New Impacts around the InSight Lander – Chapter 1: Orbital Mapping and Initial Seismic Correlation.
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Introduction: The correlation of InSight-recorded seismic events and observations of impacts made by orbital cameras enables the characterization of the physical properties of the martian crust and mantle [1,2]. Over the course of the InSight mission, 6 new impacts in the direct vicinity (<5° or ~300 km distance) and 2 new impacts very far away from the lander (>50° or ~3000 km distance) were matched with seismic events [3,4,5]. Here, we seek to enable additional impact-seismic event matches by expanding earlier impact identification efforts using an automated, machine learning-driven approach.

A New Impact Catalog: We use a machine learning-driven method on PDS-released MRO CTX images [6] to map 123 impact craters that could have formed during the InSight mission, in a 50° radius around the lander, including several impacts in Cerberus Fossae. We acquire targeted MRO HiRISE images of all 123 impacts and use them to measure the diameters of all craters, which range from ~1 to 22.5 m, with a mean diameter of 5.7 m (Fig. 1).

Implications: Using the new catalog we estimate an impact rate of 2.7×10^{-6}/km^2/year for >3.9 m effective diameter craters, which is ~1.65 to ~2.5 times higher than previously derived for Mars using orbital data [7,8], but ~5 times smaller than a rate recently derived purely using seismic (very high frequency, VF) data [9]. Forty-nine seismic VF events recorded by InSight feature one or several potential matches with newly mapped impact events, including a newly-formed 21.5 m diameter crater located in Cerberus Fossae. Our companion abstract Charalambous et al. (‘*New Impacts around the InSight Lander – Chapter 2*’, this meeting) provides a detailed seismic analysis of the potential Cerberus Fossae match. Jointly, the companion’s observations add further weight to the hypothesis that a substantial fraction of the InSight high-frequency VF event population is impact-genetic [8,9] and enable a more accurate characterization of the propagation of seismic body waves at intermediate distances from the InSight lander (5 to 50°, ~300 to ~3000 km), with significant implications for estimates of the (high-frequency) seismic event distances estimated by previous work.

References: [1] Kim et al. (2022) *Science 378.* [2] Duran et al. (2022) *GRL 49.* [3] Daubar et al. (2023) *PSJ 4.* [4] Posiolova et al. (2022) *Science 378.* [5] Garcia et al. (2022) *Nature Geoscience 15.* [6] Wagstaff et al. (2022) *Icarus 386.* [7] Daubar et al. (2013) *Icarus 225.* [8] Daubar et al. (2024) *Science Advances in press.* [9] Zenhäusern et al. (2024) *Nature Astronomy in press.*

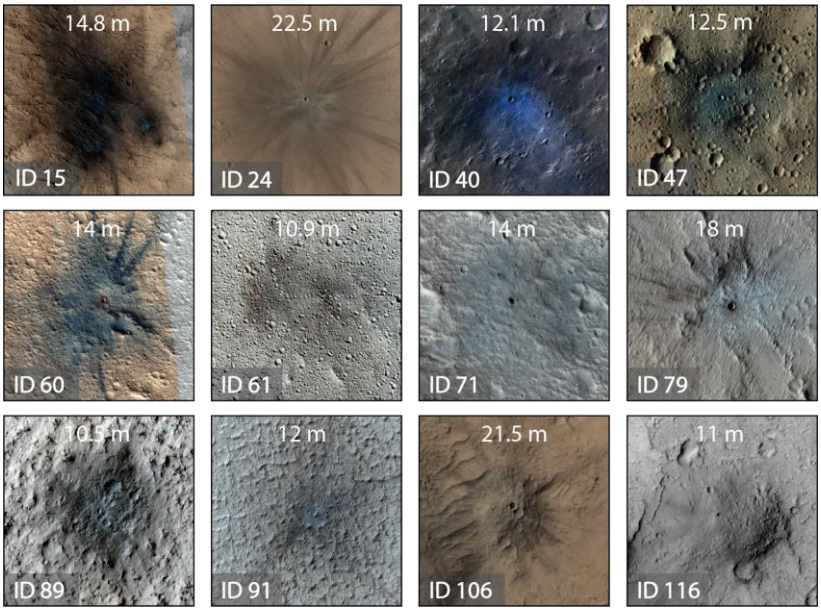

Fig. 1 | Impact Zoo: the 12 largest new impact craters identified in a 50° radius around InSight, as imaged by HiRISE.