NUMERICAL SIMULATION OF *ZN* AND *PB* DISTRIBUTION BETWEEN FLUID-MELT-SOLID PHASES IN THE PROCESS OF GRANITIC MAGMAS CRYSTALLIZATION, ACCOMPANIED BY THE FORMATION OF HETEROGENEOUS WATER-CHLORIDE FLUID

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A computer modeling has been performed for the Zn and Pb behavior in the process of degassing of granitic magmas containing H_2O and Cl during their crystallization. The model is based on generalization of the available experimental data and takes into account influence to partitioning coefficients of Zn, Pb and Cl between a fluid phase and melt of two major factors - pressure and Cl concentration in fluid [1,2]. The model allows to calculate of ore elements concentration changes in fluid, melt and crystalline phases in the process of magmas degassing both in opened conditions, when formed fluid phase escapes from the system, and in closed conditions, when fluid phase stays in the system.

The model calculations show, that the distribution Zn and Pb between fluid-melt-solid phases during of degassing process essentially depends on pressure, degree of an openness of the magma tic system, and also from a bulk partitioning coefficient of metal element between crystals and melt D(Me)s/m. Crystallization-assisted degassing of melts with the high initial contents of a water at relatively high pressure (>1.5-2 kbar) is accompanied by decreasing of Cl and metals concentrations in the fluid. Especially sharp drop of concentrations takes place in open conditions. The ore element concentration in fluid phase decreases during degassing the more fast the higher D(Me)s/m. For example, in the case of crystallization-assisted degassing at 2 bar of the initial granitic melt, containing 0.2 wt.% of Cal, 5.8 wt. of % of H2O and 100 ppm of Zn, the concentration Zn in fluid varies from 900 up to 650 ppm in closed and from 460 up to 280 ppm in opened conditions depending on D(Zn) s/m (0.4-1.2), when crystallization degree reaches ~ 50 %. The behavior Pb during crystallization-assisted degassing for similar initial conditions has the same character, however level of its concentrations in fluid at the same crystallization degree is much lower, than Zn, owing to lower values of Pb partitioning coefficients between fluid and melt.

In essence other situation takes place, if crystallization-assisted of fluid-saturated melts happens at relatively low pressures (< 1-1,5 kbar). In this case Cl and ore elements concentrations in fluid in the course of the crystallization increase both in closed and opened conditions. The increase of concentration Cl in fluid phase can result in formation at certain crystallization stage heterogeneous fluid phase, consisting from aqueous Cl-bearing phase (aq) and chloride H_2O-bearing liquid (lq). The partitioning coefficients of Zn and Pb between chloride-rich liquid (lq) and silicic alumosilicate melt in some times are higher (> 5-7 times), than the partitioning coefficients of these elements between aqueous vapor phase (aq), equilibrated with lq, and the same alumosilicate melt [3]. The formation of heterogeneous fluid phase (aq+lq) in the process of degassing has a great influence on concentration Zn and Pb in fluid and extraction degree of these elements from the melt. The variation of the concentration Zn in fluid phase during crystallization of granitic melt at 0,6 kbar is shown in the fig.1. The zinc concentration in the aqueous phase aq separating from a melt at the first stages of crystallization will increase from 500 up to 1200 ppm. The concentration trajectories for closed and open system differ from each other a little. The fluid phase becomes heterogeneous, when the degree crystallization degree reaches ~50 %. In case of the closed system the fraction of lq in the fluid increase slowly, therefore despite of occurrence of this phase much more enriched by zinc than aq, the general summary concentration of Zn in fluid (aq+lq) to be increased rather monotonically at further melt degassing. In conditions of the open system, when all fluid phase escapes a system in accordance with it of separation, the general concentration Zn in fluid (aq + lq) will increase by a jump. In this case the ratio lq/aq in fluid is much higher, than in the closed conditions. Some decreasing of Zn concentration in separating heterogeneous fluid in opened conditions is stipulated by a decreasing of Zn concentration in a melt.

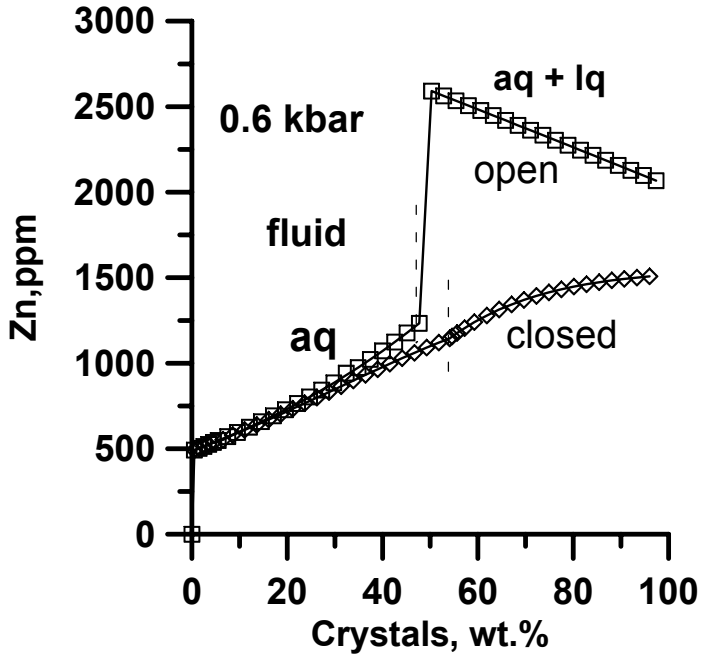

Fig. 1. Change of Zn concentration in fluid phase in the process of crystallization-assisted degassing of a rhyolitic melt at 0,6 kbar in the closed and opened conditions. The initial concentrations in the melt are: H_2O = 2.9 wt. %, Cl = 0.15 wt. %, Zn = 100 ppm. For calculations it is accepted D(Zn)s/m = 0,6; D(Zn)lq/aq = 10. The vertical dashed lines show of beginning moment of heterogeneous fluid (aq+lq) exsolution from a melt.

The results of modeling allow to make a conclusion that the most favorable conditions of formation magmatic fluids with high concentrations Cl, and also Zn and Pb are: 1) first stages of crystallization-assisted degassing on large depths (P ≥ 2-3 kbar); 2) the melt crystallization in magmatic chambers on shallow depths (P < 1-1,5 kbar), which can be accompanied by formation of chloride-rich fluids.

References

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