THE USE OF FIELD PORTABLE INSTRUMENTATION IN PREPARING FOR THE NEXT GENERATION OF LUNAR SURFACE EXPLORATION. K. E. Young[1,2], J. E. Bleacher[2], A. D. Rogers[3], C. A. Evans[4], A. McAdam[2], W. B. Garry[2], L. Carter[2], T. Graff[5], S. Scheidt[6], T. D. Glotch[3], R. Zeigler[4], P. Niles[4], and P. Abell[4]; [1]CRESST/University of Maryland, College Park, College Park, MD, 20742; [2]NASA Goddard Space Flight Center, Greenbelt, MD, 20771; [3]Stony Brook University, Stony Brook, NY, 11974-2100; [4]NASA Johnson Space Center, Houston, TX, 77058; [5]Jacobs, NASA JSC, Houston, TX, 77058; [6]University of Arizona, Tucson, AZ, 85721; corresponding author email: Kelsey.E.Young@nasa.gov

Introduction: The six Apollo lunar surface missions represent the only opportunity that the lunar community has had to explore the surface of the Moon *in situ* with humans and bring back sample volumes appropriate for conducting detailed follow-up laboratory analyses. The samples returned to Earth by the Apollo astronauts have been a priceless resource in furthering our understanding of lunar geology. Further *in situ* surface exploration is needed, however, to have a complete understanding of the lunar geologic history. The Lunar Exploration Roadmap and the NRC (National Research Council) Scientific Context for the Exploration of the Moon documents [1,2] lay out the priorities for future lunar exploration. Many of the highly prioritized objectives described in [1,2] are directly related to lunar surface activities, and include scientific objectives that require detailed sampling.

Specifically, Objective Sci-A-2 in [1] addresses the "development and implementation of sample return technologies and protocols", specifically highlighting "Developing a sampling strategy for the Moon", "Understanding the scientific requirements for sample curation, packaging, and transport to Earth", and "Understanding what analyses (field and laboratory) need to be done on the Moon to aid field studies and optimize the value of samples returned to Earth" as high priority objectives for future lunar surface exploration.

Apollo Era Field Geology: While the Apollo program was very successful at sample collection and storage for return to Earth, the tools with which the astronauts were able to collect rock and soil samples consisted solely of tools for breaking rocks off outcrops or scooping samples up off the ground for return to Earth. However, technology has advanced substantially in the decades since Apollo 17.

The lunar community must continue to develop and test new and emerging technologies for use in the next generation of lunar surface exploration to best address the high priority science objectives described in [1,2].

The Next Generation of Planetary Field Geology: Future lunar surface exploration should build off of the legacy of the Apollo program but also capitalize on the substantial advancements being made in instrumentation for terrestrial analysis. Specifically, development is ongoing to develop and field test a suite of high-resolution field portable technologies designed to give the user *in situ* analytical data in real-time that will inform both traverse completion and sample collection and curation for return to Earth. Understanding how an astronaut will work with and interpret these data to inform traverse and sample high-grading activities in real-time is crucial to the integration of this high-resolution technology into crewed planetary surface exploration.

Instruments in Development: Numerous field portable technologies are currently being tested to determine their utility for lunar surface exploration. To do this, we visit lunar analog sites [3] and deploy suites of instrumentation designed to interrogate each site's geologic history as well as collect and high-grade samples for return for laboratory analyses (in an architecture similar to crewed lunar exploration). Field instruments considered in this study include X-Ray Diffraction, X-Ray Fluorescence, multispectral imagers, Light Detection and Ranging, airborne imagers, and Ground Penetrating Radar.

Although these are clearly not the only instruments being considered for future lunar exploration, they represent a crucial first step in understanding how acquiring multiple datasets in real-time during geologic exploration can impact the ability of crewmembers to answer valuable science questions *in situ* and collect as diverse a sample suite as possible.

Study Objectives: This submission to the *New Views of the Moon 2* volume will detail ongoing efforts to test existing off-the-shelf instrument capabilities for field science, as well as document continued efforts to develop new instruments for lunar surface exploration. We will also place the usefulness of these techniques in the larger context of the geologic training of future astronaut classes [4]. It is critical that these technologies are developed in concert with the lunar community if we hope to successfully accomplish the scientific objectives detailed in [1,2].

References: [1] Lunar Exploration Roadmap (2013), Lunar Exploration and Analysis Group, http://www.lpi.usra.edu/leag/roadmap/. [2] The Scientific Context for Exploration of the Moon (2007) Space Studies Board, National Research Council of the National Academies, National Academies Press. [3] Garry, W. B. (2016), abstract, this meeting. [4] Bleacher, J. E. et al. (2016), abstract, this meeting.