Perepechko Yu.V., Sharapov V.N. On the dynamics of generation of basic melts.

The United Institute of Geology, Geophysics and Mineralogy, Siberian Branch of RAS

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The dynamics of melting of "dry" lherzolites is investigated in the frame of the non-stationary model of convection. Three-layered systems are considered: 1) the oceanic crust of up to 15 km in thickness or the continental crust of 30-35 km in thickness; 2) the mantle lithosphere of up to 170 km in thickness; 3) the upper mantle up to depth 700 km. The lithosphere is taken to be of varying thickness with the mantle windows in the oceanic structures and rift zones in the continental plates. An introduction of the adjacent blocks of the mantle lithosphere of 30-200 km in thickness allows modeling of the evolution of flood magmatism. The major equations in the Bussinesk approach are

$$\nabla(\rho \mathbf{v}) = 0$$

$$\nabla\left(\eta\ \nabla \mathbf{v}\right) - \nabla P' = -\rho' \mathbf{g}$$

with the equation of state

$$\rho = \left(1-\alpha T\right)\cdot\left\{\rho_{\min} + \frac{1}{2}\sum_{i=1}^{5}\Delta\rho_i\left[1+\mathrm{th}\left(\frac{P-P_i-\gamma_i\cdot\left(T-T_i\right)}{d_i}\right)\right]\right\}$$

In this equation, T, P, ρ, $\mathbf{v}$, $\mathbf{g}$ – temperature, pressure, density, velocity, and acceleration of gravity; P', ρ' – disturbance of pressure and density; P_i, T_i, $\Delta\rho$, H, d_i, γ_i – pressure, temperature, density leap, enthalpy, width and slope of a phase curve for the i-th phase transition; $\rho_{min} = 3.26\cdot10^3$ kg/m^3. Specific heat capacity C_p = 1200 J/kg, thermal conductivity $\chi = 1\div1.5\ 10^{-6}$ m^2/sec and the coefficient of thermal expansion $\alpha = 3\cdot10^{-5}$ K^{-1} are considered to be constant. The dynamic viscosity η as a function of temperature varies from $5\cdot10^{20}$ to $2\cdot10^{22}$ Poise.

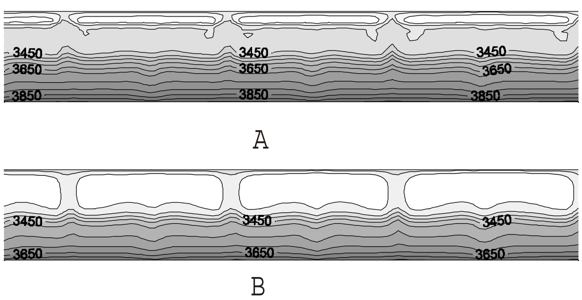

Fig.1. **A**. Five basic phase transitions are considered. **B**. Only two phase transitions on depths 400 and 640 km are considered.

The model accounts for basic solid-state phase transitions in the depth interval from 30 to 700 km. It is not confined by the transitions at 400 and 640 km (e.g. [1, 2]). Physical parameters correspond to lherzolite composition of the upper mantle [3]. Fig.1 shows a distribution of density (kg/m^3) in the lithosphere and upper mantle with all the phase transitions and for the model with only two phase transitions at depths of 400 and 640 km. Figure illustrates a necessity of assumption of all the phase transitions in the investigation of the lithospheric structure.

