INFLUENCE OF THE BOUNDARY LAYER EFFECTS TO THE MELT INCLUSIONS COMPOSITIONS

P.Y.Pletchov, S.V.Trousovt
Moscow State University, Geological department, Moscow

Herald DGGGMS RAS № 5 (15)'2000 v.2
URL: *http://www.scgis.ru/russian/cp1251/h_dgggms/5-2000/magm24.eng*

Introduction

It's well known that melt composition near crystal surface is different from bulk melt composition. It is owing to boundary effects of redistribution of substance between melt and a crystal. The observably width of this layer changes on melt viscosity and growth conditions from 10-15 (for low-viscosity basalt melts) up to 100-150 micron (for rhiolitic melts). Taking into account, that melt inclusions are formed of the melt site, directly adjoining to a growing crystal, it is logical to assume that their compositions also will be deformed in comparison with total melt composition. Smith и др. [1] was first, who showed, that boundary layer melt should be depleted in the compatible components and enriched in incompatible components.

Experimental background

For definition of boundary effect influence to melt inclusion compositions growth alkaline feldspar (Fsp) experiment was produced in granite system (Q-Ab-Or). The system was cooled during 6 day from 760 to 700 °C with speed 10 °/day and then was quenched. As a result diffusion structures were received near crystals Fsp which are given on fig. 1. On these structures effects of enrichment of the boundary layer adjoining to a crystal, those components which it is less in Fsp, than in the melt (for example, SiO2) are well visible. However, on a site of a structure through the boundary layer, far from a surface of a crystal, depletion in SiO_2 and enrichment Al_2O_3 is occurred. This effect is difficult to explain with diffusion migration of components from a growing side.

Computer modelling of the boundary layer effects

Authors carried out computer modelling of the Fsp crystal growth in the granite melt. Thus the equation of multicomponent diffusion and algorithm Oishi [2] for numerical calculation was used. Growth of a crystal was modelled on the layer-by-layer growth mechanism. Component diffusivities were taken from [3, 4]. The basic complexity was modelling the part of a structure that is far from a growing side. The configuration of a structure (fig. 1) assumes head diffusion streams, which transfer the same components to the opposite directions. It means, that these components should be in different composition particles. Thus, a growing side that the gradient of concentration was created should take out the stream of particles directed to a crystal. The assumption of that carry of components to a growing side is carried out by particles of the growing mineral composition, has allowed us to achieve the satisfactory results of modelling similar to experimental profiles.

On fig. 1a two calculated curves is represented at growth Fsp with speeds 1 and 2 mkm/hours, also is showed a calculated line for variable diffusion coefficients (dependence of factors of diffusion on concentration of components is entered). It is necessary to note, that settlement of the boundary layer profiles are non-stationery in time and represent oscillatory system (the period of fluctuations depends on frequency of new layers formation). Uncertainty of many parameters, such as factors of diffusion of complexes in the melt, their sizes, chemical interaction between these complexes etc. do not allow to create complete quantitative model of this process for today.

Estimation of the boundary layer influence to the melt inclusion composition

If to assume, that melt inclusions at formation in part grasp a boundary layer the structure of small inclusions should answer average composition of the seized part of a boundary layer. The more inclusion, the smaller influence on its composition renders a boundary layer. On fig. 2 the calculated curves of average structure of a boundary layer are shown on the size of inclusion. Points on this diagram show melt inclusion compositions having diameter appropriate to dimension of an X axe. In general, good correlation between predicted and measured melt inclusion compositions is observed.

Thus, with the help of diffusion profiles research there is an opportunity to calculate the correction to melt inclusion compositions. Theoretical modelling of growth of crystals in synthetic systems reproduces experimental structures through a boundary layer and may be used for a prediction of the melt inclusion compositions.

1. *Smith V.G., Tiller W.A. et al.* // Can. J. Phys. 1955. V.33. P.723-744.
2. *Oishi Y.* // J. Chem. Phys. 1965. V.43, № 5. P.1611-1620.
3. *Chekhmir A.S. et. al.* // Dynamic phenomenons in fluid-melt systems. M.: Nauka, 1991. 141 p.
4. *Watson, E.B., Baker D.R.* // Physical chemistry of magmas. 1991 V**9** chapter 4 p.120-151.

