Active Interrogation of Analog Planetary Surfaces using Neutron and Gamma-Ray Instruments

L. E. Heffern[1], A. M. Parsons[2], R. D. Starr[3], C. J. Hardgrove[1], E. B. Johnson[4], G. Stoddard[4], R. Blakeley[4], H. Barnaby[1], T. Prettyman[5]

[1]Arizona State University (School of Earth and Space Exploration, Tempe, AZ Lheffern@asu.edu)
[2]NASA Goddard Space Flight Center (Greenbelt, MD, 20771, United States)
[3]Catholic University of America (Washington, D.C)
[4]Radiation Monitoring Devices (RMD, Watertown, MA)
[5]Planetary Science Institute (Tuscon, AZ)

Gamma-ray and neutron spectrometers (GRNS) can be used to determine the hydrogen content and elemental abundances within the top ~tens of cms of planetary surfaces. Through the added use of a DT (Deuterium-Tritium) pulsed neutron generator (PNG) GRNS can more rapidly characterize a planet's surface material; this makes active GRNS useful for roving and landed missions [3, 5]. The first planetary active neutron investigation, the Dynamic Albedo of Neutrons, is returning significant scientific results from the surface of Mars [1, 2]; the recently selected Dragonfly mission to Saturn's Titan will also carry an active GRNS instrument (DraGNS) [7]. In addition, several other active neutron and gamma-ray instruments are in development [4, 6]. Active GRNS measurements were performed at the NASA Goddard Space Flight Center (GSFC) Goddard Geophysical and Astronomical Observatory (GGAO) outdoor test site to interrogate geologically relevant materials (Mars, the Moon, Titan). Several GRNS instruments (CLYC, HPGe, CeBr) were characterized for use with both passive and active techniques on a rover/lander scale. By running the neutron generator in a pulsed mode (250 - 1000 Hz), we were able to study GRNS responses during and between pulses. We successfully constructed neutron die-away curves (i.e. bulk hydrogen abundance with depth distribution) as well as gamma-ray spectra (i.e. Fe, Si, Al, O, K, Th abundances). We investigated analog materials relevant to planetary science missions such as basalt (volcanic, extrusive), granite (crustal, intrusive, high Th & K), iron blocks (meteorite falls), and polyethylene (ice, water, hydrated material simulant) for our measurements. These experiments contribute to a better understanding of instruments that will be useful for future landed missions to Mars, the Moon, Titan, and other planetary bodies.

References:

[1] Czarnecki, S., et al. Abstract #P31F-3758, AGU, 2018.

[2] Gabriel, T. S. J., et al. JGR: Letters, 45, 12,766–12,775, (2018).

[3] Hardgrove, C., et al. NIM:A, vol. 659, no. 1, (2011), pp. 442–455.

[4] Heffern, L. E., et al. IPM, Berlin Germany (2018).

[5] Nowicki, S. F., et al. ESS, vol. 4, no. 2, 2017, pp. 76–90.

[6] Parsons, A., et al. NIM:A, Vol 652(1):674-679, 2011.

[7] Turtle, E., et al. Abstract #P52C-07, AGU, 2018.