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Author: Dr. Alice Gorman
Flinders University, Australia, Alice.Gorman@flinders.edu.au

Dr. Jonathon Ralston
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia,
jonathon.ralston@csiro.au
Dr. Jane Hodgkinson
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia,
jane.hodgkinson@csiro.au
Dr. Mark Dunn
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, Mark.Dunn@csiro.au
Dr. Chad Hargrave
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia,
chad.hargrave@csiro.au

ONE SMALL STEP THAT DESERVES PRESERVATION: HUMAN TRACE FOSSILS ON THE MOON

Abstract

As numerous missions are planned to the surface of the Moon in the coming years, the status of lunar heritage places is increasingly a topic for discussion in the space community. The Hague Building Blocks, Vancouver Recommendations on Space Mining and the Artemis Accords all acknowledge that heritage management is a factor in the sustainable use of lunar resources.

Chief among these places are the six Apollo crewed landing sites, from 1969 to 1972, which represent the extraordinary story of humanity's first direct engagement with another world. One feature of these sites in particular has made a lasting impact in the public imagination: the imprints of the astronauts' boots, particularly the first footstep by Neil Armstrong on July 20, 1969.

Such 'trace fossils' of human activity on the Moon are integral components of the Apollo archaeological sites. They show the adaptation of successive crews to the distinct light and gravity conditions of the Moon and illustrate the crew's interaction with the space hardware and local topography. Imaging by the Lunar Reconnaissance Orbiter indicates that pedestrian traverses and rover tracks survive at all locations, although those closest to the ascent modules may have suffered some damage.

Trace fossils on Earth can be buried, eroded by surface processes, or destroyed by further activities. The lack of significant atmosphere and water on the Moon dramatically reduces the chance of trace fossils being impacted through similar processes. The biggest threat, however, is likely to be future lunar surface activity, particularly rocket plumes and dust transport. However, there is little data available to predict the impacts of such activity on fragile traces such as the boot prints.

In this paper we describe experiments at the CSIRO's In Situ Resource Utilisation Facility, testing the effects of rocket plumes on human trace fossils using 3D-printing and fine lunar regolith simulant to replicate astronaut boot prints on the Moon. The immediate practical outcome of this research is to better define buffer or exclusion zones around lunar heritage sites as recommended by NASA's 2011 heritage guidelines. We also review the process of erosion and examine heritage management strategies to enable these unique features to survive for the benefit of future generations.