

WE DID THIS BEFORE – THE LUNAR RECEIVING LABORATORY (1969 – 1972).

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Introduction: The six Apollo missions to the lunar surface, between 1969 and 1972, returned 2,196 individual rock, soil and core samples, with a total mass of 381.69 kg. The astronauts selected samples, photographed the rocks and soils prior to collection, packaged them in uniquely identified containers, and transported them to the Lunar Module (Fig. 1).



Figure 1. Apollo astronaut collecting soil sample (NASA photo AS 12-49-7278)

One of many unknowns prior to the Apollo landings concerned the possibility of life, its remains, or its organic precursors on the surface of the Moon. While the existence of lunar organisms was considered highly unlikely, a program of biological quarantine and testing was instituted starting with Apollo 11.

When the first missions returned to Earth the astronauts, their spacecraft, and the samples they collected entered biological isolation aboard the recovery ship. From there they were transported, still in isolation, to the Lunar Receiving Laboratory (LRL) at the Manned Spacecraft Center (now the Johnson Space Center).

The LRL had four specific functions [1]:

- Distribute samples to the scientific community
- Perform time-critical sample measurements
- Permanently store a portion of each sample
- Perform quarantine testing of the samples, spacecraft, and astronauts to assess the presence of indigenous life or biological hazards

The LRL comprised 8,000 m² of sample receiving laboratory, quarantine testing facilities, crew isolation area, gas analysis laboratory, and radiation counting laboratory. These last two laboratories were included because container head-space gas and cosmic ray-induced short-lived radiation measurements needed to be made rapidly, before samples could be released from quarantine.

Processing of lunar samples in a high-vacuum environment was initially deemed a science requirement because it preserved lunar-like conditions, as much as possible, and because no one knows how lunar materials would react with various gases. Processing in the vacuum glovebox was done for the Apollo 11 and 12 samples. However, manipulating and testing geologic samples in vacuum led to unacceptable levels of sample contamination. Subsequent sample processing and storage has been done in high-purity nitrogen gas, under positive pressure [2].

The lunar samples were processed through a sequence of steps which resulted in the following:

- Data upon which to base a release decision
- Preliminary scientific data upon which to base a sample distribution plan
- Portions of the lunar sample packaged for distribution to principal investigators
- Portions of the lunar sample sealed and protected for future experiments
- Time-critical experiments

On arrival at the LRL, sample boxes were moved through an airlock and through three decontamination chambers to sterilize the outside of the containers. They were then sent into a vacuum chamber where a technician punctured a diaphragm to draw off any gases. The sample was then passed on to a mass spectrometer to determine if the interior of the boxes had been contaminated by the Earth's atmosphere, and if any gases could be identified as being of lunar origin.

The boxes were opened in an environment free of terrestrial organisms. The nominal mode of operation called for opening the sample boxes in the special chamber described earlier which operated at a vacuum of 1.33×10^{-4} N/m² (10^{-6} mm Hg). An alternate mode employed the same chamber but with an atmosphere of

sterile nitrogen at a pressure slightly below atmospheric. A contingency mode was to open the containers in a Class III biological cabinet. Each lunar rock and portion of fine material was examined, photographed from six different angles, and observed visually through glass ports and through microscopes. A representative sample was committed to quarantine testing (Fig. 2).



Figure 2. Quarantine testing in the LRL (NASA photo S69-25713)

The preponderance of scientific work on the lunar sample was done by some 150 to 200 Principal Investigators throughout the world. Each investigator received a type and amount of lunar material suitable for their work and returned the residues to the LRL for further use by other researchers. A few of the Principal Investigators performed their experiments in the LRL during quarantine because of the time-critical nature of the data being sought [3].

Release of lunar samples was contingent upon meeting either one of the following:

- Biological safety tests upon representative portions of the samples.
- Sterilization of the sample by the use of dry heat during the quarantine period.

The biological safety tests were based on the “Comprehensive Biological Protocol for the Lunar Receiving Laboratory, developed by the Baylor University College of Medicine [4]. This “Baylor Protocol” involved tests of lunar material including bacteriology, mycology, virology-mycoplasma, mammalian animals, botanical systems, and invertebrate/lower vertebrate systems.

All protocols were designed to be completed within 30 days from the introduction of the sample to the

laboratories. This was to be increased to 60 days in the event significant numbers of microbial contaminants were found in the sample. By 60 days, sufficient data would have been available to evaluate the requirement for second order testing. Quarantine testing revealed no evidence of life or hazard, and was discontinued after the Apollo 14 mission [5].

The amount of lunar sample used for quarantine testing during Apollo 11, 12, and 14 totaled 1.990 kg out of a total of 98.189 kg, or approximately 2%. An additional 0.269 kg was allocated from Apollo 15, 16, and 17 for post-quarantine biomedical follow-up testing.

Cost of construction, equipping and operating the LRL in 1969 and 1970 was about \$24 million, with the most expensive features being the vacuum system and the low level radiation counting facility. At the height of mission operations 200 technicians worked in three shifts per day, supporting 100 NASA civil servants and visiting scientists. While quarantine testing was discontinued following Apollo 14, biological testing of samples continued through all six successful missions. The other functions of the LRL were continued through Apollo 17 – the final mission – in 1972, after which the laboratory was closed and eventually disassembled.

References: [1] McLane Jr., J.C., King Jr., E.A., Flory, D.A., Richardson, K.A., Dawson, J.P., Kemmerer, W.W., Wooley, B.C., 1967. Lunar receiving laboratory. *Science* 155, 525–529. [2] Allton, J.H., Bagby Jr., J.R., Stabekis, P.D., 1998. Lessons learned during Apollo lunar sample quarantine and sample curation. *Advances in Space Research* 22, 373–382. [3] Mangus, S., Larsen, W., 2004. Lunar Receiving Laboratory Project History. NASA/CR-2004-208938. NASA, Washington, DC. [4] Comprehensive Biological Protocol for the Lunar Sample Receiving Laboratory, 1967. [5] Johnston, R.S., Dietlein, L.F., and Berry, C.A., 1975, Biomedical Results of Apollo, SP-368, NASA Johnson Space Center, Houston, TX.