

INFLUENCE OF CRYSTALLIZING MINERAL ASSEMBLAGE ON THE EXTRACTION DEGREE OF ZINC BY FLUID PHASE DURING DEGASSING OF GRANITIC MAGMAS

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Introduction. This work is the continuation of the investigation of volatiles and ore elements behavior during fluid phases formation in granitic magmas based on the results of numerical simulation of H₂O- and Cl-bearing granitic magmas degassing [1-4]. The ore elements distribution between melt, crystals and fluid in the process of crystallization degassing depends on numerous factors: initial concentrations of volatile components in the melt, the PT degassing conditions, melt composition, the dynamics of fluid escape from magmatic system [2-4]. Ore element bulk partition coefficient between crystals and melt ($D(\text{Me})_{s/m}$) that is determined by the composition and the ratio of crystallizing mineral phases is one of factors that has an influence upon concentration of this element in the fluid and melt phase and upon its extraction degree from magma by fluid phase. This communication is aimed to present quantitative estimation of the influence of crystallizing minerals ratio on the degree of fluid phase extraction of zinc. Here we consider the case of deep magma degassing at pressure > 1-1.5 kbar, when nascent water-chloride fluid is homogenous.

Variation of $D(\text{Zn})_{s/m}$ at granitic magmas crystallization. The portion of such crystallizing minerals as magnetite, biotite and amphibole influences the most greatly on $D(\text{Zn})_{s/m}$ values according to available data on zinc coefficients of partition between crystals and melt in granitic magmas (Ewart, Griffin, 1994; Bacon, Drit, 1988; Burke et al., 1982; Brenan et al., 1998; Bea et al, 1994; Leman, 1979; et al.). Fig 1 shows calculated data on possible $D(\text{Zn})_{s/m}$ change depending on Bi and Mt amounts in mineral assemblage crystallizing in granitic magmas. For leucocratic alaskaite and aplite granites in which fraction of Bi (<1 %) and Mt (<0.2%) is very small the value of $D(\text{Zn})_{s/m}$ is < 1 (~0.3-0.4). In the case of melanocratic granites with high content of Bi (>8%) and Mt (+ ilmenite) (> 1.5%) $D(\text{Zn})_{s/m}$ is > 1 and can reach values up to 2 -2.5. For prevailing subaluminous granitic magmas, in which Bi and Mt (+Ilm) fraction among crystallizing phases on average is 2-3 and 0.5-1% accordingly, $D(\text{Zn})_{s/m}$ value varies within 0.8 ± 0.2 .

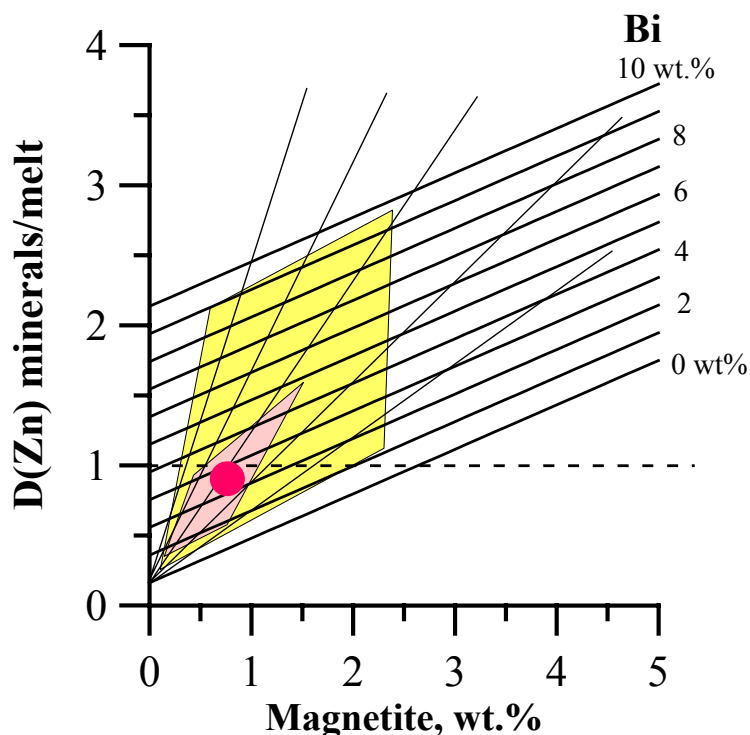


Fig. 1. Change of zinc bulk distribution coefficient crystals/melt $D(\text{Zn})_{s/m}$ depending on amounts of biotite and magnetite in crystallizing mineral assemblage in granitic magmas. It is suggested that ratio of crystallizing is

Pl: Kfs: Q=1:1:1.

