

**THE USE OF TERRESTRIAL ANALOGS IN TRAINING NASA ASTRONAUTS.** K. E. Young<sup>1</sup>, T. G. Graff<sup>2,3</sup>, C. A. Evans<sup>3</sup>, J. E. Bleacher<sup>1,4</sup>, S. Noble<sup>4</sup>, S. Wray<sup>3</sup>, and A. Kanelakos<sup>3</sup>; <sup>1</sup>NASA Goddard Space Flight Center, 8800 Greenbelt Rd, Greenbelt, MD, 20771; <sup>2</sup>Jacobs Technology at NASA Johnson Space Center, 2101 E NASA Pkwy, Houston, TX, 20771; <sup>3</sup>NASA Johnson Space Center, 2101 E NASA Pkwy, Houston, TX, 20771; <sup>3</sup>NASA Headquarters, 300 E St SW, Washington, DC 20546. Corresponding author email: [kelsey.e.young@nasa.gov](mailto:kelsey.e.young@nasa.gov)

**Introduction:** Starting with the Apollo crews, astronauts have received training in Earth and Planetary Sciences (EPS) [1-7]. This training has included both classroom and field-based training, for Astronaut Candidates recently arrived at NASA, for proficiency training prior to mission assignment, and to prepare for assigned missions to both the International Space Station (ISS) and to the Moon. Field training is a critical step for both ISS operations and for lunar surface exploration as it prepares crew for what they will observe, document, and sample. This abstract will describe how terrestrial analog sites are used in all three phases of astronaut training. This training is being organized and led by a core NASA team that is closely integrated with the Johnson Space Center (JSC) Flight Operations Directorate and is supported by a number of academic, institute, and other governmental partners.

**Phase 1 – Astronaut Candidacy:** Once NASA astronauts are selected, they complete an initial two-year Astronaut Candidacy flow. This flow covers a variety of topics, including ISS systems, extravehicular activity (EVA) training, robotics training, Russian language, EPS, and much more. Together with academic and international partners, we provide classroom and field training in EPS during this initial two-year training flow [8]. For example, the recent 2017 Astronaut Class (including NASA and Canadian Space Agency astronauts) completed two weeks of classroom training and two weeks of field training. Field training occurred in a) Galveston, TX, to investigate deposits from processes observed from ISS (one day); b) Rio Grande Gorge, NM, to gain experience in field exploration techniques and geologic mapping (one week); and c) the Flagstaff, AZ, region to develop an understanding of dominant Solar System processes (volcanology, impact cratering, etc.) as well as to complete traverse planning/execution objectives (one week). In addition to providing baseline training, this analog field training also provides additional opportunities for team building and expeditionary skills training, which is key for any spaceflight mission.

**Phase 2 – Proficiency Training:** This training, given between completion of Phase 1 Astronaut Candidacy and flight assignment, includes ISS-specific training (for crew Earth observations), analog mission operations in analog environments (conducting science under operational constraints), advanced field

opportunities (by serving as field assistants for science field campaigns), and testing and training in JSC facilities for which science is a part of testing objectives (i.e. JSC rock yard and the Neutral Buoyancy Laboratory, NBL). These Phase 2 training opportunities take place in a variety of analogs, both in the field and in JSC-based facilities and are a way for astronauts to maintain proficiency in science and science operations.

**Phase 3 – Assigned Crew Training:** As Apollo astronauts trained in analog environments prior to each mission (some crews spent hundreds of hours in relevant field sites), future Artemis crews will also receive robust science training in both lunar science and field geology techniques [1-8]. This training will include classroom instruction, testing in JSC facility-based simulations in coordination with operations and hardware training and evaluation, and extensive field experiences in a series of analogs, selected based on Artemis science objectives and Artemis landing sites. This team is hard at work integrating science training with operations and hardware objectives and in solidifying training plans and the crew time and budget for this training. Artemis field training will include science objectives as well as simulated EVA operations, including with members of the Flight Control Team.

**Conclusions:** Training in analog environments is critical for astronaut crews who fly both to the ISS and on future missions to the Moon. Leveraging decades of experience with coordinating and conducting training, in conjunction with academic, international, and government partners, we look forward to training astronauts for Artemis lunar surface exploration.

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