EXPERIMENTAL AND THERMODYNAMIC SIMULATION OF THE COSKARN ORE DEPOSITION

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This study was supported by the Russian Fundamental Research Foundation (Projects No. 98-05-64234 and 99-05-64908)
Herald DGGGMS RAS № 5 (15)'2000 v.2
URL: *http://www.scgis.ru/russian/cp1251/h_dgggms/5-2000/hydroterm1.eng*

The intrusive activity going with gradient thermal aureoles formation around the massifs of magmatic rocks does induce reallocation of metals. The concepts of regular metals leaching from sedimentary or volcanogenic rocks in the intrusive thermal field, transporting of ore components by a convective flow, and their concentrating in the area of contact-metasomatic zones are in the base of convective ore formation model in skarn that is being under the development by now [1]. The speciality of the model is the admission of an initial infection of the system by ore components: an impurity of ore metals in skarn is initial, but not introduced by later portions of solutions. Thus metals from the very beginning participate in the processes of mineral formation together with other petrogenic elements. The simulation could not only affirm such a possibility, but also display the main features of these processes.

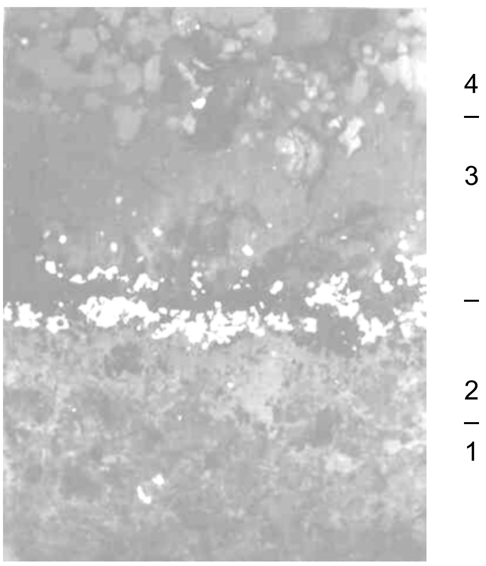

Fig. 1. Experimental skarn column. 1 – Ep+Ksp, 2 – Ep+Cpx; 3 – Wo+Gr; 4 – Cc; white – sulphides

More than hundred experiments of bimetasomatic mineral formation in the systems initially enriched by ore elements had been carried out in the Lab of Ore Deposits Modelling (IEM) during last years. It was shown, that in the whole skarn formation temperature range (350-600°C) the deposition of ore minerals definitely correlates with bimetasomatic zones, and the most concentrated deposition is observed on boundaries between separate zones [3] (fig. 1). The coskarn deposition of galena, sphalerite, chalcopyrite, pyrite, magnetite, chalcosine, scheelite, powellite, native gold, copper, platinum, etc. is experimentally reproduced.

Thermodynamic simulation of coskarn ore deposition process was carried out with the help of code "BALANCE" [4], designed for computing equilibria in multisystems. On the first step the methodology problem of such a simulation was set. Galena, sphalerite, and chalcopyrite were assigned as ore minerals. The computation runs were conducted for temperature 450°C and pressure 1 kbar. The salinity of the fluid was assumed to be 0.3 mol/kg NaCl.

Process of coskarn column formation was simulated by step-by-step magnification of a carbonaceous material (calcite) amount in the originally granite system. Thereby diffusion of opposite fluxes of components from the uninvaded granitoid and calcite was imitated. Such a flux cause change in the pore solution composition. Thus minerals of initial silicate rock (quartz, anorthite, biotite, accessory magnetite) become unstable relative to the changing solution, being completely diluted on those or diverse stages of the process. Simultaneously appearance of new minerals typical for skarn paragenesises takes place. Their appearance and disappearance is also step-typed, that displays the key feature of bimetasomatic process (fig. 2). The first one, starting from the uninvaded granitoid, epidote arises. This zone can be correlated with the granitoid which has exposed to a slight changes variation in a halo of skarn stratum. As to the next zone of epidote-pypoxene-plagioclase rocks the appearance hedenbergite and disappearance of quartz is typical. After that epidote-pyroxene-grossularite endoskarn zone is allocated (appearance of grossularite, disappearance of plagioclase). The exoskarn part of a column is presented by pypoxene-garnet (especially andradite) and garnet-wollastonite zones. Such a sequence of zones is completely identical to many experimental and natural columns of skarn deposits.

The initial presence of galena, sphalerite and chalcopyrite in the system enables to observe regularities in ore minerals solubility at each of isolated zones. The general regularity is that equilibrium concentration of ore elements definitely falls while moving from granitoid toward carbonate zones (fig. 3). So the concentration of Pb and Zn decreases more than in 20 times, copper – in 100 times. The drop of ore components solubility in pore solutions controls their deposition on the boundaries of skarn mineral zones.

