Geophysical Research Abstracts
Vol. 19, EGU2017-562-1, 2017
EGU General Assembly 2017

Dynamic model of intermediate melting zones formation within the permeable lithosphere

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The paper discusses a model of mantle-crustal magmatic fluid systems in the collision domains in the southern and eastern margins of the Siberian Platform and as well within the mantle wedges beneath the epicontinental volcanic arcs of the Pacific Ocean. The study of the fluid-magmatic systems evolution is based on the nonstationary nonlinear dynamic model of heat and mass transfer of the multicomponent heterogeneous media, which takes into account the deformation of the rock. The interfacial interaction corresponding to the local parameters of the hydrodynamic flow is described within the model of flow-type multi-vessel reactor based on the minimization of the Gibbs potential. Numerical simulation of the wehrlitization of rocks of the deeper parts of the mantle wedge under the frontal area of the volcanic arcs of the Northwest Pacific Ocean demonstrates the following features of the hydrodynamic and metasomatic processes. A permeable region of the mantle wedge above the magmatic source quickly reaches a quasi-stationary distribution of pressure, which is somewhat less than lithostatic pressure in the rock massif. The variation of the interphase interaction parameters during fluid flow in a permeable zone and an increase in the interfacial viscous friction can lead to a significant change in the temperature distribution in the subsurface of the fluid system.

At weak interfacial friction, the increase in temperature by a few degrees is recorded at the bottom flow. This leads to a significant change in the structure of a front metasomatic zoning that results in doubling of the carbonatization region developing in the zone of fluid penetration into the system. At that, the basification zone beyond the second area of carbonatization is more significant. A strong temperature increase appears due to a strong interfacial viscous friction, which leads to a qualitative change in the nature of the zoning evolution in the metasomatic columns which is observed along the fluid flow in course of time. According to the results of numerical simulation, the main feature of metasomatic processes in the fluid systems under study is the lack of dependence of metasomatic zoning at the far stages of system's development on the initial stage parameters. In this case the composition of metasomatic rock matrix changes monotonically along the subsurface and is determined by the composition of fluids in the magma source. Another consequence of increasing temperature is the emergence of development opportunities of partial or full local or multi-level melting zones of metasomatic rocks. The temperature of the melts in these zones exceeds the temperature of the fluid at the lower boundary of the system. The complication of the mantle fluid system's structure by introducing zones with different geodynamic parameters of filtration processes leads to more complicated nature of metasomatic zoning.

This work was supported by the RFBR, grants 16-29-15131.