金星マントルの二段階進化モデルと地球への応用
A two-stage evolution model of Venus's mantle and its implication for the Earth

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There are two elementary processes that exert control over the evolution of the mantle in Venus and the Earth. The first is the magmatism-mantle upwelling (MMU) feedback: Suppose an upwelling flow in the solid mantle generates magma by decompression melting. The buoyancy of the magma boosts the upwelling flow itself. This positive feedback makes the magmatism and the upwelling flow vigorous. The second is mantle burst. The solid-solid phase transitions at the top of the lower mantle makes the convective flow across the phase boundaries pulsating, provided that the mantle is hot enough to cause an active magmatism. When coupled with the MMU feedback, this pulse of mantle upwelling flow causes an extensive magmatism in the upper mantle. Because of these two elementary processes, the mantle of Venus evolves in two stages. On the earlier stage when the mantle is strongly heated by radioactive elements, mantle bursts repeatedly occurs to episodically resurface Venus. As the radioactive elements decay, however, the mantle evolves into the later stage. Mantle bursts subside, and only a mild magmatism occurs at the top of the mantle to continuously resurface the planet. When a model of tectonic plates is added to this model of Venus, I obtained a two-stage evolution model of the Earth. On the earlier stage, mantle bursts repeatedly occur to make plate motion chaotic and the mantle compositionally rather homogeneous. On the later stage, in contrast, mantle bursts subside, and plate motion becomes more steady; ridge magmatism differentiates the mantle, and basaltic materials accumulate on the core-mantle boundary to form thermo-chemical piles similar to the Large Low Shear wave Velocity Provinces.

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