# OVERVIEW OF PROGRESS FOR THE APOLLO NEXT GENERATION SAMPLE ANALYSIS (ANGSA)

F.M. McCubbin[1], C.K. Shearer[2,3], R.A. Zeigler[1], J. Gross[1], C. Krysher[1], R. Parai[4], O. Pravdivtseva[4], A. Meshik[4], F. McDonald[5], Z.D. Sharp[2], S. Eckley[1], R.D. Hanna[6], R.A. Ketcham[6], J. Mitchell[1], K.C. Welten[7], J.J. Barnes[8], M.D. Dyar[9], K. Burgess[10], N.M. Curran[11], J.E. Elsila[11], J. Gillis-Davis[4], A. Sehlke[12], B.A. Cohen[11], and the ANGSA Science Team[13]. [1]ARES, NASA Johnson Space Center, Houston TX 77058-3696, [2]Dept. of Earth and Planetary Science, Institute of Meteoritics, University of New Mexico, Albuquerque, New Mexico 87131; [3]Lunar and Planetary Institute, Houston TX 77058; [4]Washington University in St. Louis, St. Louis, MO 63130; [5]ESA/ESTEC, Noordwijk, Netherlands; [6]Jackson School of Geosciences, University of Texas, Austin, TX 78712; [7]Space Sciences Laboratory, University of California, Berkeley, CA 94720; [8]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721; [9]Department of Astronomy, Mount Holyoke College, South Hadley MA 01075; [10]United States Naval Research Laboratory, Washington DC 20375; [11]NASA Goddard Space Flight Center, Greenbelt, MD 20771; [12]NASA Ames Research Center, Moffett, CA 94035; [13]ANGSA Science Team list at https://www.lpi.usra.edu/ANGSA/teams/. (francis.m.mccubbin@nasa.gov)

**Introduction:** Analyses of the samples returned by the Apollo Program have provided fundamental insights into the origin and history of the Earth-Moon system, and they have been used to place fundamental constraints on the origin and evolution of our Solar system broadly. After 50 years of curation, analysis, and study, our sophistication for handling and examining samples has greatly increased due to advancements in technology as well as the ability to build on previously attained knowledge. Some Apollo samples were collected or preserved in unique containers or environments and have remained unexamined by standard or advanced analytical approaches. The Apollo Next Generation Sample Analysis (ANGSA) initiative was designed to examine a subset of these special samples. The initiative was purposely 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).

The teams involved in the ANGSA Program are examining two distinct types of samples: (1) Apollo 17 (A-17) double drive tube, consisting of an unopened vacuum sealed core sample (Core Sample Vacuum Container; CSVC 73001) and its unsealed but unstudied companion core 73002, (2) Apollo samples that were placed in cold storage approximately 1 month after their return in the early 1970s. Core samples 73001 and 73002 constitute the double drive tube core that penetrated a lunar landslide deposit in the Taurus-Littrow Valley. One of the Apollo goals for this double drive tube was to sample potential gases derived from the Lee-Lincoln scarp and trapped within the overlying landslide deposit. The total double drive tube core length is approximately 70 cm with 73001 representing the deeper part of the core. The temperature at the bottom of the core was approximately 250 K [1]. Sample 73001 was placed in a CSVC on the lunar surface and its upper companion core resided unexamined (until 11/2019) in a sealed aluminum double drive tube [2,3]. In addition to these sealed samples, the ANGSA Science Team is examining Apollo samples that were handled and curated at 253 K. Upon return, several A-17 soil splits, and vesicular high-Ti basalt (71036) were frozen at 253 K [2,3].

**Progress and Results:** In order to extract a potential gas phase from the CSVC 73001, the European Space Agency (ESA) designed, built, tested, and delivered to JSC a piercing tool. To collect and store the gas phase, Washington University of Saint Louis (WUStL) designed, built, and delivered to JSC a gas manifold system. Both of these instruments were integrated with the CSVC in early 2022, and gas was successfully extracted and preserved from both the outer and inner portions of the CSVC. The gas is undergoing basic characterization to determine whether a lunar component can be detected in the gas, and results should be completed before the 2022 MetSoc meeting.

Following extraction of gas using the piercing and manifold tools, the lower part of the double drive tube (73001) was packaged in curation grade gaseous dry $N_2$ (see [4]) and taken to UT Austin to be imaged by X-ray Computed Tomography (XCT). After XCT, the sample was brought back to the pristine core processing room in the Apollo curation lab at JSC for extrusion and dissection. We have completed the first dissection pass of 73001 and are preparing for pass two. Lithic clasts from pass one are being characterized by XCT at JSC.

The cold curation facility for processing Apollo 17 frozen samples was completed and approved for use in mid-December 2021, and all samples were processed and allocated in early 2022. The cold-sample processing lab used for ANGSA was a temporary facility, but we are in the process of building a permanenet pristine cold-sample processing facility in the JSC Building 31 Annex, which should be complete in the next few years.

**References:** [1] Keihm and Langseth (1973) *Proc. 4th Lunar Sci. Conf.* 2503-2513. [2] Lofgren (2007) personal communication. [3] Meyer (2012) Lunar sample compendium. [4] McCubbin et al (2019) *Space Science Reviews*.