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EDITED ORAL HISTORY TRANSCRIPT

JUDITH H. ALLTON
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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The questions in this transcript were asked during an oral history session. Ms. Allton has edited and revised the answers. As a result, this transcript does not exactly match the audio recording.

ROSS-NAZZAL: Today is August 10, 2017. This interview with Judy Allton is being conducted in Houston, Texas for the JSC Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thanks again for taking some time this afternoon to meet with me, I appreciate it.

ALLTON: My pleasure.

ROSS-NAZZAL: I was given your name by someone in Knowledge Management. They said you were the historian of the LRL [Lunar Receiving Laboratory], so I thought we had to interview you and get some of that history.

ALLTON: I was curious where you came up with my name.

ROSS-NAZZAL: They said you were retiring so I said, “We should interview her.” You graduated from college in 1969. Did you follow the space program at all?

ALLTON: Not really, I was in chemistry. I did give some thought as to how I got interested in that. I was at the [University of Texas at Austin] Marine Science [Institute] Lab in Port Aransas on July

20, 1969. We students were out on the deck at the professor's beach house looking at the full Moon and waiting for the fuzzy television images of astronauts stepping onto the Moon's surface. Most people my age remember exactly where they were when that happened.

ROSS-NAZZAL: It was certainly a momentous occasion that had never happened before, so I can imagine it was a big deal.

ALLTON: I got more interested in the space program when I applied for a job here at JSC back in 1974. I was working for the Texas Water Quality Board in the EPA [Environmental Protection Agency] Lab. We sampled and analyzed water in the Houston Ship Channel and other places. One of the NASA contractors advertised a job opening for a chemist, so I just went home and poured a glass of wine and typed out something that said I was terrific. I got an interview, and I got hired.

ROSS-NAZZAL: Where did you see the advertisement? In the [*Houston*] *Chronicle*?

ALLTON: It must have been in the Houston paper. I didn't live on this side of town at the time, so that would have been the only place.

ROSS-NAZZAL: Oh yes, kind of a drive if you're on the north side. What was your understanding of what you would be doing based on that newspaper advertisement?

ALLTON: I do not remember what the advertisement set out as the job description. When I arrived, they wanted someone to work in the laboratory where scientists returned samples from the Moon that they had been loaned for research. It was in curation. I've been in curation since 1974, so that was my first job for NASA. Scientists who had been allocated Apollo samples—they're only on loan, so when they're finished with them they have to return what's left or the residue. We would receive and document those samples and archive them under clean conditions.

In those days, we operated two laboratories, one lab for "pristine" samples (never out of curatorial control) and one lab for returned samples. These days, in the new facility built in 1979, we have two separate vaults, one for pristine samples and one for returned samples. Pristine samples are stored and handled under nitrogen in gloveboxes. About 80 percent by weight of the collection is still in that state, which is nice because it's a legacy for future generations. Even then, who would have thought it'd be this long before we'd go back to the Moon and get more? So reserving a portion of the samples for future studies was a good thing to do. We did this because NASA advisory committees were comprised of smart, visionary people.

There was a separate laboratory to process the samples being returned. Because they'd been out of curation control, we didn't have a watchful eye over exactly how researchers handled their lunar samples. So researchers were required to return a form indicating what they had done to the samples. We tried to reallocate used samples where we could, in order to preserve the pristine ones. By reviewing the handling histories of the returned samples, I learned a lot about the people who had been allocated samples, because I would look up what they were studying, what they did in their lab, and document it. That's how I learned who the customers are, the people that depend on getting good samples from curation for their experiments.

ROSS-NAZZAL: You had been doing water sampling. How did you learn about lunar science and curation? Was there on-the-job training that you were offered?

ALLTON: Mostly I'm a curious person. But I probably had the right background in that I was an analytical chemist, and my master's project was age-dating rocks, which is what many scientists measure for Apollo rocks. They determine how old rocks are. Isotopers in general tend to be pretty picky about contamination, and I had that background.

The other thing that's played into my career here more recently is I did a little bit of marine science—it was marine geology—and that's helpful in planetary protection issues. The Planetary Protection Office now convenes meetings of experts related to planetary protection issues. Participants in these meetings include people who analyze deep-sea cores or extremophiles in rocks way below the surface of the Earth. So my marine science experience has helped.

ROSS-NAZZAL: It wasn't unusual for you to come in and know how to handle these type of things, and what you had to do to handle a sample?

ALLTON: No, it was kind of natural. I knew some of the "customers" for curated Apollo samples. The same people that returned lunar samples were well-known in isotope geology, and I was familiar with their work.

ROSS-NAZZAL: Did you know many of the people who were working out here when you accepted the position?

ALLTON: No, I came in as a lower-level, hands-on sample processing person.

ROSS-NAZZAL: Were there many other women working in the lab at that point or people of color?

ALLTON: There was a fair number of women. People of color worked in the lab. I personally didn't detect any discrimination, but, in recent years colleagues have confided a few examples from those early days, the 1970s, of discrimination regarding raises and task assignments. I can think of one example of sexual harassment, but back then, most women just went out of their way to avoid this person.

ROSS-NAZZAL: I'm just curious because we don't have a lot of stats on how many people worked in what groups and how many people of color there were. You can't really tell by someone's name. How many women there were, you can normally tell that by name. It's interesting to me how NASA has changed over the years. Always curious if there were a lot of women or minorities in groups, especially in the early '70s.

ALLTON: If you were asking how many women were lunar sample investigators, that's a different story. There were not very many. I can think of three from the early days. One was a petrologist named Odette [B.] James. I think she worked for the USGS [U.S. Geological Survey]. I'm aware of her because she served on some of the oversight committees. She'd be the only woman, except the secretary of the group, in the 1972 Lunar Sample Analysis Planning Team (LSAPT) picture. Carle [M.] Pieters has been doing remote sensing for a very long time from Brown [University, Providence, Rhode Island] and was active back then and well known. Ursula [B.] Marvin was active in meteorites. I'm not real sure she had lunar samples at the time, but the studies were similar and the science groups were intermingled. Composition of lunar sample investigators and resulting NASA advisory committees has changed a lot.

ROSS-NAZZAL: I'm sure it has.

ALLTON: I can remember being at a meeting—I couldn't tell you when exactly, I think it was in New Mexico, maybe late '90s, early 2000s—in the ladies' room, and they were having a spirited discussion over some planetary science debate. I thought, "It wouldn't have been this way 20 years earlier." That was a milestone, having a discussion in the ladies' room.

ROSS-NAZZAL: I can imagine it was kind of lonely in there. Very few of you.

ALLTON: But that's not the onsite NASA folks. That's really the people we interact with at mostly academic institutions.

ROSS-NAZZAL: When you came here you started working in Building 31. The samples had already been moved over to Building 31, you weren't working out at the LRL at the time?

ALLTON: That's correct, I did not work in the LRL. Lunar samples were moved from Building 37 to Building 31 in 1973. All samples had been moved in by the time I got here in 1974, so the stories about the LRL were still alive. As you may know, there was quite a bit of tension between the biology groups and geology groups.

ROSS-NAZZAL: Can you talk about that?

ALLTON: A lot, probably. This is all from stories. I collected my stories among the geologists, so it has a certain bias. There were two kinds of geology folks. The job of the geologists who worked inside the Lunar Receiving Lab, inside the barrier, (the Preliminary Examination Team, PET) was to characterize the rocks as they were opened. They described the rocks geologically, for the purpose of making wise allocations, and reported to the advisory oversight committee, who made sample allocation recommendations.

The oversight committee geologists (LSAPT) were kept outside the bio barrier and received reports each day from the PET. LSAPT would review the requests for samples and decide if the research request was a good use of the samples—if this requestor was qualified and had the right instruments to achieve the required analytical sensitivity to address the science question. LSAPT depended on data from the PET to make their decisions. There was a tension between the insiders (PET) and the outsiders (LSAPT) when the LRL was active. This is all from stories told to me.

My favorite one is [S.] Ross Taylor, who was probably the world's best known emission spectrograph person. They had in the Lunar Receiving Lab an emission spectrograph. That is an instrument which zaps a sample between two electrodes and the light emitted is diagnostic of the elements that are in the sample. Ross Taylor received a very early sample Monday after the rock box (the Apollo Lunar Sample Return Container, ALSRC) was opened on Saturday. (The story is from an interview I did with Ross Taylor, some articles he wrote, and laboratory notebooks in our archives. There's other stories people tell about him.)

Ross received his first lunar sample in his LRL lab just before noon on July 28, 1969. The sample was inserted in the nitrogen glovebox, which is behind the biological barrier, and zapped between the electrodes; this is for Moon dust sample 10015.

I need to digress here and explain what it was like to work behind the bio-barrier and how Ross Taylor came to be working in the LRL. The Lunar Receiving Lab was built as a containment facility as well as a laboratory to examine lunar samples. Containment policies were established by the Interagency Committee on Back Contamination (ICBC). Members of the ICBC came from the U.S. Public Health Service, Department of Agriculture, and Department of the Interior. Working behind the bio-barrier, a containment barrier, involved removing all your clothes, putting on lab clothes, then entering the lab. Inside you couldn't smoke or eat. Every time you went out you had to remove the lab clothes, shower out with a harsh soap, walk naked through an ultraviolet airlock, then you could put on your own clothing and leave. I've had other people tell me they quit smoking because they couldn't stand one more shower. That was pretty stressful, and Ross felt the stress. While working inside the lab, people had to wear gas mask respirators, hanging from a cord around their neck, ready to don immediately in case there was a leak causing direct exposure to lunar dust. (An example of a leak would be a hole in the glove.) All samples were handled inside of nitrogen gloveboxes at negative pressure to the room.

