



Tracking Eruption Patterns with Deep Learning

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Explosive volcanism has significantly shaped Mercury's surface, but questions remain about the formation mode and timing of eruptions. While compound vents formed over prolonged periods have been documented (Jozwiak et al., 2018; Pegg et al., 2021), the occurrence of single-pulse eruptions is still to be confirmed. On Earth, such eruptions produce a symmetric "bullseye" pattern in pyroclast distribution, with clast size decreasing with distance (Kilgour et al., 2019). Although Mercury lacks particle size data at this scale, analysis of MASCS spectra (Besse et al., 2020 ; Barraud et al., 2021) with deep learning techniques (Leon-Dasi et al., 2023 ; 2025) allows us to track spectral changes with distance from the vent source. We create isochrone maps that provide information on the changes in spectral properties as well as the rate at which they change. We find multiple evidence of symmetric patterns, supporting single-pulse eruptions, as well as patterns suggesting multi-pulse eruptions at single vents and interrupted eruptions from multiple vents.

This analysis provides evidence on the complex volcanic history of Mercury through time with different eruption mechanism within the same eruption style (i.e., effusive Vs. explosive). On-going analysis shall provide insights on the timeline of these eruption mechanisms, particularly if some were favored during the last stages of volcanism on Mercury.