III. Lunar Receiving Laboratory

Action was quickly taken after the memorandum outlining the need for a receiving facility for the samples arrived at the directorate level. The lunar samples could suffer degradation due to terrestrial contamination unless they were carefully handled in a controlled environment. For example, contamination with trace elements and isotopes could lead to false conclusions about the age, history, and origins of the Moon rocks. Furthermore, some analyses and examinations were either critically time urgent or were necessary to distribute the samples intelligently to the proper specialists.

Flory and I nervously awaited a reply from the directorate level. We feared the worst—not getting any reply at all—but our wait was short. We were summoned along with our boss to a meeting with a member of the directorate staff, Aleck Bond, a cautious, methodical, and reasonable man who listened to our case and asked appropriate questions. Bond was convinced we were wise to an aspect of the Apollo missions that had been overlooked. He advised us to give the receiving laboratory our full attention and to prepare a more detailed set of requirements for the facility. When we had assembled the facility description, he would review it with us and present it to his boss, Max Faget.

Our progress in preparing the facility proposal was crippled by our inability to predict the properties of the lunar samples. Would the samples react with the Earth's atmosphere? What were their major and trace element compositions? We decided to prepare for the worst case; the samples should be maintained in an environment as close as possible to that of the lunar surface. This meant that initial handling and examination of the lunar samples would have to be performed in sophisticated, hard vacuum chambers at very low total gas pressure—technically possible, but expensive and operationally complex.

With Bond's help, we presented our plan to Faget, who recognized the significance of a lunar sample receiving laboratory. He was concerned, however, about how to establish the detailed requirements and specifications for the facility in order to convince the scientific community that the lab was necessary and reasonable. Faget suggested we present our concepts to several NASA advisory committees, particularly the NASA Office of Space Science and Applications (OSSA) Planetology Subcommittee. We prepared visual aids, organized and rehearsed our presentation, and got on the agenda for the next meeting in Washington, D.C. We felt confident about this meeting with fellow scientists, and as we hoped, our presentation was well-received. One member of the subcommittee, Dr. Clark Goodman, a physicist from the University of Houston, was enthusiastic. He suggested forming a "working group" with the proper expertise to advise NASA on the lab's requirements. The effort had to begin immediately in order to have everything ready in time to handle the first lunar samples. We settled on "Lunar Receiving Laboratory" (LRL) as the name for the facility, and the special advisory committee, first known as the OSSA Ad Hoc Committee, became the LRL Working Group.[10]

Soon we began to hear rumors of concerns over potential biological back contamination from the Moon. Dealing with such contamination would greatly complicate the sample work. The report of the Space Science Board of the National Academy of Sciences from its Conference on Potential Hazards of Back Contamination from the Planets, held in July 1964, sealed our fate. We argued that because of the lunar surface environment the Moon presented no potential hazard. The hard vacuum, large variations in surface temperature, high UV and hard radiation, absence of free water, and constant bombardment of the surface with meteoroids would discourage the most resilient microbes. If you wanted to design a sterile surface, you would make it as much like the Moon as possible. Furthermore, space scientists generally agreed that secondary ejecta from lunar impacts reach the Earth more or less continuously, and no infections were related to contact with meteorites. All the same, when pressed with questions, we could not guarantee the lunar surface and shallow subsurface were sterile. The design requirements for the LRL took on new dimensions.

We anticipated performing the first descriptions of the lunar samples in hard vacuum, but we hoped if the samples were nonreactive with dry nitrogen that we could execute the preliminary examinations in one-way barrier glove boxes. Now we would have to perform the procedure behind two-way, gas-tight biological barriers—one way to protect the samples from terrestrial contamination and the other way to protect the terrestrial biosphere from potential lunar organisms. In addition to providing quarantine testing for the lunar samples, we had to provide quarantine housing for the crew and the returned spacecraft. NASA once again needed expert advice and requested the creation of an Interagency Committee on Back Contamination, to be staffed by official representatives

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[10] J. C. McLane, Jr., E. A. King, Jr., D. A. Flory, K. A. Richardson, J. P. Dawson, W. W. Kemmerer, and B. C. Wooley, "The Lunar Receiving Laboratory," *Science*, vol. 155 (1967), 525–529.

of the U.S. Public Health Service, National Academy of Sciences, U.S. Department of the Interior, U.S. Department of Agriculture, and NASA. This committee continued to follow the design, construction, and check-out of the LRL from a biological hazard-containment perspective.

We knew nothing about two-way biological containment, so we visited some laboratories involved in the business. The U.S. Public Health Service Communicable Disease Center in Atlanta and the Fort Dietrich, Maryland, high hazard pathogen containment facilities were particularly instructive. They handled high hazard pathogens with success, only rarely losing a lab technician because of personal negligence or accident. I held my breath a lot while touring the facilities. One thing was clear: working on lunar rocks with microscopes and even relatively simple analytical equipment behind barriers was not going to be easy.