Ross Taylor came to the LRL relatively late. He just happened to be visiting the U.S. in 1969, and LRL managers were having trouble getting that part of the lab working like they wanted. So they asked Ross Taylor if he would come lead the emission spectrograph lab. Ross and his wife were in the middle of building a house back in Australia. His wife said, "No, you've got to go." So he came. He would work from early in the morning till two or three the next morning. The reason he had to put in those long hours was that he had only a few weeks to calibrate an instrument that somebody else had set up to make the very first measurement of the Moon's chemistry. The calibration normally would take 6 months or a year.

On July 28th at eleven forty-five a.m. lunar dust sample 10015 arrived in Ross Taylor's e-spec lab. Ross' task was to analyze the sample so the results could be reported at a four p.m. press conference. The sample is immediately placed into the glovebox and zapped between electrodes. The light emitted is dispersed by wavelength onto a negative; the wavelength is indicative of the element and the density of the line indicative of the amount. Hundreds of lines are printed onto the negative. Both wavelength and density need to be carefully measured and compared to standards. Ross begins his careful measurements and discovers an unexpectedly high amount of chromium in the lunar sample that overprints his standard calibration lines. He has to recalibrate. The spill alarm sounds. Ross dons his gas mask and keeps working. Security personnel wearing bio-isolation garments with goggles and respirators sweep through the lab and gather up anyone directly exposed to lunar material. Ross is able to complete his analysis and hand-off the results in time for the four p.m. press conference. He accomplished this under great stress, and his analysis was confirmed accurate by subsequent work under less stressful conditions.

The containment restrictions were annoyances to the some people working inside the LRL, mainly geologists, because they really didn't believe there was a problem. Now that won't be the same case for Mars. We have more evidence that there's water, on Mars and more habitable temperatures, radiation, etc. The geologists thought there was no pathogens on the lunar surface, and, in general, chafed at the restrictions they thought were not totally necessary.

Another topic, with shades of opinion, involved how much scientific data gathering should the PET do inside the LRL. The outside review committee LSAPT was taking requests from around the world for samples to analyze. LSAPT needed basic sample descriptions to make appropriate sample allocation recommendations. The philosophy was "best samples for best science." Implying that those scientists privileged to work inside the LRL and having the first look at the samples should not be able to scoop all the good science. It's a valid point of view. The tricky part was how do you describe a sample enough that LSAPT can figure out best use and not so much to scoop the science, so to speak.

Here is an example why this boundary between superficial sample description and scooping science was difficult to determine. One of the debates was "How old are the rocks?" Ross Taylor was measuring elemental content, which included the potassium content. The Gas Analysis Lab upstairs was measuring argon isotopes. There's a potassium-argon age-dating technique wherein one can calculate the age of a rock by precisely measuring small amounts of potassium and argon isotopes. LSAPT would invite the PET guys to come out every afternoon at four p.m. and ask, "Well, okay, what results did you get today?" The PET would just report the minimum they were required to report. In fact, both teams, the E-Spec Lab and the Gas Analysis Lab, were making much more precise measurements than they were required to report. Thus they could calculate how old the rocks were, and this was considered prohibited science by some on LSAPT. That is just a snapshot of the small tensions going on among geologists and the difficulty of keeping things fair. That was aside from the tensions between some geologists and biologists. At the hands-on level, I heard that geology and biology lab workers could work usefully together. For those responsible for achieving a science goal in this highly visible arena, there was sometimes comments regarding usefulness of using lunar material to "feed to mice and cockroaches." I also heard some people still remember the bad relationships in that period.

I probably shouldn't speak to the biology part. You need to talk to people like Gerry [Gerald R.] Taylor or others. I don't think they kept their records. I had a hard time finding original records from the biology side. I think we still have most of the geology documents in our archives.

The biohazard detection laboratories were not places to keep lunar samples pristine for planetary science measurements. Biohazard labs used animals such germ-free white mice, cockroaches, Japanese quail, killifish, and oysters. Animals are naturally dirty. Biohazard labs, and also geology labs, were required to provide containers filled with organic-based sterilants such as peracetic acid, and perhaps carbolic acid, for dipping containers and equipment that were used in the LRL. If one is trying to analyze for lunar organics, that's not the optimum place to keep your samples clean. So there was a technical reason there was this head butting as well.

To this day, I still talk about the tension between trying to keep sample materials clean, which is in conflict with the technology to keep it contained. An example is if you want to contain potentially hazardous material in a glove box, the glove box is operated at negative pressure. The gloves gets sucked into the glovebox. So if you have a leak, contaminants get sucked into where your samples are. If you want to keep pristine scientific samples in the glovebox clean, you operate the glovebox positive pressure, so if you have a leak in the box contaminants do not get sucked in. You prevent sweat and skin cells or whatnot inside. It's hard to do both at once. This technical tension still exists to this day, even if you throw robots in the mix. I think there's going to be ways to do it. One way to manage this tension is to have some contained samples and some clean samples in separate environments, or there could be a complex way to achieve both containment and cleanliness.

ROSS-NAZZAL: Things must have been a lot easier for you when you came since you didn't have to shower; you didn't have to do all these things. What did you have to do when you would go in to work with the samples? Say you were preparing samples for some PIs [principal investigators]. What did you do when you went in to access those materials?

ALLTON: For returned samples in 1974, where I started working in curation, we would don a smock, shoe covers, and a hat in the change room, and then we would proceed through an air shower before entering the clean lab. I don't even think we wore gloves. This was in Building 31. Now we have Building 31N, and both the pristine and the returned lunar samples are stored over there. Building 31N is maximized for clean construction and sample security. (Note the building first carried the number 31A.) In the pristine sample lab and storage vaults, the materials of the wall coverings, paint, flooring, and lights were chemically screened to exclude elements known to interfere with sample analyses, mostly age dating analyses.

When I first worked on cores, both extrusion and dissection, these activities took place in the pristine sample lab in Building 31, requiring pristine sample lab gowning requirements. The laboratory clothing consisted of a whole suit, called a bunny suit, booties, hat, and gloves that you would put on over your street clothes. Later when the lunar samples were moved from 31 to 31N in 1979, the pristine lab clothing and entry procedures were similar. The entry procedure went through a sequence of rooms, each with a room air pressure higher than the previous room. Every door opened into a higher pressure room which made the air flow outward from the cleanest core room. This keeps contaminants from entering the labs. There are six levels of clean room to go from the lobby to the sample vault: change room, clean change room where bunny suits are donned, airlock, pristine lab, buffer corridor to vault, and the vault.

I went from working with returned samples to opening and dissecting soil cores beginning in 1978 through 1981. Everything that I did with cores was delicate handwork. My little spatula was about five millimeter (mm) wide [demonstrates]. With it, I could scoop up maybe five milligrams at a time. I would sieve the subsamples through a one mm screen and then arrange the >one mm fragments on a white surface, using tweezers, to image the group. Positive glovebox pressure helps. It's not that hard. I'm a little ambidextrous, so that helped too. It would take me about three months to do one of the large-diameter soil cores.

ROSS-NAZZAL: How much material are you talking about there for a core, one-inch diameter? How long are you talking about as well?

ALLTON: Let me recap the three types of core samples taken during Apollo. We had two designs of drive tubes. A drive tube is a tube pounded into the ground to collect an undisturbed column of regolith, Moon surface fines. The third type of coring device was a rotary, percussive drill made by Martin Marietta and used on Apollo 15, 16, and 17 to collect a soil column two to three meters deep. The first drive tube samples taken on Apollo 11, the samples taken by Buzz [Edwin E.] Aldrin [Jr.], were in tubes two centimeters in diameter and thirty-two centimeters (cm) long.

The tube designers had the forethought to ask, "How are we going to get these open when we get them back in the lab?" Consequently, these tubes were double-wall. To open, we would unscrew the bit or the top end and slide out the inner tube which had already been split in half. The last step was to take a razor and slice the heat-shrink plastic that was holding it shut. This "easy open" design resulted in a thick tube wall, which along with the narrow tube diameter, resulted in tubes that did not penetrate easily into the surprisingly dense lunar regolith. The Apollo 11 drive tube samples were relatively short, ten to thirteen cm. You might have noted the Apollo 11 core that I dissected was about this long [demonstrates].

ROSS-NAZZAL: I did read that, yes.

ALLTON: The soil was more dense than people thought. I always remember that when you want to devise sampling tools or strategies on a new place, if you have multiple missions, you're going to learn a lot the first time and can make adjustments for the second time. The Moon being closer, we can do that. One great advantage of the Apollo mission series over distant one-shot robotic missions is the ability to adapt equipment to the actual environment encountered.