Color area - possible variation of $D(\text{Zn})_{s/m}$ values during the crystallization of granitic magmas of various compositions. Red circle - average $D(\text{Zn})_{s/m}$ values for prevailing subaluminous granites. Calculations are based on available data on zinc partition coefficients crystal/melt for Bi, Mt, Pl, Kfs, Q (Ewart, Griffin, 1994; Bacon, Drit, 1988; Burke et al., 1982; Brenan et al., 1998; Bea et al, 1994; Leman, 1979; et al.).

The influence of $D(\text{Zn})$ s/m on fluid extraction degree of zinc. Computer modeling of degassing processes of magmas saturated by water-chloride fluid was conducted at isobaric condition and constant temperature. Consequently it appears to be the modeling of the eutectoid case of magma crystallization, when crystallizing minerals ratio and $D(\text{Zn})$ s/m values are constant within all range of crystallization. As an example fig. 2 shows the results of calculation indicating the $D(\text{Zn})$ s/m influence on zinc concentration in melt and water-chloride fluid being formed during crystallization degassing of granitic magma as under closed and open conditions. The case, when the initial melt contains 5.8 wt. % H_2O , 0.2 wt. % Cl, and 100 ppm Zn, is presented. The Zn concentration in fluid decreases with the increase of crystallization degree. It becomes distinctly apparent at open degassing, when the forming fluid phase escapes out of magmatic system. Under given crystallization degree of initial melt the drop of Zn concentration in fluid is the more essential, the higher is $D(\text{Zn})$ s/m value.

