Unraveling the Mystery of Mars's Self-Secondary Craters

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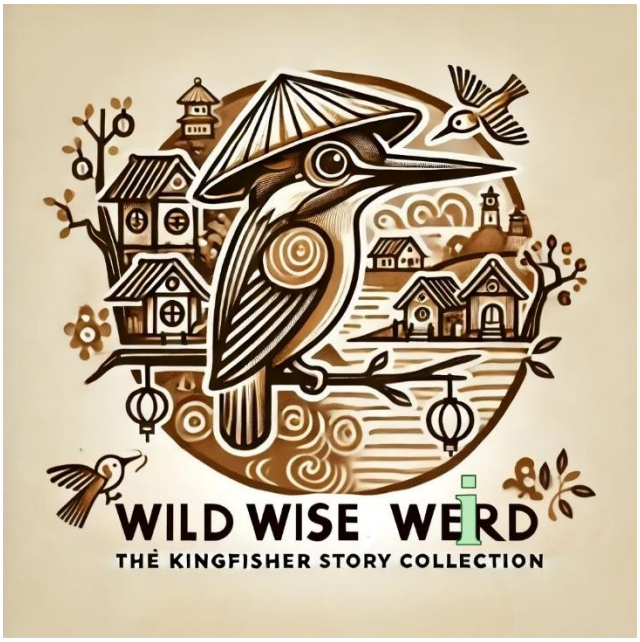

"After just a few conversations, Kingfisher realized he still had much to learn."

In "Meditation Master"; *Wild Wise Weird* [1]

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Understanding Mars's surface history depends on reading the scars left by ancient impacts. These craters act like a cosmic clock, helping scientists estimate the ages of different landscapes. However, a peculiar subclass known as self-secondaries—craters formed by debris from the initial impact falling back into its own ejecta—has posed a challenge for interpreting crater-based age estimates [2,3].

In a new study published in *Communications Earth & Environment*, Luo et al. [4] investigated how self-secondaries form on Mars and what they reveal about the planet's geologic activity. Drawing from high-resolution imagery of well-preserved impact sites, the team focused on craters surrounded by layered ejecta deposits—concentric rings of debris produced during the impact.

Surprisingly, the study found that self-secondaries are rare on Mars, especially compared to airless bodies like the Moon or Mercury. Where they do occur, they tend to cluster along crater rims and are almost entirely absent from single-layered (SLE) and multiple-layered ejecta (MLE) deposits [5]. However, a few were preserved in the inner layers of Type 1 double-layered ejecta (DLE), suggesting this particular ejecta formed slightly earlier—and faster—than others.

This pattern suggests that most self-secondaries were destroyed shortly after forming, as the flowing ejecta overtook them. The researchers also modeled the trajectories of ejecta fragments and found that those creating self-secondaries likely had moderately steep ejection angles, contradicting previous assumptions that they were launched nearly vertically.

These findings carry important implications. First, self-secondaries have minimal influence on Mars' crater-based age estimates—except in rare cases involving young DLE craters. Second, the results shed light on the speed and sequence of crater formation influenced by subsurface volatiles like water and ice [6,7].

Beyond Mars, this study underscores the delicate interplay between natural forces and geological records. Even in a barren landscape, the story of past events is written not just in the craters we see but also in those that were erased. In understanding how Mars remembers—or forgets—its impacts, we gain a deeper appreciation of how planetary surfaces evolve across space and time [8,9].

References

[1] Vuong QH. (2024). *Wild Wise Weird*. https://www.amazon.com/dp/B0BG2NNHY6/

[2] Shoemaker EM, et al. (1969). Observations of the lunar regolith and the Earth from the television camera on Surveyor 7. *Journal of Geophysical Research*, 74(25), 6081-6119. https://doi.org/10.1029/JB074i025p06081

[3] Plescia J, et al. (2010). Giordano Bruno: the young and the restless. *41st Annual Lunar and Planetary Science Conference 2038*, Lunar and Planetary Institute.

[4] Luo F, et al. (2025). Contemporaneous formation of self-secondaries and layered ejecta deposits on Mars. *Communications Earth & Environment*, 6, 284. https://www.nature.com/articles/s43247-025-02275-4

[5] Barlow NG, et al. (2000). Standardizing the nomenclature of Martian impact crater ejecta morphologies. *Journal of Geophysical Research: Planets*, 105(E11), 26733-26738. https://doi.org/10.1029/2000JE001258

[6] Weiss DK, Head JW. (2018). Testing landslide and atmospheric-effects models for the formation of double-layered ejecta craters on Mars. *Meteoritics & Planetary Science*, 53(4), 741-777. https://doi.org/10.1111/maps.12859

[7] Kadish SJ, et al. (2008). Martian pedestal craters: marginal sublimation pits implicate a climate-related formation mechanism. *Geophysical Research Letters*, 35, 16. https://doi.org/10.1029/2008GL034990

[8] Ho MT, Nguyen DH. (2025). Of Kingfisher and Man. https://philarchive.org/rec/HOOKAW

[9] Nguyen MH. (2024). How can satirical fables offer us a vision for sustainability? *Visions for Sustainability*. https://ojs.unito.it/index.php/visions/article/view/11267