After Apollo 11, the drive tube bits were quickly redesigned for Apollo 12 and improved again for Apollo 14. The Apollo 12 and 14 drive tubes were capable of collecting regolith for the entire length of the tubes. There was time to do a complete re-design of the drive tubes for the last three missions.

One of the things we did was make the core tubes where they would go into that dense soil more easily with less disturbance of fine stratigraphy. The tubes were four-centimeter diameter, very thin-wall aluminum. The astronauts could screw two twelve-inch tubes together and collect a sixty cm profile [demonstrates]. Those four-cm diameter tubes were used on Apollo 15, 16, 17. On 15 the first drill core was taken, which had the rotary-percussive action. The titanium drill tubes were two-centimeter diameter with the flutes were on the outside. The two to three meter depth of the drill samples was very helpful scientifically because it allowed measurement of the cosmic ray flux into the lunar soil.

ROSS-NAZZAL: You mentioned in your biographical sheets that you came up with the tools for how to open those cores. I wonder if you could talk about what those tools included and what you experimented with.

ALLTON: Depends on which core tube you're talking about. On the drill stem parts with titanium, those were milled open. I didn't come up with any of those. When you do a milling operation on a metal inside of a glove box full of nitrogen with no lubricants, it's a pretty screechy proposition and vibrations were a problem that could not be completely eliminated.

A well thought-out process was developed for opening the four-cm diameter drive tubes, which involved pushing the "soil," also known as regolith, out of the tube in the same direction as the soil entered the tube while being collected on the Moon. This minimized distortion of the stratigraphy. The soil was pushed from the bottom using a ram into a container that was comprised of layers, which were removed sequentially to allow several passes for sampling the core vertical profile. The equipment to do this, used to do this, inside of a nitrogen-filled glovebox was complex, requiring tight tolerances and rehearsals.

ROSS-NAZZAL: You did rehearsals, dry runs?

ALLTON: Oh, yes.

ROSS-NAZZAL: Can you talk about those and why that was necessary?

ALLTON: There are two parts to examining a four-cm drive tube: extrusion and dissection (the careful subdivision into half-centimeter depth increments). The equipment to push the soil out of the tube was called an extruder. The receptacle for the extruded soil had several layers screwed together to make the smooth bore. The layers were parallel to the length of the core tube. There are a lot of tight tolerance parts that need to be assembled in a precise sequence. We carefully controlled the materials allowed to come in contact with lunar soil. Most of the structural parts were made out of aluminum alloy 6061 with clear anodize on it.

The only lubricant used at that time was Xylan, which is a Teflon compound allowed only because it was thought that the fluorocarbons would not be confused with natural organic compounds. It turned out that Xylan also contained an organic binder; therefore, Xylan was stripped from the screw threads for recent core extrusions and dissections. That was a lesson learned and a reminder to pay attention to details.

When you design new sample return mission hardware, choosing a lubricant needs careful consideration. You need to pick a lubricant that is not going to off-gas organics, if you're looking for life. For the Moon, there was so little carbon and so little water, many people interested in doing organic analyses on Apollo samples drifted away from requesting Apollo samples after the first few missions because the carbon on the Moon tended to be from the solar wind.

Now we're going back to the Moon and looking for water: new set of instruments, new people attacking the problem. So we might get a slightly different answer, but the thinking back then was on keeping hardware very clean, restricting the kinds of materials, and cleaning each piece of hardware rigorously.

ROSS-NAZZAL: What did you practice on then? You obviously weren't practicing with lunar rocks, but what were you practicing with?

ALLTON: These remarks apply to the four-cm drive tubes. The extrusion and dissection hardware was developed in the early 1970s. Simulants used in core tubes during the development and testing of the hardware included powdered basalt, white minerals, and dark minerals and small rock fragments of various grain sizes. The light and dark materials were placed in visible layers in the "soil" so distortion of stratigraphy could be visually assessed. Most of these test runs were conducted on laboratory tabletops.

ROSS-NAZZAL: Was there a glove box set aside just for simulations for that reason?

ALLTON: Final test runs were conducted inside of a nitrogen glovebox used for testing. The extrusion and dissection hardware was thoroughly cleaned before being placed into a lunar sample glovebox. The extrusions required three people in the gloves and a reader for each step of the procedure. We needed to work well together to assemble the intricate pieces because helpers would be required to hold hardware in position with tweezers while fasteners were attached, etc. Our goal was to be as coordinated as a pit crew in the Indianapolis 500.

ROSS-NAZZAL: I was reading your article about the Apollo 11 core. I thought it was interesting how they had opened part of the cores from 11, but then you went back and did some more work on it. Why was that the case? What did you learn that was different from when they looked at it in '69 when you did it later?

ALLTON: The Apollo 11 drives tube samples were the first cores that I dissected, in 1978. They had previously been opened in the Biological Preparations Laboratory as a requirement for biohazard testing. This was done in a temporary facility to acquire preliminary images and remove half of the core material under nitrogen. The remaining half cores, still in their original inner half tube, were stored until I dissected the remaining portions. I have forgotten what I wrote!

ROSS-NAZZAL: It's very specific, I know. I just thought it was fascinating. Your article was really interesting, about the mix-up of where these were, which one it was, and the boxes that they got put in. It was just a really interesting article. How they used aluminum foil to keep it in the core, and how it reshaped the core a little bit. I just read this, so that's why I have a little bit more detail.

ALLTON: Send me back to research it.

ROSS-NAZZAL: No, it's fine, I just wondered if that was something that stuck out in your memory. Were there differences between the cores that you looked at, between 11, 15, 16, and 17? Or were they all fairly similar in terms of what you were looking for?

ALLTON: They cores are expected to be different in composition and texture because they were taken in unique locations. The biggest difference from a dissection viewpoint is that the Apollo 11 cores were in two-cm diameter drive tubes that had already been opened and half the soil removed without detailed documentation. In one core, the soil was not confined and slid around a little inside the tube. In contrast, the remaining cores that I opened were in four-cm drive tubes, carefully extruded and documented in detail. The Apollo 15 core that I did was a double, samples 15010/15011. It was on the edge of Hadley Rille, which was a rocky basalt surface. Consequently the lower tube had a rock that big in the bottom [demonstrates], which pretty much would have had to rotate to get slipped in this way because it wouldn't have gotten in crosswise.

The reason I could spend three months digging through something at a very slow pace is that it was always a possibility there would be something new and exciting in the next scoopful. To sieve the particles and take a look at them in the microscope was a delight. For example there were beautiful glass beads of different colors, mostly green on 15. I did not do any 17, but that's where the orange glass beads were.

ROSS-NAZZAL: I was curious about that one, too.

ALLTON: The Apollo 16 core I dissected had more visible layering, the abundant white plagioclase contributed to greater color differences.

ROSS-NAZZAL: As you are working through these cores, how are you keeping track of what it is you're finding? You're in the glove box so you're obviously not taking out your hands every time to document and write. How did you keep track of what you found?

ALLTON: No, we took our hands out and wrote.

ROSS-NAZZAL: Did you? Oh, okay.

ALLTON: I think they're a little better at it these days. We have an upgraded experimental cabinet. We can take pictures, and of course it's all electronic now. I don't favor electronic note-taking because it's like filling out the form. What you want to say never fits that form exactly. We did a lot of drawing of features we observed.

ROSS-NAZZAL: That definitely added to the amount of time it took to go through the core.

ALLTON: Yes. Besides, I liked looking at it.

ROSS-NAZZAL: Were there other people that were working with you on those cores as you were going through? Or that was your project for those months?

ALLTON: There's very few people who have dissected lunar soil cores, working at most two core gloveboxes simultaneously. Those who have include myself, Stewart Nagel, Stephen [R.] Waltz, and Carol [M.] Schwarz. If I were working on a core, that would be my core, and I wouldn't want the other person to come in and dig in it. Same thing would apply to their core. We interpreted what we saw probably a little bit differently, but then this was a basic characterization. I think researchers understood that. The science from the cores samples came from the detailed analysis by investigators, measuring the changing chemistry with each little increment of depth in the soil.

ROSS-NAZZAL: One of the other things I had read that you worked on was preparing samples for PIs. Wondering if you could talk about how you did that. How did you decide which samples? Was that something that they proposed? They wanted rock, whatever the title was at that point?

Or did you get to decide which sample they would receive, and how did you go about making that decision?

ALLTON: The decision was technically not mine. If it were for a returned sample, I would browse through the database and look for something that I thought would fit this researcher's requirements. We would just make that suggestion to the oversight committee, and they would have a discussion based on the science merits. They had a fairly detailed database and knew how much of the different kinds of samples were available. They still do it that way today. Their recommendations have to be signed off at [NASA] Headquarters [Washington, DC], but they pretty much agree with the committee's assessment.

For new samples, the committees had a better handle on the chemistry of the different rock types, because all of them were also investigators. That's important, I think. They knew the samples. They knew the analytical sensitivity requirements that would be required to get meaningful results.

Today when planning for Mars sample return, assembling the right sets of people to set worthwhile, workable analytical requirements is difficult. One, because it's such a long time period between setting requirements and analyzing the samples. But in Genesis [Discovery Program], the people that decided how clean the collectors had to be were actually the people that were going to make the analyses. They had the instruments to verify a collector was clean enough to do this.

