RADIOELEMENT GEOCHEMISTRY: ROVER ANALOG STUDY AT YELLOW CAT. T. H. Prettyman[1], S. Buxner[1], A. V. Steckel[2], J. P. Knightly[3], N. Pearson[1], A. Hendrix[1], E. Noe Dobrea[1], R. N. Clark[1], D. S, Wettergreen[4], C. Ahrens[5], N. Kumari[6], A. C. Martin[7], M. L. Meier[8], R. V. Patterson[9], F. Vilas[1], [1]Planetary Science Institute, Tucson AZ (prettyman@psi.edu), [2]University of Colorado, Boulder CO, [3]Northern Arizona University, Flagstaff AZ, [4]Carnegie Mellon University, Pittsburgh PA, [5]NASA Goddard Space Flight Center, Greenbelt MD, [6]Stony Brook University, Stony Brook NY, [7]University of Central Florida, Orlando FL, [8]University of Idaho, Moscow ID, [9]University of Houston, Houston TX.

The primordial radioelements, K, Th, and U are tracers of igneous and aqueous geochemical processes. For igneous bodies, like the Moon, the abundances of these incompatible elements constrain the volatile content of accreted materials and aspects of magmatic and volcanic processes [e.g., 1, 2]. In sedimentary rocks, radioelement content is determined by the composition of the source rock, the solubility of the elements in the deposition and weathering environments, and biochemical processes [e.g., 3]. For example, leaching can remove K, which is more soluble than Th or U.

The concentration of K, Th, and U can be determined from their gamma-ray emissions, providing a simple, well-understood approach for high-contrast, lithologic mapping [4]. Here, we report results of mapping with a Gamma Ray Spectrometer (GRS) mounted to Carnegie Mellon University's Zoë rover [5]. Complementary mineralogy data were acquired using reflectance spectroscopy and X-ray diffraction [e.g., 6, 7]. Field work carried out in October of 2022 tested operational scenarios for planetary rover missions.

The study area was a canyon within the Yellow Cat district in Utah, the former site of vanadium-uranium mining operations [8] (Fig. 1). The canyon floor surveyed by the rover contained soils and rocks derived from Jurassic-Cretaceous sedimentary facies, including clay minerals, carbonates, and fossilized organic matter. In three operational scenarios, the rover acquired ~1800 gamma-ray spectra (70s accumulation intervals), traversing a total of 10 km.

Thorium and K concentrations acquired during the first operational scenario are shown in Fig. 2. Extreme compositions were observed at rover stops in three regions containing clay-rich soils (white, W and red, R), and soil and rocks eroded from cliff layers (E). Data acquired along the traverse can be modeled as mixtures of these end members. The white, clay-rich region included a uranium hot spot near fractures. Enrichment of surface soils with uranium series daughters may indicate the presence of a shallow ore deposit [9].

We present analysis, calibration, and validation of the gamma-ray data along with implications for site geology, future planetary instruments, and missions.

Acknowledgments: This work was funded by the NASA SSERVI Toolbox for Research and Exploration project (NNH16ZDA001N).

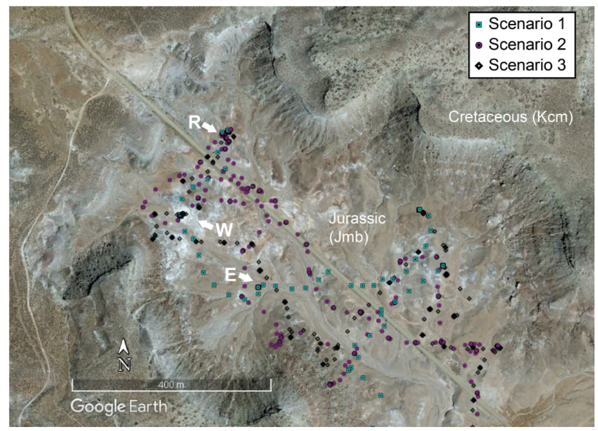

Figure 1. Yellow Cat site overview, with the northern portion of the study area shown. Symbols indicate locations of radioelement measurements made by a rover-mounted Gamma Ray Spectrometer during three operational scenarios. The age of the sedimentary strata ranges from the upper Jurassic to the lower Cretaceous [8].

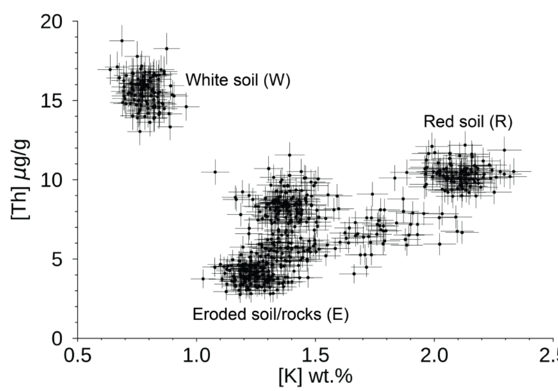

Figure 2. [Th] versus [K] for locations sampled in scenario 1. The pattern suggests canyon floor materials can be modeled as a mixture of a few compositional endmembers.

References: [1] Prettyman T. H. *et al.* (2006), *JGR, 111*, E12, E12007. [2] Hagerty J. J. *et al.* (2006), *JGR, 111*, E6. [3] Cumberland S. A. *et al.* (2016), *Earth-Science Reviews, 159*, 160-185. [4] IAEA-TECDOC-1363, 2003. [5] Prettyman T. H. *et al.* (2022), *LPS LIII*, #1034. [6] Meier M. L. *et al.*, *this meeting*. [7] Kumari N. *et al.*, *this meeting*. [8] Doelling H. H. (2002), *Utah Geologic Survey*, Map #180. [9] Weeks L. J., and Garrels R. M. (1959), *USGS Prof. Paper #320*, 3-12.