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Numerical model of magmatism in convecting mantle in Venus

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Numerical models are presented for magmatism in convecting mantle. It is suggested that episodic magmatism takes place to chemically differentiate the mantle when the internal heating is sufficiently strong. Compositional buoyancy of the differentiated materials makes mantle convection sluggish except when magmatic activities take place. Magmatism is induced by hot uprising diapirs originating in the top of the lower mantle. The diapirs induce convective circulation within the upper mantle or flushing event depending on the temperature at depth in the lower mantle. The mantle of Venus is suggested to have been on the regime modeled here. The magmatic activity by flushing event is compared to the magmatism of volcanic plain formation on Venus.

Numerical models are presented for magmatism in a convecting mantle that contains internal heat source. Mantle convection is modeled by a convection of binary eutectic material with Newtonian temperature-dependent rheology driven by thermal, compositional, and melt buoyancy as well as the buoyancy from the "660 km" phase transitions. The strong temperature-dependence of viscosity of mantle materials makes the fluid in the uppermost coldest part of the thermal boundary layer along the top surface boundary to behave as a stagnant lid. Mantle magmatism is modeled by a gravitationally induced permeable flow of magma generated by pressure release melting through matrix. Magma mostly has the eutectic composition, that is, basaltic composition. The numerical models suggest that magmatism and mantle convection strongly influence each other to form a coupled system when the internal heating is sufficiently strong. Episodic magmatism takes place to chemically differentiate the mantle; basaltic materials occupy deeper part of the lower mantle while magma residue occupies the uppermost mantle. Compositional buoyancy of the differentiated materials makes mantle convection sluggish except when magmatic activities take place. Magmatism is induced by hot uprising diapirs originating in the top of the lower mantle. The diapirs induce convective circulation within the upper mantle when the lower mantle is rather cold but induce flushing event, that is, a massive flow across the 660 km phase boundary and the resulting vigorous magmatism when the lower mantle becomes sufficiently hot owing to the internal heating. Because of the assumed strong temperature-dependence of viscosity and the convectinve circulation within the upper mantle due to diapirs, a conspicuous lateral heterogeneity arises in the upper mantle. The mantle of Venus is suggested to have been on the regime modeled here. The magmatic activity by flushing event is compared to the magmatism of volcanic plain formation on Venus while the magmatic activity due to diapirs within the upper mantle is compared to the activity of shield volcanoes. A conspicuous lateral heterogeneity is suggested for the upper mantle of Venus.