BEHAVIOUR OF ORE COMPONENTS AT ONE-DIMENTIONAL SOLIDIFICATION WITH MELT COMPOSITION SIMILAR TO NATURAL Fe-Cu-Ni-S MAGMATIC LIQUID, WITH IMPURITIES OF Pt, Pd, Rh, Ru, Ir, Au, Ag

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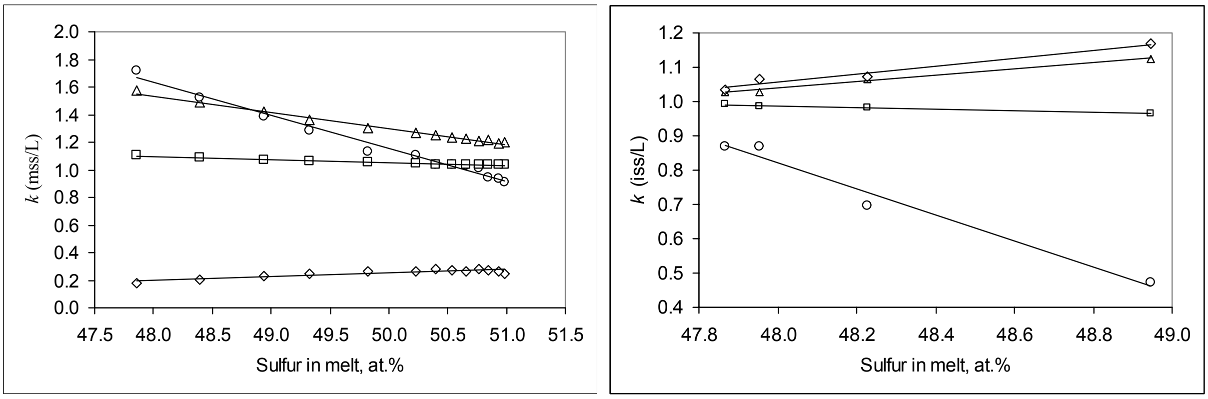
Now there is a lack of quantitative data for the description of behavior of the components at a solidification of the Fe-Cu-Ni-S magmatic melt. A number of authors [1-6] note the deficiency of experimental data on partition coefficients (*k*) of precious metals that does not allow constructing adequate models for their fractionating. In the present work the directed melt crystallization of the composition, similar to natural Fe-Cu-Ni-S melt is carried out. The magmatogene sulfide deposits of Noril'sk and Sudbury type were apparently formed in this way.

The sample of composition (in at. %): Fe 32.55, Cu 10.70, Ni 5.40, S 51.00, Pt, Pd, Rh, Ru, Ir, Au and Ag (0.05 of any impurity) was crystallized by the Bridgman technique. The details of this method have been described in our previous work for the Fe-Ni-S system [7]. The chosen rate of $2.25*10^{-8}$ m/s provided a quasi-equilibrium run of the process. Temperature at the lower end of the quartz container at the beginning and end of crystallization was 1046 and 721°C accordingly. The ingot, 70 mm long with diameter 8 mm, has been cut on 24 parts by sections, perpendicular a longitudinal axis. Polished sections were examined with optical and electronic microscopic, X-ray diffraction and microprobe methods. The initial part of an ingot up to g ~ 0.68 (*g* is the fraction of crystallized melt) consisted of a monocrystalline Fe-mss matrix with systematically oriented lamellae of chalcopyrite in the section plane. The size of inclusions gradually increases by the end of this part of an ingot. Chalcopyrite $(Fe,Cu)S_2$ enriched in Fe (Fe:Cu = 1.66 at g = 0.68) also contains nearly 1 at. % Ni. High-temperature mss transforms to monoclinic mss at g = 0.03. At 0.03 < g < 0.68 mss is similar to low temperature pyrrhotite with a hexagonal supercell (SG: P31) [8]. Its composition corresponds to formula $Fe_{0.372}Ni_{0.085}Cu_{0.010}S_{0.533}$ at g = 0.68. The following part was a monocrystalline iss matrix with breakdown products in the form of chalcopyrite, bornite, pentlandite and pyrrhotite mixture. The distribution curves of the macrocomponents were built on the basis of the chemical analysis of mss and iss. These results were used to calculate their *k* (mss/L) and (iss/L) at the melt composition along the crystallization path (fig. 1a,b). It was found out that the melt was enriched in Cu and depleted in Fe, Ni an S during mss crystallization (fig. 1a). *k* Ni, Fe and S increased with S content decrease in the melt, and most considerably for Ni (from 0.9 in the beginning of the process up to 1.5 by the moment of the ending of its crystallization). *k* Cu (mss/L) is equal to 0.25±0.03. We determined that during iss crystallization (fig. 1b) Cu and Fe concentrated in this phase whereas Ni enriched melt. *k* S (iss/L) is close to 1.