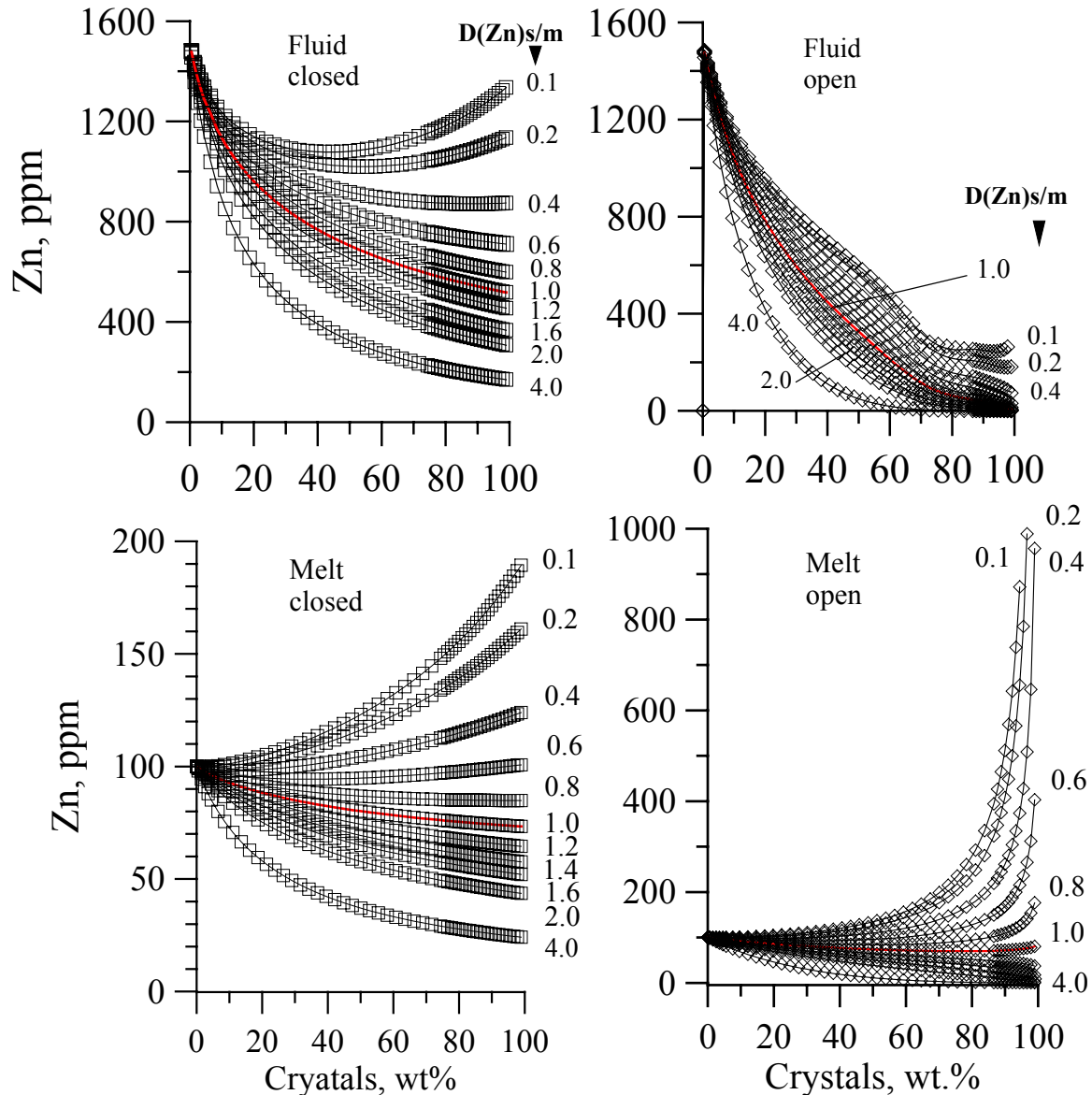


Fig. 2. The influence of $D(\text{Zn})$ s/m on zinc behavior in the process of crystallization degassing at 2 kbar under closed and open conditions. Initial melt contains 5.8 wt. % H_2O , 0.2 wt. % Cl and 100 ppm Zn.

The results of balance calculations presented on the fig 3 demonstrate the change of Zn extraction degree by fluid from magma depending on $D(\text{Zn})$ s/m. On the first stage of crystallization (15-20 %) $D(\text{Zn})$ s/m value does not influence practically on amount of Zn escaped from magma together with fluid irrespective whether the system is closed or open. The influence of $D(\text{Zn})$ s/m becomes apparent

only during subsequent crystallization. The higher is $D(\text{Zn})$ s/m value, the larger is amount of zinc that distributes in crystals and consequently the less is amount of Zn extracted by fluid phase. This tendency appears to be more pronounced with the increase of crystallization degree especially in closed systems.

