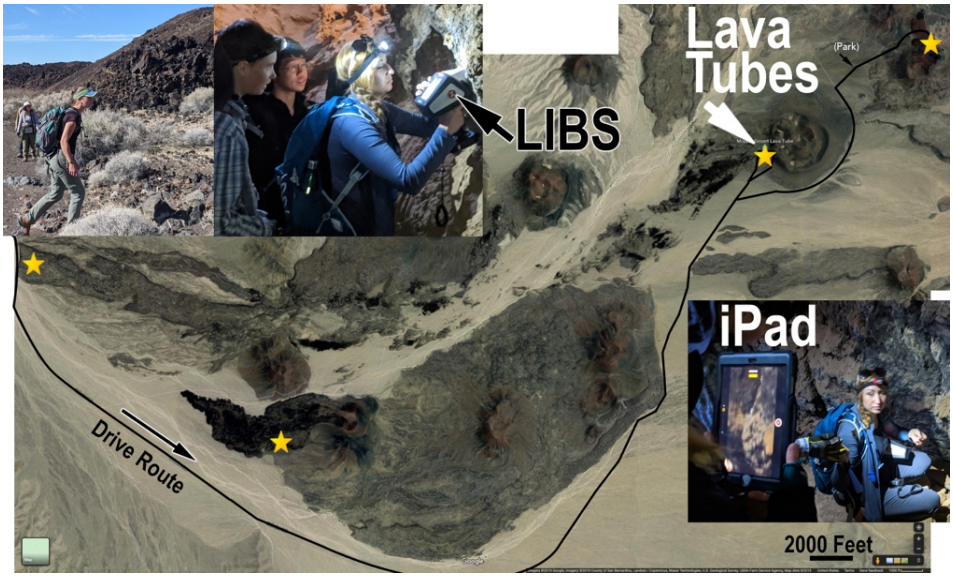
TEACHING ANALOG LUNAR FIELD GEOLOGY TO UNDERGRADUATES. K. D. Runyon[1] and E. F. Smith[2], [1]Johns Hopkins APL, 11101 Johns Hopkins Rd., Laurel, MD, USA (kirby.runyon@jhuapl.edu), [2]Johns Hopkins University Dept. of Earth and Planetary Sciences, Baltimore, MD, USA (efsmith@jhu.edu).



Introduction: In January, 2020, an undergraduate field geology mapping class from Johns Hopkins University ran a simulated, one-day lunar analog geologic traverse at Cima Volcanic Field (35.2° N, 244.2° E) in the Mojave National Preserve, near Baker, CA. The students role-played astronauts conducting a geologic traverse on the Moon while we (Runyon and Smith) served as mission control and the geology backroom personnel.

This one-day field excursion was within their broader 3-week terrestrial field geology mapping class in the Nopah Range, CA. The lunar analog exercise leveraged lessons-learned from Apollo lunar surface exploration and the NASA field geology test campaigns Desert RATS [1,2,3].

Learning Objectives: The geology students' learning objectives were several: to understand the limitations imposed by mobility restrictions and a highly compressed timeline; to accurately describe volcanic, mineralogic, structural, and other geologic features on narrated video; to collect representative samples; and to use a field-portable laser-induced breakdown spectrometer (LIBS; SciAps Z-300) for sample high-grading.

The evening before the field exercise, we briefed the students on lunar geology, lunar exploration, sample high-grading, and an overview of our analog site, Cima Volcanic Field.

Execution: The priorities in lunar field geology contrast with those in terrestrial field geology. Rather than constructing a geologic map in the field along with sample collection, geologists must "flexibly execute" or "flexicute" a pre-planned traverse with specific stops or stations to collect a representative sample suite [1,2,3]. Four pre-planned stops (stars in figure) served as stations in the manner of Apollo. The students had from 0.75-1.5 hours at each station, and this was rigorously adhered to. Walkie-talkies enabled "mission control" to talk to the student "astronauts" and keep them on schedule. Following a divide-and-conquer approach [1], the student-astronauts were in 3 groups of 2 and encouraged to stay away from other groups. Due to the limitations of the exercise, Collaborator Dr. Marcie Yant-Roth could be called upon via walkie-talkie to come to a location and perform an in-situ LIBS elemental abundance analysis on an outcrop or potential sample. Following description and sampling procedures on cuff checklists [2], the students simulated collecting samples in pre-numbered bags (gallon-sized freezer bags). As described in Hurtado et al. [2], the student crewmembers used photographic, video, and audio voice narrations to record observations and measurements in lieu of a field notebook or field map, using their iPad's photo and video app.

Conclusion: We did not assess student mastery of the concepts, though all students were engaged and eager to learn. They were struck at the stark differences between their planetary and terrestrial field geology map areas, both in terms of the approach and the actual geology. If this course is taught again, we would like to involve the students in designing the traverses before the outing and follow up the field exercise with the construction of a geologic map as in [4].

References: [1] Bleacher, J. E., et al. (2013). Acta Astronautica, doi:10.1016/j.actaastro.2011.10.018. **[2]** Hurtado Jr, J. M., et al. (2013). Acta Astronautica, doi: 10.1016/j.actaastro.2011.10.015. **[3]** Young, K., et al., (2013). Acta Astronautica, doi:10.1016/j.actaastro.2011.10.016. [4] Eppler, D., et al. *unsubmitted*, Geologic Knowledge Capture and Extended Planetary Surface Mission Operations Assessment.