The proposed method also allows to model gradients of deposition of various ore elements. In our case it is brightly exhibited concerning copper. So, if lead and zinc are deposited in the first three zones in about equal amounts (37 and 39, 35 and 33, 28 and 27 mol % from total amount accordingly), the relative amount of copper essentially varies: from 23 mol % in a zone of the slightly invided granitoid, up to 45 % in endoskarn. The 100 % of total ore load lay on copper in the exoskarn part of the column.

1. Ezhov S.V. Convective model of formation of skarn-complex deposits of Altyn-Topkan region as a basis for the geologic prognosis of ore formation // Ore and Metals, 1994, № 3, p.18-29.
2. Ezhov S.V. Relationship between processes of skarnformation and deposition of sulphide ores at complex deposits of Altyn-Topkan ore region (Central Asia) / Geology of Ore Deposits, 1994, т. 36, № 3, p. 237 - 249.
3. Ezhov S.V. Experimental study of coskarn ore formation and transformation of ore aggregates. Experimental and theoretical modelling of mineral formation processes. M. Science, 1998, p. 210-225.
4. Akinfiev N.N. Algorithm of calculation of heterogeneous equilibria for micro-computer. Geokhimiya, 1986, № 6, p. 882-890 [In Russian].

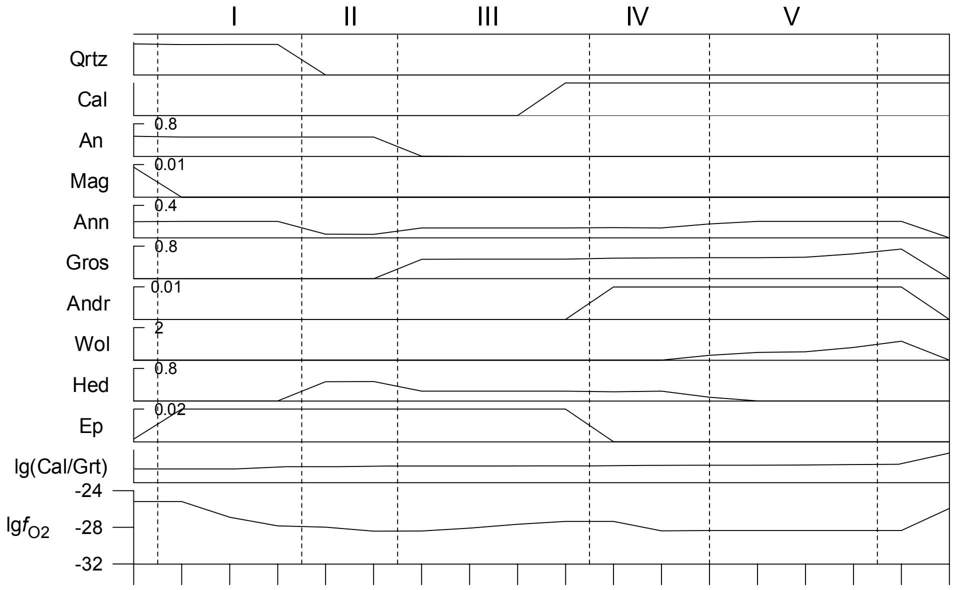

Fig 2. The computational skarn column. I - V - zones of the column (see text).

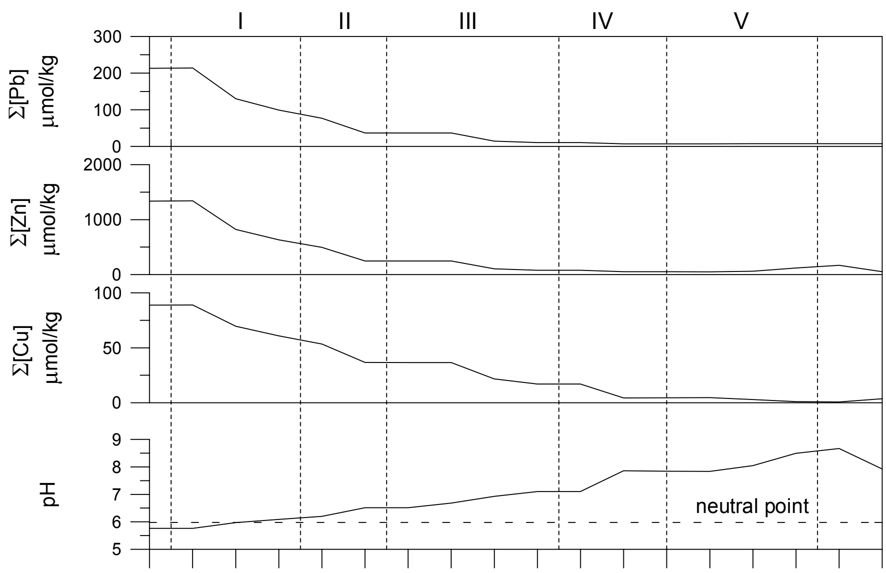

Fig 3. Equilibrium concentrations of ore elements vs column zones