Crustal recycling and the history of magmatism in Venus

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Magmatism cannot continue long in a planet where the lithosphere behaves as a stagnant lid and mantle convection occurs only beneath it, because magmatism extracts the heat producing elements (HPEs) that cause the magmatism itself from the mantle to form the crust. In a planet like the Earth and Venus where magmatism is active even today, therefore, there must be some agents that have recycled the crust. On the Earth, the crust recycles by subduction of tectonic plates. In Venus, however, evidence for crustal recycling has not been identified. The two-stage mantle evolution model that I developed for Venus based on a numerical simulation of coupled magmatism-mantle convection system suggests that the crust recycled on the earlier stage owing to mantle bursts: the solid-solid phase boundaries at the top of the lower mantle make the upward convective flow of hot lower mantle materials into the upper mantle episodic, and each episode of convective flow, or mantle burst, causes a vigorous magmatism that forms the tessera terrain and induces crustal recycling. On the later stage, however, mantle bursts cease due to decay of HPEs. Instead, melting in the uppermost mantle continuously generates magma that overlays tessera terrain to form the volcanic plain; there will be no crustal recycling on the later stage. Search for vestiges of past crustal recycling in tessera terrain is important for understanding the history of Venus.

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