It is more of a challenge when you have a ten- or twenty-year project. You're pulling in people with a more biological bent that we had after Apollo had matured a little bit, and you cannot know the sample characteristics until you actually bring something back. But it's critical if you have people in the loop that understand the detailed chemistry and petrology of planetary samples.

Those outside committees comprised of actual sample researchers would know which rocks to choose, the history of all the analyses that had been done on it, and understand how it all fits together to make a picture.

ROSS-NAZZAL: That's quite a bit of knowledge contained in one human being's brain.

ALLTON: Yes.

ROSS-NAZZAL: What about museums and other places that would make requests for lunar samples? Would you also pull those, or work with people who were working on exhibits?

ALLTON: That process for making requests for museum display samples was channeled through JSC Public Affairs Office. They needed different information to evaluate the benefits of allocating a sample for public display. This included descriptions of the display and context, the expected audience, and a security plan. After meeting the PAO requirements, the request would be forwarded to the lunar sample curator for presentation to the oversight advisory committee (depending on the date called LSAPT, LAPST, the Lunar and Planetary Sample Team, or the CAPTEM, the Curation Analysis Planning Team for Extraterrestrial Materials, the current committee name and function).

While researchers would typically request a specific sample by sample number from a catalog, museum requests would likely focus on type of sample, such as basalt or breccia from a specific Apollo site, and allow the curator to make recommendations. Usually the sample chosen was a subsample of a large, homogenous rock. This approach still leaves a lot of material for science. Breccias, for instance, vary quite a bit internally, since they are comprised of impact-generated rock fragments that could be from anywhere on the Moon. You could inadvertently use up something that might be extremely valuable in those kind of rocks. There are probably a few breccia displays, and these would be mounted in cases that could be recalled for further research.

ROSS-NAZZAL: In your resume you also talked about how you helped set up a Class-100 cosmic dust tunnel. That was something that you did after you came here to JSC. What is a cosmic dust tunnel? I think that's probably the first thing people will want to know.

ALLTON: The tunnel is a description of the clean laboratory where we handle cosmic dust. "Cosmic Dust" is our nickname for interplanetary dust that falls on the Earth. It falls through the atmosphere. We collect it with two types of high-altitude aircraft. It started with derivatives of the [Lockheed] U-2, now flown on the ER-2 from Armstrong Flight Research Center [Edwards Air Force Base, California] and the [Martin] B-57s [Canberras], now flown from Ellington [Airport, Houston, Texas], that are going to go chase the solar eclipse in a couple weeks

ROSS-NAZZAL: Yes, that's very exciting.

ALLTON: Curation has had a long relationship flying collectors for "cosmic dust" on the WB-57s. The cosmic dust collected consists of particles shed by comets or asteroids that fall to earth. These sometimes intersect Earth's atmosphere at high velocity and become molten small spheres.

Sometimes they just float through the atmosphere, and they arrive still looking like fluffy grains, more like their original cometary composition. The WB-57s fly around at high altitude, in the lower stratosphere, exposing gooey plates to capture ten-micron particles. The collection plates are only opened at high altitude, where there are very few earth-generated particles. That way the plates do not get so contaminated that the cosmic particles are obscured. Other particles, derived from spacecraft engines or an energetic volcanic eruption, sometimes accumulate on the plates in small amounts and require chemical analysis to identify. One set of plates may be exposed for cumulative flying time over several weeks.

I was involved in establishing an ultra-clean lab to prepare clean collection plates for flight and to examine plates recovered from the aircraft containing the dust particles. We set up a clean room that had a whole wall of HEPA [high-efficiency particulate air] filters setting up a horizontal flow Class 100, ISO Class 5, cleanroom which we called a tunnel. The dust was picked from the plates using a glass needle right in front of the filter bank, so the cleanliness was in practice Class 10, ISO Class4. The gowning requirements for working in the Cosmic Dust Lab was a full bunny suit, complete head cover with only the eyes exposed, gloves, and booties, I never did any particle picking, but helped establish the Class-100 tunnel. That was our first laminar flow room that we put in for curation. Don [Donald E.] Brownlee from the University of Washington in Seattle first showed these particles could be captured from the stratosphere. We also visited the interplanetary dust handling facility at Washington University in St. Louis [Missouri] and received advice on lab design from both groups. The JSC Cosmic Dust Lab was established in 1981.

ROSS-NAZZAL: What was the reason behind collecting all this material? Do you know what it was eventually going to be used for in terms of scientific research?

ALLTON: Samples of comets or asteroidal dust—at first they were called Brownlee particles. I can remember Don [Donald E.] Brownlee on stage in the JSC Teague Auditorium talking about Brownlee particles. That's probably the first year I was here. The science was way over my head, and he looked so young. He was the one that proposed collecting those particles with high altitude aircraft.

NASA collaborated and took over the operation of the airplanes and setting up the lab. The particles are allocated just like lunar samples, requiring sample requests and committee review before approval. This open access enabled Brownlee and other researchers access to samples for analysis and use the composition results to make predictions about interplanetary dust sources. Some dust grain results are correlated with specific meteor showers or comets. There are some estimates of a couple of tons of cosmic dust falling on the Earth each day worldwide. The dust collection at JSC is a very, very, very small subset, but a subset in which detailed chemistry can be precisely measured. A ten-micron grain can be divided among several research groups with different expertise and instruments enabling comprehensive characterization.

ROSS-NAZZAL: That's quite a bit.

ALLTON: Yes, it is an impressive number. Some of the particles collected are orbital debris, exhaust from rockets that gets lofted up that high. The lab workers who pick particles from the gooey plates have an eye for cosmic dust versus rocket exhaust. Once picked, then the workers mount the particle for SEM [scanning electron microscope] screening, resulting in a good mugshot with the SEM and a little bit of chemistry. They publish catalogs using SEM data so researchers can shop for particles meeting their particular research requirements and request that particle. In all the curatorial collections, we still do basic characterization of samples and publish the results so researchers world-wide can access samples through requests and peer-review. We still do the equivalent of the Apollo PET to promote wise use of limited samples for best research.

ROSS-NAZZAL: I noticed you had worked on some of those catalogs.

ALLTON: I don't remember working on cosmic dust catalogs, maybe I helped with the database or something. I have written lunar core catalogs, historical summaries of the way Apollo samples were handled, and in recent years lunar and planetary science abstracts describing Genesis solar wind sample processing and sample status.

ROSS-NAZZAL: You have a lengthy publication record, that's for sure.

ALLTON: It's interesting. Brownlee—he was the Stardust PI for the mission that went and directly collected particles in aerogel from Comet Wild 2 and returned those samples to the Stardust Lab. The Stardust Lab is separate from the Cosmic Dust Lab. Cosmic dust is a random mix of stuff that happens to fall on the Earth.

ROSS-NAZZAL: I was curious if you could talk about how procedures have changed since you started there, if they have at all. If things have changed or the facilities changed. Obviously there was the annex that was built in '79 and opened. I don't know if you want to talk about some of those changes, or if things have been pretty consistent over the years.

ALLTON: I have two comments on that. We're charged with tracking every little milligram and grain of lunar material, you might know that. Our other collections also have to be documented.

Back, about maybe the late '70s, we got audited. People from Arthur Andersen [LLP] came. The curator at the time, Pat [Patrick] Butler [Jr.], said, "Just cooperate with everybody that's coming." They gave us a report that made some constructive suggestions on how to close the loop on tracking the materials internally and how to audit the samples accurately. I think that improved tracking, and a lot of new procedures came out of that in terms of database modifications. The database double-checked the amount of material before and after processing lunar samples. When sample transfers were made within curation, the database kept track of who initiated the transfer, who received the sample, and issued notices if the transfers did not match.

That one audit that went into a lot of details. Those suggestions were taken to heart, and I think greatly improved our tracking capability. I know some folks were still bent out of shape by being interviewed by the auditors, because I guess being grilled was not something they were used to. Nothing bad happened to anyone, and we actually, I think, came out of it better with a good set of procedures. The procedures that we have today follow that tradition, with how we document what we do and archive all the changes that happen. I'm thinking the changes are coming now as we try and bring more labs online, in more of a hurry than I would like to work.

ROSS-NAZZAL: That's interesting. Were you interviewed as well by Arthur Andersen? Do you remember that?

ALLTON: No, I was not interviewed. I didn't know anything significant and they didn't talk to me.

ROSS-NAZZAL: I wonder if you would talk about the building of 31 North. I understand that was a big undertaking and you actually had to do dry runs to move the samples and pack the samples, make sure that they were safely packed. I was looking through some of the curatorial newsletters. People, secretaries, technicians—a lot of people—were in the facility on their hands and knees cleaning at one point before everything got moved in. I was curious what your memories are of that effort and those first couple of months moving in there.

ALLTON: The effort was really good. I think it's a landmark. It was more than a couple months. The samples were removed from the Lunar Receiving Lab because it wasn't set up to keep samples clean—that tension between "contained" and "clean," about negative versus positive air pressure, sterilization chemicals, animal effluvia. What was good about the 31N facility was the great care taken by the oversight by the facility subcommittee of LAPST to produce a clean facility.