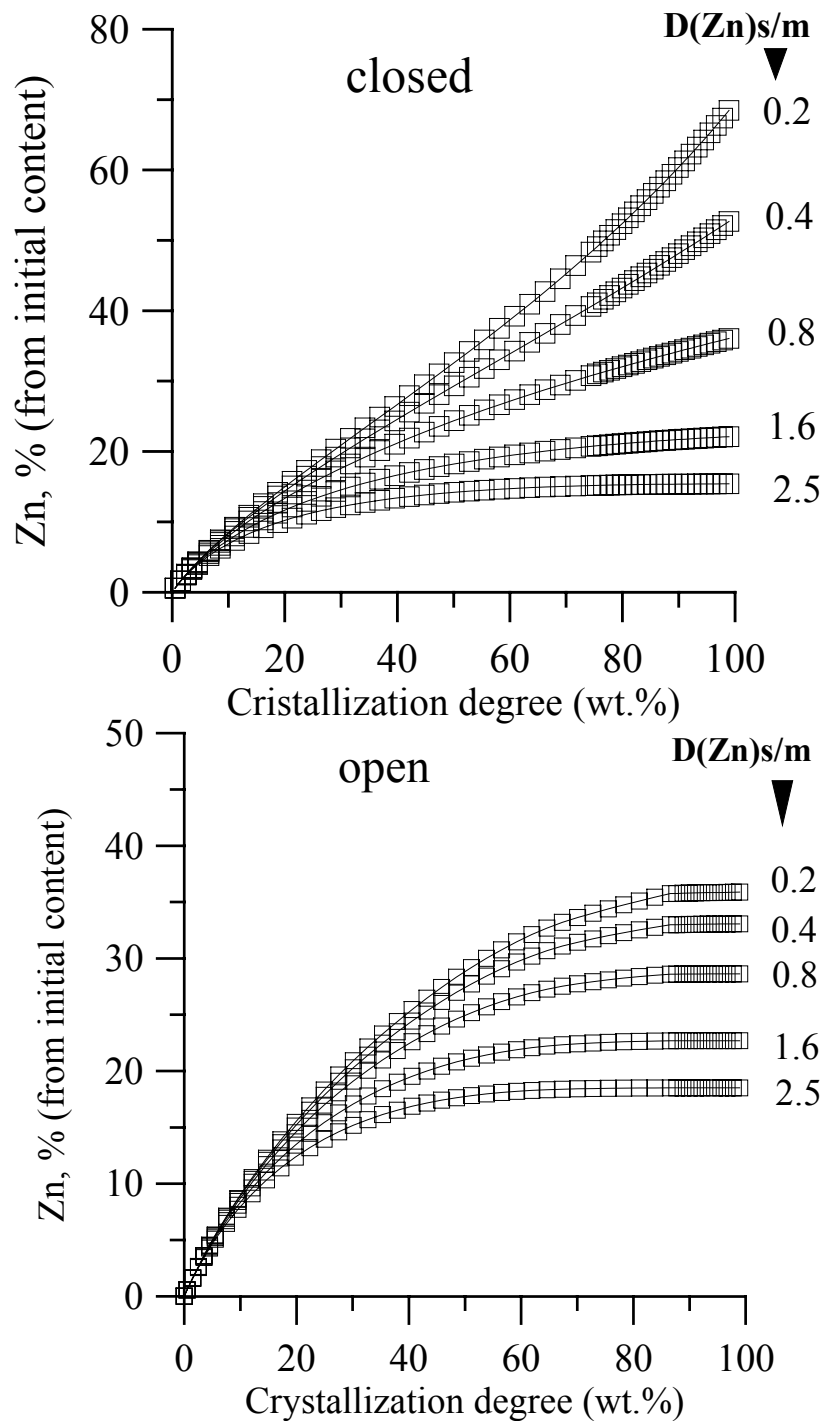


Fig. 3. The influence of $D(\text{Zn})$ s/m on fluid extraction degree of zinc from granitic magmas in the process of its crystallization degassing at 2 kbar under closed and open conditions.

For $D(\text{Zn})$ s/m values, that are typical for prevailing ordinary granitic magmas (~ 0.8), approximately 1/3 of initial amount of Zn is extracted by fluid from the melt when its crystallization degree reaches 75-80%. Zinc extraction degree is practically the same as in closed (30-32%) as in open (27-28%) system. In case of $D(\text{Zn})$ s/m values that are typical for leucocratic granites (~ 0.4), the amount of Zn extracted from magma is accordingly 40-42% (open system) and 32-33% (closed system) under initial melt crystallization degree of 75-80%. Within range of $D(\text{Zn})$ s/m values that are characteristic for melanocratic granites (~ 2.5), the main portion of Zn is extracted from magma by fluid phase at

crystallization degree that is less than a half of initial melt (30-40%). The zinc fluid extraction is 15-16% for closed system and comes to 18 % for open one at crystallization degree of initial melt within range of 75-80 %. These values are approximately twice as less as ones for leucocratic granites at the same crystallization degree.

Conclusions. On the example of zinc it is shown, that amount of ore elements extracted from granitic magmas by fluid phase essentially depends on the composition of crystallizing mineral species especially at the final stages of crystallization. Zinc fluid extraction degree from leucocratic granitic magmas should be more essential in comparison with iron enriched melanocratic granites that form mineral assemblages containing much more biotite and Fe-Ti oxides.

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