At the moment of the L + mss → iss phase reaction, connected with the ending of mss crystallization and the beginning of iss crystallization, the distribution curves in the solid have discontinuities, and the component concentration in the melt versus *g* plot shows a kink.

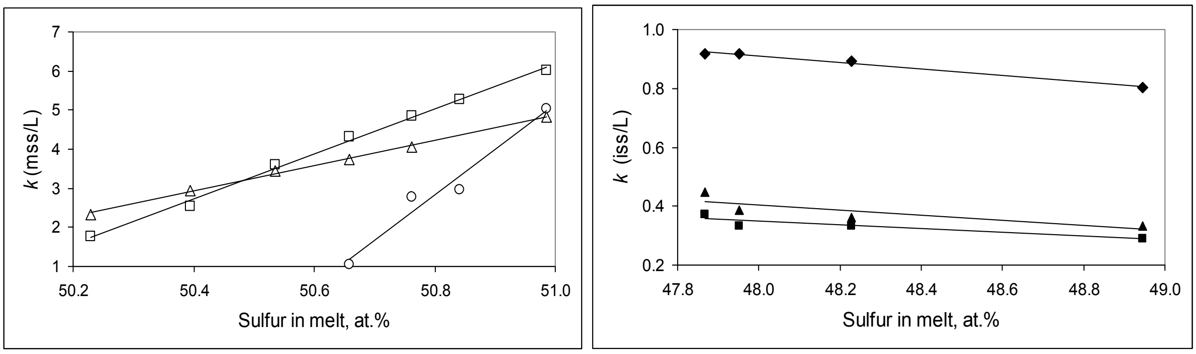
Similar behavior of Rh, Ru and Ir, which are absorbed in initial portions of mss (*k* mss/L > 1) (fig. 2a), and Pt, Pd and Au concentrated in the sulfide melt (*k* iss/L <1) (fig. 2b) are observed for precious metals. *k* Rh, Ru and Ir (mss/L) increased while *k* Pt, Pd и Au (iss/L) slightly decreased with increasing in S content in the melt. Forms of own phases of precious metals were established. They are laurite crystals with impurities (in at. %) 2.8 Ir, 2 Fe, on 0.4 Pd and Cu and 0.3 Ni in a matrix mss in the beginning of the ingot. Numerous fine crystals and grains of own phases of Pd, Pt and Ag are formed in the end of the sample. They are vysotskite with an impurity (in at.%) 7.5 Ni, 2 Cu, 1 Fe, 0.5 Au; Pt-containing sulfide $CuPt_2S_4$ with an impurity of ~ 9 at.% Ni and 6 Fe; Ag with an impurity of 3.5 at.% Cu, 0.4 Pd and 0.1 Pt, etc. Cu-rich pentlandite (up to 3.2 at. % Cu), which forms as a result of iss decay, contains near 0.34 at. % Pd.

The obtained results can be used for modeling of fractionation of main components at formation massive PGE-bearing Cu-Ni-sulfide ores, their possible zoning and mineral forms of micro-impurity inherentin various mineral zones.



(a) (b)

Fig.1. Cu, Fe, Ni and S partition coefficients (rhombuses, triangles, circles and squares, respectively) mss/L (a) and iss/L (b) as functions of the S concentration along the crystallization trajectory



(a) (b)

Fig.2. Rh, Ru and Ir partition coefficients (open triangles, squares and circles, respectively) mss/L (a) and Pd, Ag and Au (solid squares, triangles and rhombuses, respectively) iss/L as functions of the S concentration along the crystallization trajectory.

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