The oversight committee was composed of people who wanted to analyze lunar samples, knew how to do that and recognized contamination sources. Forward thinking curators and advisors had ideas for the type of facility needed to preserve the lunar samples, probably starting about the time samples were moved into Building 31 as an interim facility in 1973. The facility subcommittee started meeting for regular reviews of the plans and subsequent construction about 1975 and the building was finished in 1979. It was a committee of about five to seven people. Most of them were isotopers, people real picky about process details and interested in making sure it was done right. Two facility subcommittee members that stand out in my mind are Dimitri [A.]

Papanastassiou, formerly of Caltech and JPL [Jet Propulsion Laboratory, Pasadena, California], and JSC's Lawrence E. Nyquist. Both served on the Facility Subcommittee as tenacious members for contamination control and have a continuing genuine interest in astromaterial sample preservation, serving on advisory committees up to the present day. Everything that went into that building—the floor coverings, the paint, the wires you plugged into the light fixtures—was analyzed for chemistry. The subcommittee approved specific construction materials and furnishings for the whole building based on the least contaminating chemistry, even though the samples were going to be inside the glove box. They did a good job.

So the building looks to me like it did in 1979. I think it's in pretty good shape. You can find some small places requiring more frequent maintenance, but the security is there with the vault doors. Cleanliness is robust, achieved by the set up with the high-pressure areas, the storage, and the buffer area where the samples are transferred into glove boxes. As you go in, suiting up, you have to go through six increasing pressure changes. Every time you open the door, the air flows out. The air handlers are HEPA filtered. The pristine samples are handled in nitrogen-filled gloveboxes, which are monitored for water and oxygen content. It's a really good building. I observed good communications between the facility subcommittee and the curatorial facility engineer in obtaining good workmanship and materials from the contractor. JSC facility people provided great support for the contractor interfaces.

ROSS-NAZZAL: Did you play any role in some of these discussions? Or perhaps when you started to move samples, were you participating in some of these dry runs or discussions about how best to pack up samples? Any memories of those days?

ALLTON: I do have memories of everyone on staff, including the curator Pat Butler, on hands and knees wiping down the vault floor with Freon or maybe isopropyl alcohol. It was hot and people were wearing summer clothes. We were lined up in a grid, with all behinds oriented in the same direction so the entire floor would be wiped. This occurred as we prepared to move samples into the building.

Because I spent a lot of time looking up the chemistry of different materials proposed for the new building as the subcommittee requested, in subsequent years people would ask me, "What's in the paint on the door? What's on the floor covering?" We had good documentation, and I could go look it up. That's why I was aware of that.

Plus, I could attend the twice-a-year meetings at which the facility subcommittee reported to the oversight committee. When they were working on the building, curation furnished an LRL veteran building engineer, William A. Parkan, who had an excellent working relationship with the subcommittee. I could hear the discussions and witness the resolution of problems in a professional atmosphere.

When we moved the samples, we already had the procedures in pretty good shape. There was a worry along about that time, that all of the samples shouldn't be in one basket. So curation prepared for a remote storage facility, which at that time was going to be at Brooks Air Force Base in San Antonio [Texas]. In the meantime, while all that was being set up and deliberately planned, there were temporary storage places onsite called interim storage. Samples were packed in a certain way. I supplied some of the packaging.

ROSS-NAZZAL: Were you involved at all in that move to take some of the samples and take them out to San Antonio out at Brooks?

ALLTON: Mostly an observer. Curators got a Greyhound [Lines, Inc.] bus whose vibration characteristics were less than any other bus they could find. They took out all the seats and strapped the isopods containing samples in with seatbelts. My husband, Charles S. Allton, provided the engineering support securing the isopods in the bus. Sometimes I found out things through him.

ROSS-NAZZAL: That's funny. I didn't know about the Greyhound bus, that's pretty interesting.

ALLTON: They drove in the dark of night at thirty-five miles an hour so they wouldn't jostle the samples, with a security escort.

ROSS-NAZZAL: Thirty-five miles an hour. You all knew that was happening, but they didn't make that announcement at the Center, I imagine.

ALLTON: Right.

ROSS-NAZZAL: That's interesting. So you primarily were just doing research during these days.

ALLTON: What would I have been doing? I was probably doing core samples.

ROSS-NAZZAL: Still exciting work, I think. After you were a research analyst for a few years, you became a senior research analyst. I was curious if your role changed at all in any way or you just sort of continued—it was just a promotion, a change in salary, things of that nature.

ALLTON: The change in position titles reflects longevity of a willingness to work wherever needed, I think. Perhaps an enthusiasm for all projects. I'm just an ordinary person, but I was lucky enough to be able to spend a lot of extra time researching topics related to good curation, learning how to use Datatrieve [software] to compile sample statistics, collect documents and study photographs while compiling the Apollo geology sampling tool catalog, which is much used today by the young generation engineers designing tools for our future lunar missions.

ROSS-NAZZAL: You have an archive of all the materials that you have over in Building 31 and records related to the building and hardware and all those things?

ALLTON: Yes. Hardware that was built for us through the engineers here onsite—of course they had JSC engineering drawings, and we still need to get those from drawing control. We had a stash of paper blueprints, but you know what happens to those with time. So our person who's currently the archivist tracks those things, and we get copies of our hardware. Because we haven't done a core in a long time, we might need to reconstruct some to open the last cores. I hope we know where we put that core equipment, because it's been a long time since that equipment was put in storage. But we have copies of the engineering drawings, so equipment could be re-generated.

Our archive has copies of many LRL images, but originals for would be the JSC photo library. Not all those images are online. Our archivist orders the electronic image files that we need for historical purposes. An example would be the images taken as the Apollo 14 sample box was packed for flight. Click, click, put something in, take pictures. People will be interested in how that box was packed. I think the record is in the pictures, although there are a lot of written records as well.

So what do we have that's original? In the vault—there's a data vault—are audio tapes. They're from the early Apollo days. We did have a discussion, the archivists and I did, about how can we recover what's on them. I don't know if you can play them anymore. The audiotape's about that wide [demonstrates]. So there is a resource there.

I would need to check with Debra [L. Baxter] because I know we talked with folks over the years what should we do with these. I don't think there's transcripts of all those; I think they're real early conversations in the LRL. A lot of the kinescopes from the surface, we had those reels. Other people have taken those and made them into VHS [Video Home System] tapes. We shouldn't be the primary repository of that data either, but we do have that.

What we do have that is unique is the data packs for all the processing done on the rocks. "What did it weigh when you started? What did it weigh when you finished?" When you do a rock, you put an orientation cube with it. So if this piece got taken off early on, and forty years later somebody wants a piece right next to it, we can do that. You can do that with big rocks. You can't do that with soil. There's many linear feet in a fireproof vault. In addition to the datapacks for each numbered lunar sample, we have the Lunar Receiving Lab logbooks where the techs would log in actions associated with the vacuum chamber and sample gloveboxes. For example, the techs logged the time the Apollo 11 ALSRC was placed into the vacuum glovebox and what time they opened it.

ROSS-NAZZAL: That's fascinating. So is that something that you would do when you would handle samples? You would log those sort of things when you took a sample, were looking at it, or even the core? Were you writing all that?

ALLTON: That information is in the sample data packs. You asked about taking my hands out of the glove box to write. I'm left-handed for writing. I can do a many sample handling actions with either hand, and it helped. Yes, I took many pictures of core dissection. Back when I was doing that, we took images using 4x5 cut film which had to be sent to Building 8 for film processing before we could see if the image was good. We could also take 4x5 black and white Polaroid images, and it was these that we made notations with Sharpie markers.

ROSS-NAZZAL: One of the things that I had read was that for a period of time you didn't open any cores, for about six years. I was curious why that was the case. Was that a policy decision? Or there was just no need to open those cores for a while?

ALLTON: I'm thinking—I would have to look at what you read. About the time Ronald [W.] Reagan became president, they started cutting the budget. A lot of thought was given to mothballing certain activities. I think that might be the time period you're talking about. People decided they would not keep opening cores at that rate. That's the only thing I can think that happened. We did have a staff reduction back then.

ROSS-NAZZAL: It's a shame. You talked about slabbing breccias for creating new samples. I thought that that was fascinating. If you could talk about that. What does that entail, and how do you create a new sample?

ALLTON: It's like raisin bread. Breccias are rocks that contain small clasts of precursor rocks, like raisins in bread or fruit in fruitcake. Some of the lunar rocks made by impact have fragments of precursor rocks. If you hit something with a high-speed projectile, like the meteors that hit the Moon, you're going to break the rock, you're going to melt the rock, you're going to vaporize the rock. The pieces get flung far and wide, but some get glued together by molten rock. Over many generations of that, you end up with a rock that's full of pieces that could be from near and far. The rock is not homogeneous. There could be a valuable piece hiding in the interior of a breccia.

All of the large rocks have been photographed and described for characterization purposes. If you took a slice off the end of a large breccia, like slicing bread, you would expose new material, perhaps a clast type never seen before. So it's like a new sample. When we slice a breccia exposing new clasts, we publish the pictures and optical description by a trained observer so researchers would be informed of sample availability. If someone requested a clast, and the request was approved, the clast could be extracted from the slab of rock that was creating by sawing the slice.

