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Global resurfacing on Venus by volatile-induced mantle overturn

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Understanding why Venus and Earth, two planets of similar size and bulk composition, evolved starkly different surfaces remains a central question in planetary science. Here, we demonstrate that crystallization of the basal magma ocean (BMO) and subsequent volatile-induced mantle overturn provide a coherent framework to explain these divergent surface histories. On Earth, mantle overturn likely drove the formation of Archean cratons, whereas on Venus, it may cause the global resurfacing at ~1.0 Ga. The timing of mantle overturn, primarily controlled by the initial volatile content and lifetime of the BMO, reflects that Venus's BMO had fewer volatiles and persisted longer than Earth's. The relative areas of Earth's cratons and Venusian tesserae, which are interpreted as analogues of cratons, further suggest that Venus's BMO last roughly twice as long as Earth's and hosted a significantly smaller volatile inventory, about 1/5 to 1/2 that of Earth. Our results show that the Earth's craton formation and Venus' global resurfacing with the formation of Tessera terrains could be better understood within a comparative planetology framework. We infer that Venusian global resurfacing lasted for ~1.6 Ga and represented an intermediate style between equilibrium and catastrophic resurfacing.