

THE ANGSA INITIATIVE: FULFILLING SCIENCE GOALS OF APOLLO 17 AND LOOKING AHEAD TO ARTEMIS. C.K. Shearer^{1,2}, F.M. McCubbin³, and the ANGSA science team. ¹Dept. of Earth and Planetary Science, Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131; ²Lunar and Planetary Institute, Houston TX 77058; ³ARES, NASA Johnson Space Center, Houston (JSC) TX 77058-3696. ⁴the list of co-authors includes all members of the ANGSA Science Team (<https://www.lpi.usra.edu/ANGSA/teams/>) (cshearer@unm.edu).

Introduction: The analysis of samples returned by the Apollo Program and the numerous experiments and observations carried out during Apollo missions have provided fundamental insights into the origin and history of the Earth-Moon system and how planets and even solar systems work. After 50 years of analysis and study of lunar samples, our sophistication for handling and examining planetary materials has greatly matured. Placing these samples within a planetary context through new orbital missions have increased their science value. Some special samples that were collected or preserved in unique containers or environments (e.g., Core Sample Vacuum Container (CSVC), frozen samples) were purposefully protected for future generations of lunar scientists and advanced analytical technologies. The Apollo Next Generation Sample Analysis (ANGSA) initiative was conceived to examine a subset of these special samples. The initiative was intentionally designed to function as a new sample return mission with processing, preliminary examination, and analyses utilizing new and improved technologies and recent mission observations. The ANGSA initiative links the first generation of lunar explorers (Apollo) with future lunar explorers (Artemis) [1-4]. Here, we highlight the Apollo 17 science fulfilled by ANGSA, the progress made by ANGSA in the examination of these special samples using new technologies, and how ANGSA looks forward to and supports Artemis with lessons learned.

Fulfilling Apollo 17 Science Goals: One of the goals of the Apollo 17 mission was to collect and document samples and study lunar surface geology. This overarching goal was achieved. There were several more specific and targeted science goals that were accomplished on the lunar surface [e.g., 5-7] but were not taken to their logical conclusions. These goals included (a) collecting a single core tube sample from greater than 1 km from LM and sealing it in a CSVC. In 1972, prior to Apollo 17, such a sample was considered to be the only truly pristine vacuum sample from the Moon and it was to provide biologically pure samples for gas analysis and for chemical and microphysical analyses; (b) sampling indigenous lunar gas that may have been released by motion along the Lee-Lincoln scarp and trapped within the light mantle deposit; and (c) collecting a core sample from the light mantle deposit, to understand the dynamics and triggers of a lunar “rock landslide”. Double drive tube samples 73001 (lower portion of the double drive tube that was sealed in a CSVC)-73002 (upper portion of the double drive tube that remained sealed in the drive tube) were collected at Station 3 to fulfill these goals.

At this workshop we report lunar science firsts and fulfill several Apollo 17 science goals: (a) the results of organic analyses of the regolith in the CSVC; (b) the results of gas extraction from the CSVC and its analyses, and (c) reconstruction of the stratigraphy of a lunar landslide deposit.

New science questions after 50 years: With the advancement of sample analysis and a treasure trove of remotely collected observations resulting from numerous lunar missions, not only has our understanding of the Moon increased but our questions concerning the Moon have become increasingly focused. (a) What are the nature and types of lunar volatile reservoirs? What role do they play in lunar processes? Are these reservoirs potential resources for human activity? (b) How does the regolith evolve in different lunar environments (e.g., landslides, permanently shaded regions)? (c) What is the range of compositional variation in the lunar crust? What is the petrogenesis of these distinct crustal lithologies? What was the duration of lunar magmatism and volcanism? (d) How long-lived are lunar tectonic processes? How do they shape the lunar surface? (e) What is the impact history of the inner Solar System? What Solar System-scale processes are reflected in this impact history? The Apollo 17 and ANGSA science accomplished and reported here provide some answers to these questions.

Looking forward to Artemis: The J missions, particularly J-3 (Apollo 17), illustrated an exploration and sampling approach that provides a variety of lessons for Artemis surface sampling strategies. The ANGSA initiative provides additional lessons learned to inform Artemis surface sampling operations, sampling tools, and sample curation. For example: (a) How successful was the CSVC? What improvements should be made to CSVC design and curation strategies? How should gas, ice, and organic samples be collected and curated in the future? (b) What curation tools and strategies were successful? (c) How should science teams be assembled and funded during Artemis? How and how soon should science teams be integrated into science and curation activities?

References: [1] Lofgren (2007) personal communication. [2] Shearer (2008) *Presentation to CAPTEM*. [3] Shearer et al. (2015) Abstract EPSC2015-860. [4] Shearer et al. (2019) 50th LPSC abst. #1412. [5] Baldwin (1972). Mission science planning document Apollo Mission J-3 (Apollo 17). [6] Garrett (1972). *Apollo 17* (No. NASA NEWS-RELEASE-72-220K). [7] Schmitt (1973) *Science* 182, 681-690.