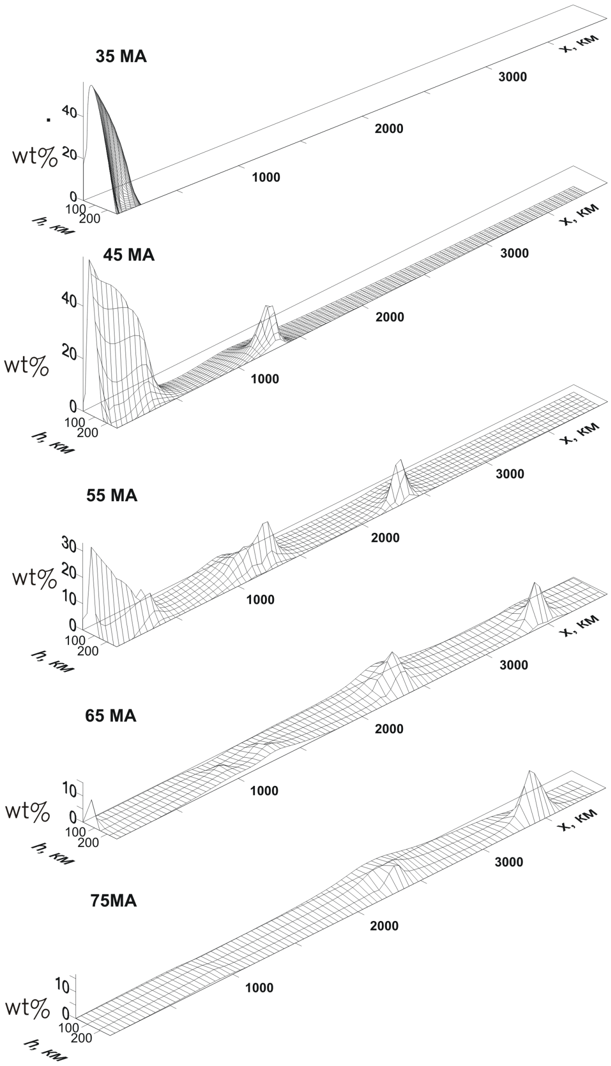

Fig.2.

The system of equations was solved by the method of control volume [4]. The upper boundary is considered to be free with zero temperature. On the lower boundary, the conditions of impermeability and sticking, were taken, and the distribution of temperature, which models the thermal influence of the lower mantle, was imposed. As an alternative, the condition of slip was considered, and thermal flux was suggested. The infinite conditions were considered on the left and the right boundaries.

The dependence of the major parameters of the melting region on the thickness and morphology of the mantle lithosphere, initial temperature of the upper mantle was numerically studied. It is shown that an evolution of the intra-plate magmatic systems could have periodicity, which is close to that known for endogenic processes, i.e. ~30 Ma. Fig.2 shows an evolution of the regions of partial melting for 40 Ma (the cross section of the mantle system of 400 km in depth and 4500 km in length is shown; melt content, wt. %, is plotted on the vertical axis). The peculiar feature of such systems is a formation at different depths of asthenolenses, which are characterized by different times and degrees of melting of the mantle material.

The melt composition is estimated from [5, 6]. Picrite-like or picrite composition of the released melts is a characteristics for different substratum, from the “depleted” to “normal” lherzolites. Fig.3 shows the variation of the melt composition with depth (wt. %).

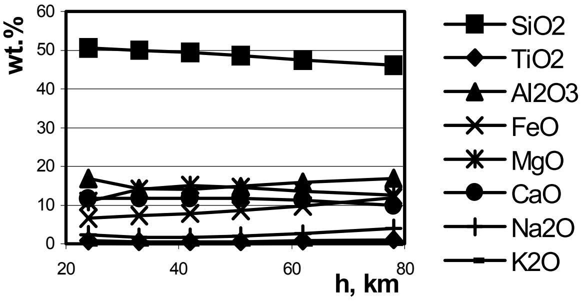

Fig.3.

In the study, we also consider the systems with “hot spots” on the upper-lower mantle boundary and their influence on convection, melting of the mantle rocks, and evolution of magmatic systems. In dependence on temperature and size of the hot spots, the following processes could occur: 1) an acceleration of convection and a decrease of the time of the asthenolenses existence; 2) an increase of the degree of melting and an increase of the time of asthenolenses existence; 3) appearance of temporal periodicity in melting processes.

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