With the LRL Working Group, we strived to nail down the scientific requirements for the lab. At the same time, we were coordinating the quarantine and pathogen detection requirements with the Interagency Committee. The biological requirements involved a number of artistic, if not arbitrary, decisions. For example, in order to ascertain the length of the quarantine period, we had to estimate the incubation period of the mythical microbes. Similarly, in case of a break in the biological barrier, we needed to know how to sterilize the potentially contaminated area. Should we saturate the area with sodium hypochlorite, fuming nitric acid, or Scotch whiskey? What did it take to kill a potentially harmful lunar organism? "Heat to incandescence!" was a favorite phrase of the time. After criteria for sterilization of the lunar samples were established, we had the option of sterilizing a sample and working with it outside the awkward containment system—provided the process of sterilization itself did not seriously degrade the sample.

During the quarantine period, many biological test systems would be exposed to the lunar samples to detect any pathogenic reactions. We were concerned about the scale of the quarantine testing because each test required lunar samples. We wanted to keep the amount of lunar samples used for quarantine testing to a minimum. Obtaining scientifically priceless samples from the Moon and then using a significant portion of them for injections into mice or soil or wheat seedlings seemed absurd. At one point, Dr. Harold Urey, Nobel Laureate in chemistry and an enthusiastic student of the Moon, volunteered to eat some of the lunar sample himself if it would simplify the quarantine requirements. In the end, voices of reason prevailed, and the scope and duration of the quarantine were something NASA could live with. The spacecraft would be returned to the LRL, sealed, and isolated for the duration of the quarantine. The crew would be sequestered in a special habitat in the recovery area, returned to the LRL, and isolated in the Crew Reception Area there, where they could be debriefed across a biological barrier. The Crew Reception Area was a vacant hotel. It was designed to house the three-man crew, some support personnel, and any scientists or technicians exposed to potential lunar pathogens in case of an accidental break in the biological barrier.

When we compiled a nearly complete set of requirements for the LRL, NASA requested proposals for the detailed design of the lab. Contracts also were signed for the fabrication of the high vacuum system in which the samples would first be opened and visually examined. Similarly we initiated design and fabrication of various gas-tight glove boxes required for quarantine testing and the preliminary mineralogical, petrological, and geochemical examinations.

The LRL was taking so much time that the directorate decided to form a small organizational unit, or "office," whose primary responsibility was the LRL. Jim McLane, an experienced NASA engineer, was selected to head the office. Although McLane was uncomfortable with the science involved in the LRL, he was a levelheaded, practical manager who knew how to get things done within the space center and the agency.

Utility and excavation work began on the LRL site, and the lab began to take shape. Two special scientific laboratories were identified as part of the LRL. One of these, the Radiation Counting Laboratory, a state-of-the-art gamma ray spectrometry laboratory fabricated from low radiation background materials, was constructed 50 feet below the ground floor offices and housed the latest large-volume detectors and electronics (Figure 2). This facility was important for measuring the natural radioactivity of the lunar samples, some of which is caused by cosmic rays. Because the radioactivities of

