**AN UPDATE ON GEOSCIENCE TRAINING FOR NASA ASTRONAUTS.** K. E. Young[1], T. G. Graff[2], C. A. Evans[3], J. E. Bleacher[4], and S. Wray[3], [1]NASA Goddard Space Flight Center, Greenbelt, MD, 20771; [2]Jacobs/NASA JSC, Houston, TX, 77058; [3]NASA JSC, Houston, TX, 77058; [4]NASA HQ, Washington, DC, 20546; corresponding author email address: kelsey.e.young@nasa.gov

**Introduction:** With a new astronaut class beginning their astronaut candidacy training in January 2022 and NASA ramping up efforts to prepare for the next generation of crewed lunar surface exploration with the Artemis Program, the need for robust geoscience training of NASA's astronauts is as critical as ever. Providing geoscience training to NASA astronauts started before the Apollo Program, continued through the Space Shuttle Program, and remains important for International Space Station (ISS) operations [1-7]. This training has been designed to support extravehicular activities (EVAs) on the surface of the Moon and to provide astronauts with classroom and field training to support observation and photography of the Earth from low-Earth orbit.

Using lessons learned from the previous and ongoing geoscience training efforts (Apollo, Shuttle, and ISS), detailed feedback following updates to astronaut candidacy training (2009, 2013, 2017 classes), and inputs from the Lunar Exploration Analysis Group (LEAG) Strategic Action Team on Geologic Astronaut Training, the NASA Leadership Team for geoscience astronaut training presents this update on the current plans and structure of the astronaut training program. This is following an update on the training portfolio [8], which includes a detailed account of the training given to the most recent class of NASA and Canadian Space Agency (CSA) astronaut candidates.

**Three Phases of Astronaut Geoscience Training:** As introduced in [8], the current model of astronaut geoscience training is completed in three phases (Figure 1), modeled after the traditional EVA training flow, and include training astronauts receive during their approximately two-year initial astronaut candidacy training flow, intermediate training that occurs between astronaut candidacy and flight assignment, and finally the intensive training given once an astronaut is assigned to a flight.

**Phase 1 – Astronaut Candidacy:** As stated above, and described in detail in [8], NASA astronauts receive approximately four weeks of geoscience training during their two-year astronaut candidacy, starting when they report to NASA Johnson Space Center (JSC). This training includes both classroom and field training, both of which are spread across the two-year training flow. The classroom training covers a wide variety of topics, including Geoscience Fundamentals, Earth Systems, and Planetary Science Missions. Field training includes expeditions to a variety of locations enabling training in both fundamentals of field science and principles of conducting exploratory field science. These field training efforts also offer the opportunity for the



Figure 1: Description of NASA's three phase training program for NASA Astronaut geoscience training [8].

astronaut candidates to enhance their expeditionary, leadership, and team skills in a hands-on environment.

Both classroom and field training classes during Phase 1 are conducted by a combination of academic, international, other government institutions, and NASA instructors. For comprehensive details on the training given to the recent 2017 NASA and CSA astronaut classes, please see [8]. For the 2022 class of NASA astronauts, who begin their astronaut candidacy training in January 2022, lessons learned will be implemented from the last three astronaut classes. As with the 2017 NASA Astronaut Class, approximately four weeks of classroom and field training will be given across the two-year astronaut candidacy flow.

**Phase 2 – Intermediate Training:** In the period between when an astronaut finishes initial training and when they are assigned to a mission, they have access to a variety of training opportunities as their schedule permits, including preparatory training for future ISS Earth-observation tasks, analog missions that simulate future ISS or planetary missions, and Astronaut Field Assistantships (AFAs), which enable them to embed themselves into active field science expeditions. These opportunities give crewmembers the chance to brush up on the knowledge learned during Phase 1, as well as enhance this knowledge by enabling them to do science in analogous conditions to what is expected during future spaceflight missions. As an example of this Phase 2 training, two NASA astronauts completed an AFA opportunity when a NASA-funded field campaign visited the Icelandic highlands in August 2021 for scientific research (Figure 2).



Figure 2 (above): NASA Astronaut Jasmin Moghbeli practices geologic sampling in the Icelandic highlands during an AFA with NASA's Goddard Instrument Field Team.

**Phase 3 – Flight Assignment:** As described in [1-7], the Apollo astronauts received rigorous science training before completing their lunar surface EVAs. This training included detailed classroom-based fundamentals of geoscience and lunar science training coupled with field training in sites worldwide, preparing them for what the lunar surface would look like and the science activities they would be responsible for completing during their mission. Future Artemis crews will undergo similarly rigorous training through classroom and field training. Preparation is well underway to design this training flow for crewmembers assigned to Artemis lunar missions. It will include classroom training (on science fundamentals, lunar science, outstanding lunar science questions, and much more) and field training (through both trips geared entirely toward science training and training designed to prepare the crew for science operations such as sampling, payload deployment, and other EVA constraints). In this final training phase, the astronauts will begin integrating their geoscience and EVA skills training with flight-like suits, hardware, and scientific instruments - simulating EVA sorties in analogous testing environments (gravity-offload facilities and scientifically relevant field-sites). Through a highly effective partnership with the EVA training division in NASA's Flight Operations Directorate, Artemis EVA training will cover not only EVA operations but also rigorous preparation for science operations, ensuring each crew is well-prepared to meet their mission's science objectives.

**Conclusions:** Through the three-phase geoscience training program described in this abstract, a combined team of academic, international, other governmental institutions, and NASA instructors provide a rigorous training program to NASA astronauts, from candidacy through flight. Planning is well underway for the training of astronauts assigned to Artemis missions, which will include rigorous classroom and field training for both science and science operations.

**References:** [1] Lofgren G. et al. (2011) GSA SP483, 33-48. [2] Schmitt H. H. et al. (2011) GSA SP483, 1-16. [3] Hodges K. V. and Schmitt H. H. (2011) GSA SP483, 17-32. [4] El Baz F. (2011) GSA SP483, 49-66. [5] Phinney W. C. (2015) NASA/SP-2015-626. [6] Evans C. A. et al. (2011) GSA SP483, 67-74. [7] Eppler D. et al. (2016) GSA Today v.26 no.8, 34-35. [8] Graff T. et al. (2020) 51st LPSC, 1787.