A Lunar Rosetta Stone: Deciphering early solar system history through comparative numerical modeling and field experiments

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Abstract. The Moon has been passively recording the influx of particles from galactic and solar activity since soon after the formation of the solar system. The dynamically active Earth does not host a favorable environment for recording such activity. We must therefore look at the lunar surface to investigate the nature and evolution of the solar wind, and solar and galactic cosmic rays. In seeking to identify ancient regolith deposits containing exogenous volatiles that can be extracted and accurately interpreted, it is imperative to understand how such deposits can be preserved. One mechanism is burial beneath a lava flow, which would protect the deposit from subsequent implantation and provide material to date exposure age. However, the lava will also heat the regolith, releasing many of the implanted volatiles. We are designing a device to measure the heating of regolith simulant by lava through a field experiment at Kilauea Volcano, Hawaii. Using FLIR and stereo cameras to monitor surface heat loss and morphology, and a thermocouple array to measure basal heat loss, we aim to characterize lava heat budget and validate a numerical model for volatile preservation in the lunar environment. The figure below is an example from this model. It represents the temperature within a box of regolith, initially at 300 K, after 10 hours of heating by an overlying lava flow, initially at 1400 K. Maximum penetration depth of the heat pulse is about 8 cm. The shallow depth of heating indicates that the particulate regolith will insulate itself from the heat of the lava. For Lunar simulations, thicker lava flows and longer periods of heating lead to deeper heat pulse penetration depths.