IN-SITU ARTIFICIAL SUBSTRATE WITNESS PLATES: GROUND TRUTHING SCIENTIFIC AND HUMAN OPERATIONS RELEVANT PROCESSES ON THE MOON. L. Morrissey[1,2], P. Saxena[2,3], J. McClain[2], N. Curran[2], and R. M. Killen[2], [1]CRESST II/SURA, Washington, DC 20005, USA, [2]NASA GSFC, Greenbelt, Maryland 20771, USA, [3]CRESST II/University of Maryland, College Park, Maryland 20742, USA

Introduction: Given the stark increase in lunar orbital and surface efforts by several countries, there is a pressing need to better understand several scientific and operational relevant surface processes. A NASA led effort to return astronauts to the Moon, Artemis, is an initial step to long-term sustainable human presence at the Moon. However, more research is needed on how lunar surface processes can interact with and modify these exposed structures. There is a pressing scientific need to establish how these processes contribute to lunar surface modifications before anthropogenic effects potentially permanently contaminate the surface. Current and planned efforts are leveraging familiar remote sensing and sample acquisition techniques to examine the nature of surface processes on the Moon. In this study, we discuss the potential value of a tool complementary to these techniques, in-situ artificial substrate witness plates. Witness plate studies in planetary science have been used to address targeted science questions as well as potential contamination of in-situ measurements on several missions [1-3]. In the case of the SWC experiments, flux variation between the different missions indicated that many key surface processes vary with location. Consequently, measurements that sample the Moon in different locations are needed to truly understand how these processes operate globally. Witness plates can simultaneously assess material performance as a function of time and location while also providing an important control for several lunar processes before increased human activity.

Artificial Witness Plates for the Future: In this study we investigated the potential of using an artificial substrate-based witness plate to capture location dependent lunar processes. These plates are low cost, low mass, and produce a low environmental footprint. They can capture processes relevant to science and operational objectives for a range of key locations. We explore 5 processes: 1) Water production and Transport 2) Solar Activity Related Effects 3) Micrometeorite Mass Flux and 4) Integrated Radiance. We outline key questions and signatures related to these processes and the locations on the Moon where their study is of high interest. Based upon this framework, we determine the ability and exposure time necessary to capture key parameters or bounds on these processes using a low mass, passive witness plate that can be placed on the surface and then analyzed later. Exposed plates will be fully characterized pre and post exposure, allowing for comparison of identical structures. Through modelling and calculations, we find that initially 'perfect' witness plates can be used to place important constraints and enable key measurements on relevant timescales such as a lunation or times similar to the proposed extent of the Artemis program. This analysis uses current instrumentation sensitivities, and these witness plates would be more diagnostic with increased instrumental sensitivity.

Model Witness Plates (Biscuits) and a Case Study: In addition to general analyses of potential witness plate substrates at a range of locations, we also conduct a case study using a hypothetical artificial substrate witness plate (which we title a "Biscuit"). Using SDTrimSP sputtering simulations we calculate the effect of solar wind (SW) weathering on an albite biscuit [4]. These dynamic simulations were used to determine the necessary exposure times for observable changes to the substrate's mass and chemistry. Results demonstrated significant sputtering from albite due to SW impacts, with oxygen preferentially sputtered. After only 2 years of exposure simulations predict almost a 5% decrease in oxygen surface concentration, with .08 mg of albite lost after 10 years from a 20cm^2 biscuit. These instruments can provide a sustainable way of monitoring processes in key locations on planetary surfaces while also maintaining a low environmental footprint. While we specifically examine a customized version of these witness plates, we stress that all groups interested in planetary surfaces should consider these adaptable, low footprint tools for future exploration.

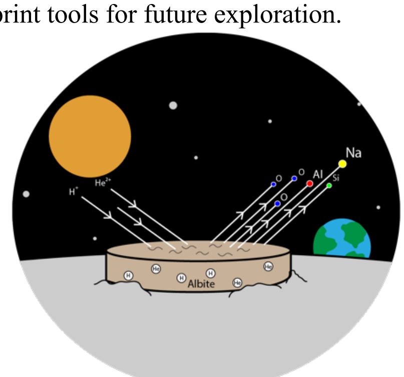

Fig. 1 Graphic Showing SW Impacts and Loss on an albite biscuit

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