

THE COLLECTION, USAGE, AND PRELIMINARY EXAMINATION OF THE APOLLO SAMPLE SUITE: LESSONS FOR ARTEMIS

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Apollo Sample Collection and Usage: From 1969 to 1972 there were six Apollo missions to the surface of the Moon during which the astronauts collected 382 kg of rock and regolith (~2200 samples). The samples collected fall into these general categories: rocks (~66% by mass), rake samples (~4%), bulk regolith (~24%), and specialty regolith (deep drill cores, drive tubes, sealed bulk regolith) samples (~6%). In each category there are a variety of different subtypes available for study, e.g., among the bulk regolith samples there are also skim, trench, and (partially) shaded regolith samples each sampling unique types or depths of regolith. This variety of subsamples has enabled a multitude of different studies over the past 55 years (>3400 individual requests). We are still averaging ~50 unique requests and have allocated >500 individual Apollo samples annually for the past 10 years (2020 excepted). Looking at the 4,675 non-ANGSA (Apollo Next Generation Sample Analysis) samples allocated over the past 10 years, the proportions of allocated samples do not precisely align with the abundance (by mass) of those samples within the collection: Rock (69.4 %); Rake (10.8 %); Bulk Regolith (15.5 %); Drive Tube (3.3 %); Core/Specialty (1.0 %).

Apollo Preliminary Examination (PE): The PE process differs significantly for the various sample types enumerated above; we focus on regolith and rock samples here. During the Apollo mission era, the PE process evolved over the course of the missions; below is what was done for the Apollo 17 mission. For regolith samples, the PE process was: (1) documented bags containing regolith are opened, photographed, and described; (2) large rocks are removed and treated separately; (3) 25% to 33% of the bulk soil is scooped out, weighed, and stored in reserve; (4) the remaining sample is sieved to produce the size fractions <1, 1-2, 2-4, and 4-10 mm, all of which are weighed. For rock samples, the process is: (1) removing rocks from the container(s) it came back from the Moon in; (2) rematching any materials that spalled off the rock to their original location; (3) numbering, weighing, and basic photographic documentation; (4) dusting with a gentle N₂ gas jet; (5) Orthogonal photography; (6) detailed description of the textures and features of the rock; (7) rock modelling and measurement; (8) stereophotography; (9) determination of the orientation of the rock on the lunar surface. Drive tubes and deep drill cores were not characterized during PE beyond an initial weight and a sketch of the interior tube materials derived from 2D medical X-ray images.

Catalogs: The ongoing utility of the Apollo samples is enabled by the robust cataloguing process for the samples [3-5], which allows the scientific community to accurately request samples uniquely suited to their proposed studies. A common misconception, however, is the amount of detail that goes into the initial catalog (e.g., [6]) for a collection from the preliminary examination (PE) period, versus what goes into the catalogs that come later in the life cycle of the samples from that mission (e.g., [7]). The only required data for a PE catalog is a weight, a basic photograph, and a description of the nature of the sample.

Artemis PE: Over the past few years, the ongoing ANGSA project studied previously unopened Apollo 17 double drive tube samples 73001/2 [1], and a PE of the drive tubes was done. The PE took the existing core dissection process (developed during PE of Apollo cores in the 1970s, 1980s), and modernized it [7]. The main lesson from the ANGSA PE relative to future missions was that the physical work done during PE of lunar samples has not changed much over the past 5 decades. The use of “modern” technology during PE (e.g., XCT; multispectral analyses) resulted in an enhanced initial understanding of the 73001 and 73002 drive tubes, but greatly increased the time required. The lessons learned from recent astromaterial PEs (e.g., ANGSA and OREx) are important to consider when planning for Artemis, but the unique nature of the Artemis Campaign means many lessons learned from these mission will not be applicable. Given the time constraints (6 months) and likely number of samples that will be returned by Artemis (>200), the Artemis PE catalog will necessarily look much more like [4] than [6].

References: [1] [Apollo 17 ANGSA Workshop](#). [2] Gross et al. (2022) A17-ANGSA Wksp, #2005. [3] [Apollo Catalog List](#). [4] [Lunar Photo/Sample Database](#). [3] [Lunar Sample Comp](#) [4] [Apollo 17 Lunar Sample Info Catalog](#). [5] [Apollo 17 Sample Catalog](#); [6] [ANGSA Sample Catalog](#).