We may not have to do that so much anymore because now we've got a micro-CT [computed tomography] scanner. A rock can be imaged and the result is three-dimensional x-ray with chemistry, so we'll be able to see where the pieces are inside of a big rock. We might not have to slice so many.

ROSS-NAZZAL: That's amazing.

ALLTON: Now they did x-ray the soil cores in the early days to see if they were full of rocks, but they were fuzzy images on the early ones. Later ones got a little better. But even so, when you collect a core on the Moon and you tamp down the top so it doesn't slide around, and you bring it back, it gets jostled a bit. The main thing is when it sits sideways on the shelf it just sort of settles on the end. There is not gross distortion, but it's obviously not exactly like it was on the Moon.

ROSS-NAZZAL: How did you account for that when you were going through those core samples?

ALLTON: We took better x-rays on those larger cores from the last three missions. Small void space is often visible on the ends. When the soil is pushed out of the tubes, the void space fills in. We just had to be aware that the ends might have been a little bit distorted.

After the soil is pushed into the receptacle, the fused quartz top is removed and the exposed outer one mm of soil is scraped away to remove the soil that came in contact with the anodized aluminum tube wall. Anodization process is dirty, relatively speaking, and traces of contamination were detectable in that outer 1 mm, so we'd take that off. Then we would dig through the core in half-centimeter increments and place each subsample into a separate container.

Subsamples were described with the depth from the top of the core. Finally, a lengthwise portion soil of the entire depth profile remained in the receptacle, and this material was removed from the nitrogen glovebox and taken to laboratory where the material is preserved in epoxy, some of which is prepared as thin sections.

ROSS-NAZZAL: Sounds like a lot of work.

ALLTON: Hence all those procedures for extrusion, dissection, epoxy preservation, thin section preparation. The procedures were annotated as executed. We had a reader and a doer.

ROSS-NAZZAL: How many people were working with you on those?

ALLTON: When we did an extrusion, or any of these specialized things, about three people.

ROSS-NAZZAL: How long did that take?

ALLTON: I think some cores might have been done in a couple months. I was slower than everybody else, but I probably ran longer than three months on some of them.

ROSS-NAZZAL: Just enjoyed playing around with them and seeing and enjoying what was in there?

ALLTON: It was a bit tedious physically, too. I'm not going to shovel soil out of the tube really fast. That's just not what you do.

ROSS-NAZZAL: It seems like it's a very detailed process.

ALLTON: It is and very controlled. For those you pretty much know exactly what was done.

ROSS-NAZZAL: Were you sharing what you were learning as you were going through these cores? On a daily basis were you sharing with the curator, "This is what I found"? Would he come by and take a look, or were they just waiting until you finished and you gave a report?

ALLTON: Mostly they were waiting until I finished. But every once in a while I would find something really cool and then get somebody to come in and look at it.

ROSS-NAZZAL: What were some of those really cool moments, or really cool things that you found?

ALLTON: The thing that comes to mind is something somebody else found. It was a glass bubble that was hollow that was this big [demonstrates] in an Apollo 17 core. It had enough metal in the glass, it looked like metallic glass. That was a little odd.

ROSS-NAZZAL: Were you speculating on what that could be?

ALLTON: Yes, I don't remember what the outcome was. I don't think it was something that changed a lot.

ROSS-NAZZAL: You had been there for a while and then you got promoted to a management position where you were overseeing about ten folks and a clerk. I was curious how you made that change from a researcher into more of a manager, and what you did to prepare yourself for that kind of role.

ALLTON: My basic answer is I don't recall, but I do know it was a change of pace. I decided I couldn't really concentrate on science kind of things or contamination control kind of things if I were to follow that many people and keep up with what they were doing. So I did change how I approached that project. I don't think it lasted that long. One of the people I supervised later supervised me, that kind of thing. We'd both been there since '73 and '74. It just helps when you have people that know a many useful skills.

ROSS-NAZZAL: I guess you work independently quite a bit in that lab, I would think.

ALLTON: Doing cores, yes.

ROSS-NAZZAL: You mentioned earlier about the conference that you went to where there was a discussion in the women's restroom. Are there other conferences that you would attend over the years where you recall any interesting events or moments, or some interesting discoveries that stand out in your mind, or maybe a presentation that you gave?

ALLTON: Let me just say that the Lunar and Planetary Science Conference is key to everybody that works in curation. Generally, curation presentations are not research science, but they document the samples and the background and the handling that the science guys need to know if they're trying to interpret their data. We go because we need to understand what their needs are, what they consider as contaminants in their samples. We're trying to preserve samples so good science can be done. I'm a big advocate of everybody that's involved in curation understands the science that they're supporting, as opposed to just reading procedures.

I think that's paid off over the long term in the LRL in the contractor people. At first in the LRL technicians performed the work in the glove boxes. The LRL science observers were generally some of the outside scientists. They would just stand and watch; they didn't put their hands in the glove. By the time I got there post-LRL in 1974, the people that were working hands in the gloveboxes with the samples were people with master's degrees in geology or chemistry. So they were changing over from a procedure and tech-driven sample handling to more science-knowledge sample handling. Some of the techs acquired excellent science knowledge and had more common sense than the scientists, but that was one change in designation of sample handling personnel education requirements.

ROSS-NAZZAL: I find that interesting that you said that lunar curation is not science. I often equate it with science. Can you explain that a little more? It's just documenting, just keeping those samples available for researchers at universities and other labs across the country?

ALLTON: I was speaking of competitive science. Most of the people we prepare samples for compete on proposals for proposal funding to answer a science question. Many people in the curation staff also do that. I don't, but I'm the odd person out. I pay more attention to contamination control and lab operation. These responsibilities require science knowledge and are important in sample preservation. The other curators have their own narrowly focused research goals and proposals. My interests are broader, and sometimes I make connections between collections that are beneficial. Papers detailing curation handling of samples are important to science interpretation.

ROSS-NAZZAL: Okay.

ALLTON: The people that make the science conclusions need to know all that background material. We put out the catalogs for many of the collections. Genesis, for instance, we try and write abstracts every year that describe how we handle the samples, or what we're doing. That would not be something that would make a publication in a peer-reviewed journal.

ROSS-NAZZAL: I see.

ALLTON: But it's helpful. Besides, if it's an abstract, then I can always know where to find it. I don't have to worry about it getting lost on an archive shelf. That works out nicely.

ROSS-NAZZAL: You've written quite a bit on lunar samples and the cores over the years. You've been going to the Lunar and Planetary Conferences for years. Have things changed in terms of the way people are using these samples and what we're learning about the Moon, maybe even the universe?

ALLTON: There's been some trends. When we prepare to return to the Moon, and we did that for Constellation and are now doing that, there's engineering interest in doing things on the Moon; those folks also need to know characteristics of lunar soil. So there were periods when requests were submitted for lunar samples upon which to do technology experiments. Making concrete from lunar soil, extracting propellant, and assessing health hazard are examples.

The curator and the advisory committee have primary responsibility to preserve samples for planetary science and historically have been stingy when allocating lunar samples. Yet these people are uniquely qualified to judge the varying science value of different samples. Historically, very small amounts of low-science-value specimens have been allocated—very sparingly—and there is not agreement on policy. Examples of a lower science value sample would be dust remaining in a transfer bag or a returned sample exposed to the environment. One big difference is the amount of lunar sample required for a science versus an engineering experiment. A typical lunar sample investigator is used to using, I don't know, fifty milligrams, but a guy who wants to do an engineering study is thinking in kilograms. That's a mismatch.

Two things happened to address this issue. One, for special engineering requests, a few people with engineering expertise were included in committee deliberations. And two, technology people were required to have done some work on a simulant for the purpose of reducing the amount of sample needed and also demonstrate that what they were doing, from the engineering standpoint, would actually require a lunar sample. The simulant requirement stimulated the lunar simulant production efforts.

The other trend would be people that want to do microbiology on the samples. That's a planetary protection interest. But at this point, what microbes would be in there after forty years of being handled? Clean is not the same thing as sterile.

ROSS-NAZZAL: All these terms I've never given that much thought to, but I guess I do equate certain things. You mentioned the lunar simulant, which you were involved in, JSC-1, and was it JSC-1A? Can you talk about that and why they were created? What the purpose was behind them?

ALLTON: I think I talked about lunar simulant in a paper in Wendell [W. Mendell]'s book on lunar bases [*Lunar Bases and Space Activities of the 21st Century*]. Why did I do that? I tried to write what characteristics a simulant needs to have, and this was early in the times people started thinking about simulant. That's because I had spent all that time digging in real lunar dirt and understood the effects of electrostatic charging and agglutinate physical properties. I think that was the outcome of that. Also, I wanted to emphasize the surface changes on lunar grains due to solar wind and micrometeorite impacts. These changes affect chemical reactivity, and these changes are not reproducible in simulants on even a modest scale.

The other thing that I can recall—when they were looking for larger volumes of simulant, especially to support the engineering studies, Charlie [Charles S. Allton] and I were on vacation in Arizona near Sunset Craters [Volcano National Monument]. One of my USGS colleagues suggested Merriam Crater when I asked about basaltic composition volcanic cinder sources.

