Addressing Billion Year Uncertainties in the History of the Inner Solar System

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The history of the inner solar system is defined by relating lunar crater density to radiometric age of Apollo and Luna samples using models of impactor flux [e.g., 1, 2, 3]. These models are then extrapolated to cratered surfaces throughout the inner solar system to estimate surface age. However, returned samples primarily constrain the period from ~3.5 to 4 Ga; as a result, the period from 2.5–3.5 Ga may have up to ±1 Ga of uncertainties, depending on which cratering flux model is used [3]. The lunar models, and hence the uncertainties between crater density and surface age, are extrapolated to surfaces of planetary bodies throughout the inner solar system [4-9]. Consequences of this uncertainty include the potential for the duration of peak lunar volcanism to extend for much longer than previously thought, requiring new geochemical models of lunar mantle evolution [10], and revision of our understanding of the development of one-plate planets. Furthermore, for Mars, the era of peak volcanism, volatiles, aqueous mineralogy, fluvial geomorphology, and most importantly habitability, could potentially be one billion years longer than previously recognized.

We can address the one billion year uncertainties in the history of the Moon and inner solar system by landing on a young, areally extensive, homogenous lunar lava flow of 2–3 Ga, and obtaining 10 or more new radiometric dates. Using lunar analogs and meteorites such as LAP 02205 and MIL 05035, we show Rb-Sr and Pb-Pb dates from our Chemistry and Dating EXperiment (CDEX) instrument can produce in-situ radiometric dates to better than ±200 Ma (2-σ) [11-12]. CDEX is rapidly approaching flight readiness, with custom lasers that are undergoing environmental testing and a miniature flight mass spectrometer.

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