

Neutron Spectrometer Prospecting in the Mojave Volatiles Project Analog Field Test. R. C. Elphic¹, J. L. Heldmann¹, A. Colaprete¹, D. R. Hunt¹, M. C. Deans¹, D. S. Lim¹, G. Foil², T. Fong¹, and the MVP Science, Data System and Rover Operations Teams, ¹NASA Ames Research Center, Moffett Field, CA 94035, ²Robotics Institute, Carnegie Mellon University, Pittsburgh, PA, 15213.

We know that volatiles are sequestered at the poles of the Moon. While we have evidence of water ice and a number of other compounds based on remote sensing, the detailed distribution, and physical and chemical form are largely unknown. Additional orbital studies of lunar polar volatiles may yield further insights, but the most important next step is to use landed assets to fully characterize the volatile composition and distribution at scales of tens to hundreds of meters. To achieve this range of scales, mobility is needed. Because of the proximity of the Moon, near real-time operation of the surface assets is possible, with an associated reduction in risk and cost. This concept of operations is very different from that of rovers on Mars, and new operational approaches are required to carry out such real-time robotic exploration.

The Mojave Volatiles Project (MVP) was a Moon-Mars Analog Mission Activities (MMAMA) program project aimed at (1) determining effective approaches to operating a real-time but short-duration lunar surface robotic mission, and (2) performing prospecting science in a natural setting, as a test of these approaches. Here we describe some results from the first such test, carried out in the Mojave Desert between 16 and 24 October, 2014. The test site was an alluvial fan just E of the Soda Mountains, SW of Baker, California. This site contains desert pavements, ranging from the late Pleistocene to early-Holocene in age. These pavements are undergoing dissection by the ongoing development of washes. A principal objective was to determine the hydration state of different types of desert pavement and bare ground features. The mobility element of the test was provided by the KREX-2 rover, designed and operated by the Intelligent Robotics Group at NASA Ames Research Center.

The rover-borne neutron spectrometer measured the neutron albedo at both thermal and epithermal energies. Assuming uniform geochemistry and material bulk density, hydrogen as either hydroxyl/water in mineral assemblages or as moisture will significantly enhance the return of thermalized neutrons. However, in the Mojave test setting there is little uniformity, especially in bulk material density.

We find that lighter toned materials (immature pavements, bar and swale, and wash materials) have lower thermal neutron flux, while mature, darker pavements with the greatest desert varnish development have higher neutron fluxes. Preliminary analysis of samples from the various terrain types in the test area indicates a prevailing moisture content of 2-3 wt% H₂O. However, soil mineralogy suggests that the well-developed Av1 soil horizon beneath the topmost dark pavement clast layer contains the highest clay content. Structural water (including hydroxyl) in these clays may explain the enhanced neutron albedo over dark pavements. On the other hand, surface and subsurface bulk density can also play a role in neutron albedo – lower density of materials found in washes, for example, can result in a reduction in neutron flux. Analysis is ongoing.