So Charlie and I drove to Merriam Crater and talked to the guys running the bulldozers and brought back samples. I did a little bit with finding out how we could get the stuff sieved to small grain size. The good thing about that material was tiny vesicles in the volcanic glass. When broken, it has sharp little edges like the agglutinates that really form in lunar soil. The chemistry is grossly right.

One problem from a large-scale production if simulant is that the average grain size of lunar soil is about seventy microns, which is pretty fine. Getting material sieved that fine, that is not as easy as one would think. Carlton Allen stepped in and facilitated involvement of James [L.] Carter in UT [University of Texas] Dallas. They got involved in actually doing the logistics to make it work and getting funding to do all that. It came from this crater out in Arizona.

ROSS-NAZZAL: That's fascinating. I thought it was interesting, I'd never heard of a lunar soil simulant before. I wonder if you would talk about technology and how technology has changed since you worked out at the lab. I imagine when you first started working there, computers were very large, if you used them at all. You mentioned those magnetic tapes. Maybe you could talk about the database that you used, and how that's evolved over time.

ALLTON: You're right, technology has changed a lot. The original lunar inventories were on seven- or eight-track tapes like that [demonstrates]. I don't know if those can now be read. They're a little later tape than the old LRL audiotapes somebody recorded.

I'm thinking when I first started working there they were still using punch cards and maybe Fortran taken to Building 12, but I'm not sure. Subsequently, the curation computer was in a room and the programming was Datatrieve. I could actually figure out enough to pull up data for different sample sizes. I spent some time figuring out the size distribution they raked up on the different missions and such like that, because I thought that was a science question.

When we went to individual workstations, I could not keep up with programming. When we started adding meteorites, and cosmic dust was probably next, we had: lunar, meteorite, cosmic dust, Genesis, Stardust, Hayabusa, microparticle. We've got seven right now.

What we want is all of those databases to be on the same platform so the same IT [information technology] people don't have seven different systems. Transitioning to a common platform is a work in progress. Genesis is an outlier because ours is done by a different group onsite. That was an experiment in contracting out the database.

ROSS-NAZZAL: I can imagine.

ALLTON: It's worked well for us. In the end it needs to all go back together. People consistently underestimate the resources it takes to track all that stuff. Everybody seems to think it's so easy.

ROSS-NAZZAL: I think people tend to underestimate a lot of things. They think something's going to be very easy, but you have to plan and think about users in the future and all those things.

ALLTON: You reminded me that the new thinking is to put more sample data online, including analytical results. That is an overwhelming task.

ROSS-NAZZAL: That's the way everyone is moving these days, everything online, everything accessible. One of the articles that I had taken a look at, and I thought was interesting was your study of Apollo tools and containers. Why was that study undertaken at that point?

ALLTON: I was doing a stint as archivist then, and I'm a lousy archivist. I'm not organized, but I did realize that some of the stellar lunar scientists were getting old and retiring and passing away. So about that time that person who was curator, who asked me to be the archivist, wanted me to write that tool catalog.

That was fun. Most of that catalog was done from sample datapack research and lunar surface photographs because the flight manifests did not list items inside of outer containers. It was geological sampling tools and containers because I wanted to capture the material composition, how it was finished, because that information is essential to knowing what contaminants might be in samples. I also had access to the drawings, so I could look up the specific compounds and alloys and make estimates of the volume and the weight that was on some of the packing list.

That catalog was used more than I ever thought. Because about the time I finished, five or ten years later, they started the Constellation [Program], to go back to the Moon. We had a whole new generation of young engineers who had not made or flown any Apollo hardware. They wanted to know the weight, volume, how you do those things, the boxes, and the core tubes. So the catalog was used by a lot of people; it still is I think. One day I got a call from [Astronaut] Alan [L.] Bean, he wanted a copy.

ROSS-NAZZAL: Oh, isn't that nice?

ALLTON: I thought, "Yes, sir, I can send you one." He was wanting it for his painting.

ROSS-NAZZAL: I can imagine that would be really helpful. That's really nice. I think I used it in December. I got a call from the Legal Office when the Neil [A.] Armstrong—that [lunar sample return] bag showed up. That was an interesting one.

ALLTON: Not in my catalog, I swear I did not find that. I had not seen one like that. I searched through our archives. We asked everybody who was around back in those days. My husband Charlie works in Crew Systems. He and a colleague went through the closets in the soft goods, spent several hours. "No, we don't have anything like that." So I said, "I don't think that's genuine lar bag."

But then they did the last thing. They did a tape pull, put that in the SEM, and there was lunar grains on it. One of our young guys, I'm so proud of him. He went and dug up the photographic documentation for that.

ROSS-NAZZAL: Oh, good.

ALLTON: Kind of bad the way that turned out in court. But I felt like we've got a new generation of somebody who likes digging in old records and learning this history.

ROSS-NAZZAL: How did you get picked to be the archivist? Is that a position that you take turns doing over there?

ALLTON: I think I was the first one. The curator just gave me a fancy title, and I took it.

ROSS-NAZZAL: It sounds like an interesting job.

ALLTON: It was, because I got to look through all those Lunar Receiving Lab records. I think I got it because they didn't have anything else to do with me. I had been working on a flight instrument for Jim [James L.] Gooding and that ran out of money. I wasn't doing curation that much at that time, but once I went around talking to people I discovered such a gold mine of stories.

ROSS-NAZZAL: Yes, we've got to figure out how we can collaborate together on those interviews. Maybe we can make them accessible, see about getting some of them transcribed. Even the cafeteria one.

ALLTON: I'd like to do that. I made a list of some people I talked to.

ROSS-NAZZAL: That can be something that we could look at and see if that were a possibility. Be nice to make them available, because I'm sure there's some great information in there.

ALLTON: I didn't ask good questions like you did. They rose to the occasion. The interviewees certainly recognized the historic importance of their participation and told me great stories with similar themes.

ROSS-NAZZAL: Hey, that's great, and they're not around for us to talk to. That would be a good partnership. We'll have to talk more about that, I think that'd be good. You also worked on some parts of the Solar Max [Maximum Mission] satellite, which I thought was interesting.

ALLTON: Yes.

ROSS-NAZZAL: How did you get involved in that? That's a little different than lunar curating.

ALLTON: We curated the blankets from Solar Max. They were scanning the microcrater populations. Herb [Herbert A.] Zook was the PI on that and the tech was Jack [L.] Warren. It was kind of a tech job of scanning. I just did the logistics stuff; I think I drafted the paper.

ROSS-NAZZAL: You were the main writer on that.

ALLTON: Oh, really? It was a documentation really, of a survey. Herb put the science in it—what the populations were based on our crater counts and the direction that the blankets were facing, what that told us about orbital debris population in orbit. We curate those pieces. We've got items from several things that spent time in space, and they collected micrometeorite impacts. In some of those you can get the chemistry of the impactor, so it gives you a feel for the identity of the source population. Not all of it is orbital debris. Some of it is micrometeorites.

Think we have Palapa and Westar blankets. We might have Mir. I haven't done that in a long time so I've kind of lost track. We had Genesis and Stardust capsules. The Stardust capsule is at the Smithsonian, and the Genesis capsule is still at JSC but not very presentable after the crash.

ROSS-NAZZAL: I think those would be interesting to talk about. You got involved at some point working on the Mars Rover Sample Return project. How did you get involved in that effort?

ALLTON: That was a 1980s effort, as I recall. You mentioned JPL. If I were going to speak about JPL, the interactions during Genesis would be more meaningful to me. I attended MRSR [Mars

Rover and Sample Return] meetings from the curation point of view, when they talked about "What kind of samples do you want and how do you get it back?" Since I was familiar with the drills used on the Moon; drills and sample containers was the expertise I contributed to that discussion.

As I recall, JPL had some advanced technology money. We tried to figure out how dust interfered with container seals here for one project. They also had two big contractors, Lockheed Martin [Corp.] was one and TRW [Inc.] was another. They had different suggestions for what the spacecraft should consist of. I tried to keep all those notes. We should have a lot of that in our archive. They're not totally complete. They're what people had in their office, and we just scarfed up when they retired.

ROSS-NAZZAL: Still valuable though, as you know, being the archivist over there.

ALLTON: Yes. We'd have a fair start if you wanted to do the history of Mars Rover Sample Return. Mars sample return has been in work for—that was in the 1980s I think when I did that. It was my first look at watching engineers and scientists work together. That's probably the most interesting thing that needs to be solved in return.

ROSS-NAZZAL: Can you elaborate on that?

ALLTON: MRSR, that was a fairly congenial group. That was my first look at the engineers saying, "Well, what are the requirements? We can design anything. What are the requirements? What do you require this piece of hardware to do?" Scientists often have difficulty setting a practical requirement, especially when they need to make cutting-edge measurements.

Somewhere in the middle is an optimum compromise. The more complex spacecraft mechanisms, the more risk it will not work reliably—reliability versus returning a sample that's worth analyzing. That's always an interesting dance of watching how they arrive at something in the middle. At least the science people tend to stake out very rigorous conditions. I guess it's just a bargaining point. I wasn't used to that.

ROSS-NAZZAL: Was that the case with the Mars Rover Sample Return?

ALLTON: Yes. I did put in my two cents' worth. They started to define a Mars rover of a Volkswagen variety, but it grew into a Cadillac and got too expensive, so no rover was built for MRSR. That's the basic story there.

