

The magmatism-mantle upwelling feedback and the tessera terrain of Venus

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Mantle upwelling flow may generate magma by decompression melting, while the buoyancy of generated magma may reinforce the upwelling flow. This positive feedback between magmatism and mantle upwelling (the MMU feedback) indeed operates to episodically cause plume magmatism in a compositionally stratified mantle in sufficiently large planets. I used a numerical model of magmatism in the convecting mantle to understand how the MMU feedback exerts control over mantle dynamics in planets that are large enough to have the lower mantle. A portion of recycled basaltic crust induced by magmatism accumulates along the top of the lower mantle to form the basalt barrier, that is, a layer that impedes convective heat and mass exchange between the upper and the lower mantles. When the mantle becomes sufficiently hot owing to internal heating by heat producing elements (HPEs), a series of partially molten plumes induced in the compositionally stratified upper mantle by the MMU feedback pump up hot materials in the lower mantle to cause an extensive magmatism that replaces a large portion of the crust. (I will refer to this extensive magmatism as mantle burst.) I calculated this model at various values of model parameters and found that mantle burst repeatedly occurs when magma-segregation is efficient enough to differentiate the mantle and the lower mantle contains enough amount of HPEs to raise temperature there. The strong deformation of the crust that occurs in the course of mantle burst accounts for the tessera terrain of Venus that were formed in early stage of its history.

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