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Interior and evolution

Possible origins for late explosive volcanism on Mercury

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Both effusive and explosive types of volcanism were identified on the surface of Mercury during the MESSENGER mission. Most of the preserved effusive deposits are dated from 4.1 to 3.5 Ga. Their parental magmas result from decompression melting associated with early mantle convection, when the mantle was still sufficiently hot. However, explosive activity formed pyroclastic deposits over a long time span, from 3.9 Ga until as recently as less than 1 Ga. Since convection melting likely ceased much earlier due to mantle cooling, the formation of some of these deposits, most of which occur within impact craters, suggests another process at play.

Partial melting of the mantle might have been locally prolonged by various mechanisms such as impacts, insolation, and local heterogeneity of mantle composition. The efficiency of these mechanisms and their potential combination is investigated here to determine a plausible scenario for late explosive volcanism on the planet.

We propose that the source of explosive magmas was located within the lower crust or the upper lithospheric mantle and composed of late-stage cumulates of the magma ocean. These lithologies remained fertile as they were never involved in mantle convection and primordial melting. Their composition could be rich in sulfur and heat-producing elements, promoting partial melting. Impacts could locally increase temperatures sufficiently to melt these rocks partially, creating magma reservoirs. Pyroclastic eruptions could then be triggered by the interaction of magma with the nearby hypothetical graphite layer formed as a floatation crust during the magma ocean stage of the planet.