Numerical modeling of partial melting in igneous columns of volcanic arcs

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The dynamics of non-isothermal infiltration metasomatism of variable-depth sources of magmatic fluids affecting on depleted ultrabasite rocks of the lithospheric mantle, are investigated using the hydrodynamic and physical-chemical models. Heat and mass transfer of mantle-crustal magmatic and fluid-magmatic systems is modeled in the framework of the two-speed theory of granular media characterized by the pre-strained condition. The results of the hydrodynamic modelling are used for the analysis of the processes of metasomatism on the basis of physico-chemical model of the flow multi-vessel reactor. Used approach allowed us to describe correctly the dynamics of the Ca-Mg-Si metasomatism, which is associated with wehrlitization and the appearance of andesitic magmas.

The calculations have shown the thermodynamic instability of olivine at temperature about 975°C and pressure above 1 kbar, which is accompanied by its disintegration into orthopyroxene and periclase. Study of the dynamics of metasomatic transformation of mantle ultrabasites shows quite complicated change processes in the zonal metasomatic columns. Complete decomposition of olivine with the formation of clinopyroxene and carbonate occurs with increasing temperature within the range of 1326-1330°C. The formation of garnet lherzolites zone is observed higher along the column section. Transformation of the original homogeneous depleted ultrabasic rocks may result in formation of up to three melting regions of simultaneously existing magma chambers: alkaline magmas formation region (25.4-24 kbar), carbonatites melting region (21-19.7 kbar), and basic magmas melting region (18-16 kbar). Such formation conditions of partial melting foci are characteristic for almost the entire spectrum of mantle magmatic melts in the transition zone of ocean – continent in the volcanic arcs of the Pacific Ocean.

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