ROSS-NAZZAL: You also, I had read, worked on packaging of Martian samples. You had worked with lunar samples. What impact did that have on your decision about what you can do with Martian samples and how they should be packaged and handled?

ALLTON: Oh, that's a bit tricky, because the Martian samples we do have, the meteorites, I have not personally worked with. And the meteorites that come from Antarctica are not handled quite as rigorously as lunar samples, because they've already fallen on the Earth.

ROSS-NAZZAL: You came up with a brochure for handling these samples.

ALLTON: I sent that out. Yes, there's a packaging industry, and I was plugged into them. I thought, "Well, I'll just ask their leaders what we should do," and I got lots of suggestions. That's back when we were looking at your soda can thing, what it takes to seal a soda can. It can hold ninety psi [pounds per square inch] pressure, which is quite a lot for not much weight. I got a number of replies that were very creative, but that's all I did with that. The curator was aware of it. We didn't make any PR [public relations] thing out of it. It was generally people who found that an interesting intellectual challenge. They had an idea, and they'd draw it up. It wasn't high-paid graphics. It was people sitting down with pencil and paper.

ROSS-NAZZAL: It sounded like you were getting a step further, "How are we going to do this?" The next step, if we're going to get samples and bring them back.

ALLTON: I'm trying to recall what some of them were. They had to do with canning, was one of them. They were certainly worth looking at. I probably have those somewhere.

ROSS-NAZZAL: When you retire, you'll have to go through your records and donate those or keep them with the collection over in Building 31. I wanted to ask you a little bit more about those interviews that you did with some of the planetary scientists. Do you remember some of the people you interviewed?

ALLTON: I wrote that down. I looked that up today. Where'd I put them?

ROSS-NAZZAL: I was curious who some of those folks might be.

ALLTON: Down here at the bottom. There are several. I went around with my own tape recorder. I talked to these people. Elbert [A.] King [Jr.] was done. Joe [Joseph N.] Tatarewicz was in town. Do you know him?

ROSS-NAZZAL: No, that name doesn't ring a bell.

ALLTON: He's more of an official historian. I think he lives in Silver Spring, Maryland. He wrote [*Exploring the Solar System: The Planetary Sciences Since Galileo*]. That was my first experience with a professional recorder of stories. He came by, talked to somebody, and I said, "Oh, I know him, let's go talk to him together."

We interviewed Elbert King. I think I have a couple transcripts from this that he had done and shared. We were both recording it. I had my own notes, and his was high quality. But that's not all. I think it might only be Elbert King and maybe Jerry [Gerald J.] Wasserburg. I'll have to look.

John [R.] Bagby [Jr.] is interesting. He was the head of the Interagency Committee on Back Contamination, back when they were arguing over whether the Lunar Receiving Lab had to contain things or not. The head of the Public Health Service was David [J.] Sencer; Bagby was the deputy and the spokesperson, so when I met him we collaborated on an LRL paper in '96. I had forgotten I talked to him. These are folks which I have transcripts of a couple tapes of some, and there's three extra tapes I haven't figured out who they are.

Richard [S.] Johnston and Rich [Richard A.] Wright, I don't know if I can find that. I do have notes. That was 1993. These people were part of a storytelling effort where my friend Kay [W.] Tobola who got me into storytelling—she was a NASA education person. They hired a professional storyteller to come sit and interview these people. So there's video of these taken by Jacobs [Engineering Group, Inc.].

It's in a format that may or may not be so useful, but I do have transcripts of David [S.] McKay, Don [Donald D.] Bogard, who has some of the most interesting stories. That's where I got a lot of good ones from. Jack Warren was the tech that opened the first Apollo rock box. I'd known him for years. He retired back three or four years ago. I have him on a tape too, but you guys interviewed him as well.

ROSS-NAZZAL: Yes, we've interviewed him.

ALLTON: Everett [K.] Gibson, Gary [E.] Lofgren. I was just a test subject to test out the process.

ROSS-NAZZAL: That's quite a lot. There's some good history of the materials and the folks working up there, that's great.

ALLTON: I was hoping Beth Horner could take that and tell stories that would really be effectively told. I think somehow or other the contract she had with Jacobs didn't allow her to do that with them, which is odd. And Kay didn't get releases from these people.

ROSS-NAZZAL: Ah, that could be a challenge.

ALLTON: I'm not sure I did either back in '93. So I don't know if that can be worked retroactively or not. They exist, so people could—my view is they could come to the archives and do what they wanted to with them.

ROSS-NAZZAL: I'd have to investigate that, but I'm sure we could figure something out.

ALLTON: By the time we did these, I knew we needed releases, but I just couldn't be persuasive enough to get that done. David McKay has passed away, but his widow is still living.

ROSS-NAZZAL: I'm sure that you could probably ask the family for a release. We'll have to figure that out. It'd be nice if you could release some of that work that you've done. I'm sure there's a lot of good detail that people don't know much about.

ALLTON: Yes. Bogard's stories are good. You've talked to Everett, you know his stories are all good.

ROSS-NAZZAL: I think everyone's interesting when we sit down and talk with them. They've all got good information, good stories.

ALLTON: Bogard told me the Ross Taylor story, and that he was in the Gas Analysis Lab. How they could figure out the rocks were old. Going into that, I put together a story I have told to storytelling groups. That when the Moon rocks arrived at the LRL, Harold [C.] Urey and Gene

[Eugene M.] Shoemaker were there. Harold Urey had predicted Moon rocks to be old, Gene Shoemaker thought they would be young and volcanic. The rock box was opened, and some rocks looked volcanic, so Harold Urey went home.

Then when Ross Taylor and the people in the Gas Analysis Lab fessed up to the LSAPT committee, that they could calculate the rocks were old, and they weren't supposed to do that. Somebody ran out of the LSAPT room to telephone Urey and said, "Harold, come back, they're old." I mean who knows how true that is, but I think the tone of the whole story probably is.

ROSS-NAZZAL: I'm sure there was a lot of competition between scientists at that point. It's interesting. We have a few minutes. I wanted to ask you about your own research. You've done some historical research. You've written about *The Little White Church on NASA Road 1* [*From Rice Farmers to Astronauts, A Centennial History, 1893-1993*]. What interested you in writing that book, and then also interweaving some NASA history with the church history?

ALLTON: The first one is easy. It was the hundredth anniversary of that church. So we thought "Well, we'll write the history." We interviewed older people in the church, and they all told great stories. The other thing is [Astronauts] John [H.] Glenn [Jr.], Buzz Aldrin went to that church, Jerry [Gerald P.] Carr. So a lot of members of the church were actively involved in the space program, and they shared their stories, especially Buzz's story about Communion on the Moon.

What role does a religious base form in exploration? That was a little lunar community church thing. Was not really a theological article, it was cultural. "How do you tie back to the culture you came from?" A lot of people I would—this is guesswork on my part—under stress and isolation like space travel, might find comfort in religious and cultural ties to their homeland. That was the driver for making those connections and then using the stories I had at hand.

The [Charles A.] Murray and [Catherine B.] Cox book [*Apollo: Race to the Moon*], which quotes a lot of people from our church.

ROSS-NAZZAL: It's a great book.

ALLTON: Dick [Richard H.] Koos sat down and wrote a piece to glue in the copy that's in our church library. He talked about the role, just being able to sit in Sunday services and have a period to reflect, which allowed him to come to grips with some of the hard decisions that had been discussed or argued over the previous week. So I thought that that might have been the case with many of the people that were making Apollo decisions, not just astronauts. I thought maybe there was a role.

ROSS-NAZZAL: I thought it was an interesting article, giving some thought about that.

ALLTON: Wendell got somebody in sociology to review it before he put it in his book.

ROSS-NAZZAL: I wonder if you want to review your notes and see if there's anything we haven't talked about, or if there's something more you think we should talk about in terms of the lunar curation and your involvement and maybe processes or procedures. I know I wanted to come back and talk to you about Genesis, and now I know I need to ask you about Stardust as well.

ALLTON: No, most of these were tagged from what you asked here. The only thing that I thought of—I thought back over the time I worked here, "What did I come away learning in terms of what advice would I give for future efforts?" So I collected some thoughts on that.

ROSS-NAZZAL: Do you want to share those now? Or would you like to talk about those the next time we come?

ALLTON: It's kind of long, let's see. Discussing things now, the advantages of sample return are many. If I could advertise something, that would be it, because it lets more people be involved in making analytical measurements and participating in the science. With more people with different ideas and different instruments, you can confirm science results or refute them. This is better science. You can't do that very well robotically or in situ. You need samples here. Socially, it's just good to involve more people in participating in this exploration.

You get state-of-the-art instruments, you can do complex sample preparation. I guess the main thing is you can recover from mess-ups like the Genesis crash. So sample return is very important. I'm not the only one that says that, but if I had a free soapbox that's what I would talk about.

ROSS-NAZZAL: Those are important, and you know because you worked with them on a regular basis. I thank you for coming by today, and I will send you an e-mail about getting together again to talk about Genesis and Stardust.

ALLTON: If you want the names of the people I have that.

ROSS-NAZZAL: Yes, I will.

[End of interview]