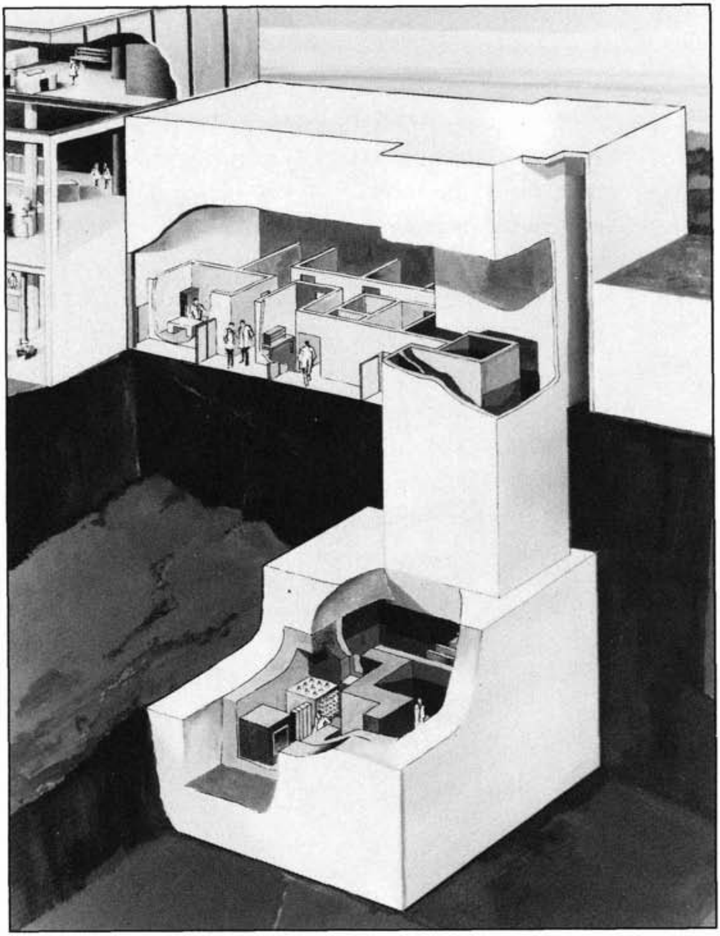

Figure 2. Artist's cutaway view of the underground low level gamma counting laboratory of the LRL. (NASA photograph S-66-50256)

some nuclides have very short half-lives, they would have to be measured during the quarantine period or the data would be lost. Even with the cosmic ray–induced activity, the total radioactivity in lunar samples was expected to be low—thus the need for very sensitive, low background measurements.

Another specialized lab, the Gas Analysis Laboratory, constituted the third floor immediately above the main vacuum system (Figure 3). The samples would be returned in two vacuum-sealed metal boxes, enabling scientists to analyze any gases emitted from the samples when the box was opened in the main vacuum chamber. Also, gases that might be released during unpackaging or splitting of individual samples could be monitored by a sensitive gas chromatograph–mass spectrometry system. Part of these early measurements would include gases evolved from a specially collected sample maintained at ultra-high vacuum.

The general plan of sample flow called for 1) introduction of the

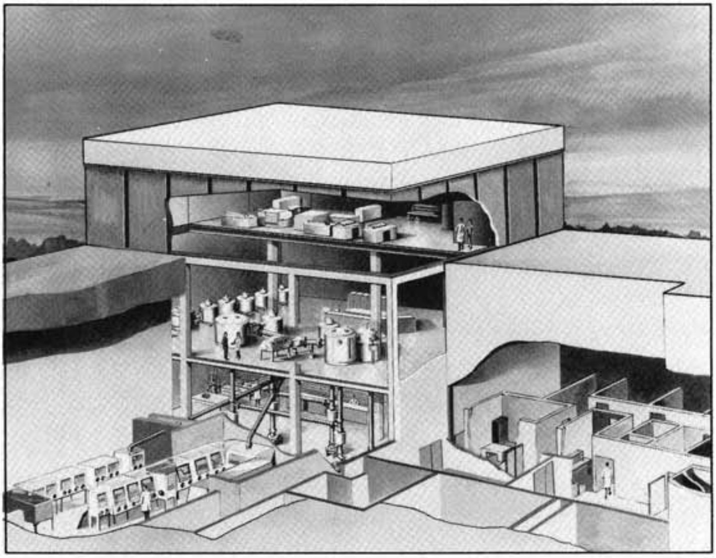

Figure 3. Artist's cutaway view of the LRL gas analysis laboratory (third floor), main vacuum laboratory (second floor), physical sciences and biosciences test laboratories (lower left), and office space (right). (NASA photograph S-66-50257)

rock boxes into the main vacuum system, 2) opening of the rock boxes, and 3) visual inspection of the samples in the main vacuum system. Two small chips of each sample would be taken. One would be sent down a metal pipe to the physical-chemical test area where it would undergo preliminary scientific examination and characterization; the other would go down a similar pipe to the quarantine test area for pathogen testing. Specially packaged samples would be removed from the vacuum system, sealed in three biological barriers, and transported to the Radiation Counting Laboratory.

The bulk of each sample would be retained in the high vacuum system for long-range storage under ultra-clean conditions in specially prepared containers. Storage and curation of the lunar sample collection would be an important long-term responsibility of the lab.

We were under pressure from the LRL Working Group to appoint a leader for the LRL. McLane was offered the job but declined because he felt more qualified for an engineering assignment. The Working Group identified Dr. P. R. Bell of the AEC Oak Ridge National Laboratory as a potential candidate. A well-respected scientist, Bell had a lot of experience with high-vacuum systems. Also, he had served on the LRL Working Group and was intensely interested in the LRL and the lunar samples. Bell agreed to interview and was subsequently named director of the LRL (Photo 39).

The MSC science staff knew Bell from his contributions to the Working Group, but we got to know him a lot better as a passionate, energetic man. He tended to be opinionated, but frequently he was right. His ability to take part in an argument without taking it personally was one of his greatest traits. Meetings in Bell's office were often audible at the far end of the hall, but he gave everyone a thorough and fair hearing. No matter how heated the discussion became, tomorrow was a new day.

During the construction and equipment installation phase, we spent a lot of time identifying construction errors by checking actual "bricks and mortar" against blueprints and specifications. We be-