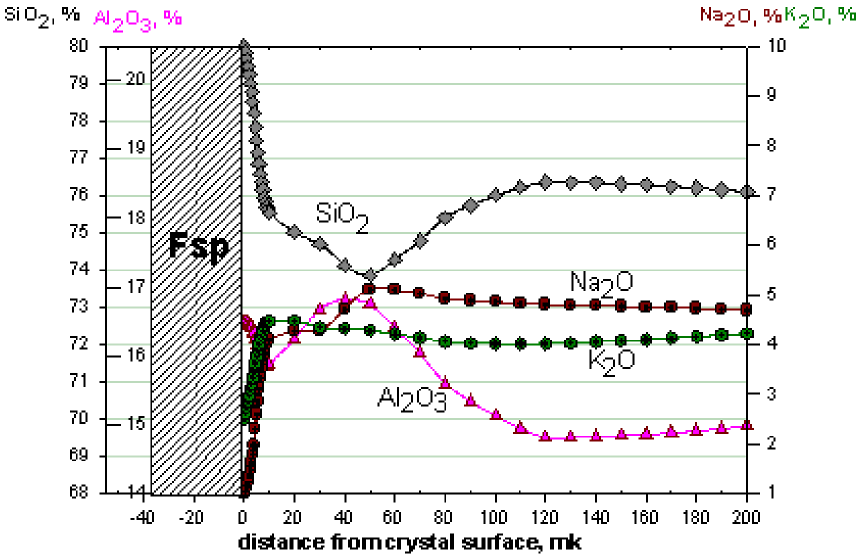

Fig. 1. The melt components distribution near Fsp crystal surface

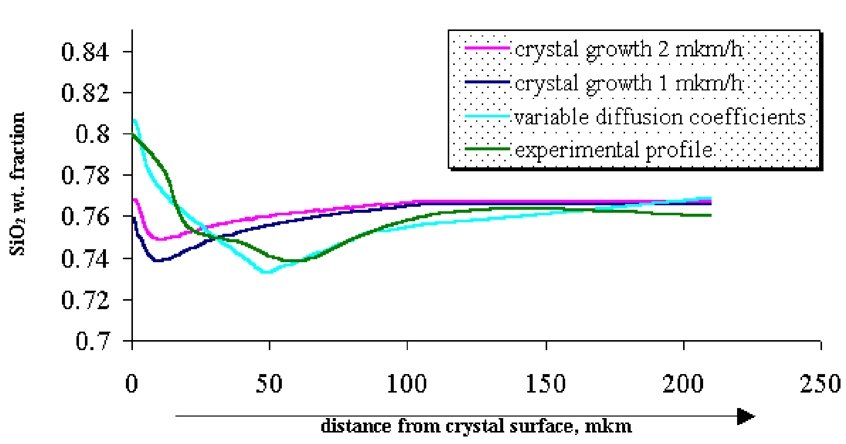

Fig. 1a. Computer modelling of boundary layer effects at Fsp crystal growth

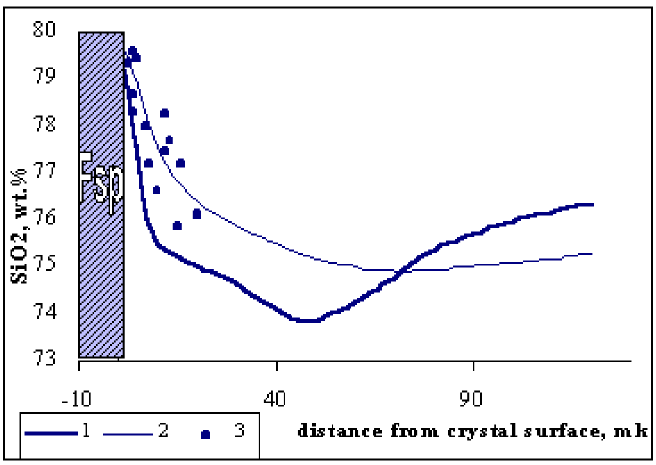

Fig. 2. Relationship between melt inclusions composition and computed average composition of boundary layer: 1 – experimental diffusion profile, 2 – average composition of boundary layer, 3 – melt inclusions compositions