.