**AirSpace Transcript Season 9 Episode 7: Lasso the Moon**

**Emily:** Would it surprise you to find out that I don't have a rock collection?

**Matt:** You're pretty unique among geologists, I think, for that.

**Emily:** I know. Well, I was, it's because I started studying space geology before I started studying Earth geology. I think that's what it is. And since I'm not allowed to own any Moon rocks, like what am I supposed to have in my collection?

**Matt:** Yeah, what's the point?

**Emily:** What's the point?

*AirSpace theme in and under*

**Matt:** Welcome to AirSpace from the Smithsonian's National Air and Space Museum. I'm Matt.

**Emily:** And I'm Emily. From 1969 to 1972, six Apollo missions brought home a total of 842 pounds of Moon rocks and lunar soil.

**Matt:** Some of those samples remain in isolated storage still today, but a lot of samples have been loaned out for science or display, and some were even given away as diplomatic gifts.

**Emily:** Today on AirSpace, we're talking about who gets to use those Moon rocks and what for.

**Matt:** And we're taking you on a field trip with us to visit one of the most uniquely displayed Moon rocks on Earth.

*AirSpace theme up and out*

**Emily:** I feel like when we talk about Moon rocks, it seems like we have a lot of Moon rocks, but there's no such thing as too many Moon rocks, right?

**Matt:** I mean, I guess there is probably a finite number of Moon rocks, Since the Moon is a thing with a specific mass and shape and size. But, yeah, you're right. You can never have too many Moon rocks.

**Emily:** So we have Moon rocks from two different sources. One is, sort of, forces of nature, right? We get Moon rocks, um, in the form of meteorites falling to the surface of the Earth. Um, but the Moon rocks we're mostly talking about today are Moon rocks that were returned by the Apollo missions.

And there were six of the Apollo missions[1] that actually brought Lunar samples back here to Earth.

**Matt:** Right, and some people might be wondering, wait, but you have Apollo 11 through Apollo 17, you know, how are there only six missions that brought back Moon rocks? But don't forget, Apollo 13[2], which we've covered on this show a couple of times, didn't actually make it to the Moon's surface. So yeah, we have six missions that brought back Moon rocks from different parts of the Moon.

**Emily:** So Apollo 11 was the first landing on the Moon by humans, and they brought back 48 pounds of Moon rocks. And I think it's a really interesting comparison between that and the later missions like Apollo 16 and 17, which brought back 210 and 243 pounds of rocks, respectively.

And I'm just gonna go ahead and make sure we shout out the fact that Apollo 17 had the first geologist astronaut[3], right? I mean, all astronauts were very well trained in geological sciences and geological fieldwork, but we finally sent a geologist in Apollo 17, and I'm gonna go ahead and say that's part of why we brought back so many rocks

**Matt:** That's definitely a big part of why. Also, you know, in those later Apollo missions, NASA got more confident about how much weight they could actually add to the spacecraft when it was returning. And remember, from Apollos 15 through 17, they also left a pretty big lunar roving vehicle[4] on the surface of the Moon, so they had some extra space basically to bring those rocks and the confidence that the engineers needed to say okay bring hundreds of pounds of Moon rocks back.

**Emily:** Well, and those lunar rovers, I don't know why in my head they're called buggies, but in my head their called buggies

**Matt**: They look like dune buggies a little bit

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[1] https://curator.jsc.nasa.gov/lunar/
[2] https://www.nasa.gov/missions/apollo/apollo-13-mission-details/
[3] https://www.nasa.gov/former-astronaut-harrison-schmitt/
[4] https://airandspace.si.edu/collection-objects/lunar-roving-vehicle-qualification-test-unit/nasm_A19760746000

**Emily:** They look like dune buggies, but those vehicles really allowed astronauts to move much further away from their landing site. And so they were not only being able to collect more rocks, because they could load them up into the buggy, rover, sorry, but they could also collect a much broader variety of samples from a lot of different other places on the surface that you wouldn't have been able to reach from, say, Apollo 11[5].

But when all the samples were brought back down to Earth. They were brought to the Lunar Receiving Lab[6] at the Johnson Space Center in Houston, which is still the place where the samples are held today.

**Ryan:** Well, I'm Dr. Ryan Ziegler[7]. I'm the Lunar Sample Curator here at NASA Johnson Space Center in Houston, Texas. Uh, I've been here for about the last, almost 13 years now. I always want to talk about Moon rocks. *laughs*

**Matt:** And keep in mind right it's a very specialized facility that was designed so that those lunar samples could be brought back from the Moon in their sealed containers and then be processed in a facility where they would not touch terrestrial air or any water or anything that could corrupt those samples.

We're talking about, you know, these airtight glove boxes where people handled the rocks and sort of characterized them, classified them and preserved them for storage.

**Ryan:** If we do it by mass, we have about 83 percent of the material left by mass. If you think about the collection as a whole over the last 55 years, we've used about 5 or 6 percent that are in museums. So they're not lost to science, but they have been used for something else, at least for now.

Another 5 percent or so have been used and completely destroyed as part of the analytical process. And then 5 or 6 percent is actively being studied or has been studied and returned to us. So we actually have more than the 83%.

We have maybe closer to 90 percent physically existing on Earth. But a fair fraction of that has been heavily altered by the process to study them. So, we do try to reuse samples, if we can. But that's not always appropriate, just depends on the study.

**Emily:** In addition to receiving, processing and preserving the Moon rocks, Johnson Space Center has a lot of other work to do in terms of deciding who gets samples and for what science

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[5] https://www.skyatnightmagazine.com/space-missions/where-did-the-apollo-astronauts-land-on-the-moon
[6] https://www.nasa.gov/history/building-on-a-mission-the-lunar-receiving-laboratory/
[7] https://ares.jsc.nasa.gov/people/bios/ryan-a-zeigler/

**Matt:** That's right. The lab is really responsible for loaning out samples for science[8]. So, you know, a scientist is never really given a Moon rock to work with. They are loaned a Moon rock. And you have to make a request to NASA and spell out exactly what you're going to do with it, why you need it, and What's the significance of your project? You know, why is it worth using this very precious sample and potentially destroying a little bit of it in the process?

**Ryan:** If you had a great idea, you wanted to request samples, what you would do was you would write up, uh, basically a, um, sample request.

And that sample request would explain what science you want to do, uh, why it's important, that it hasn't been done before, or if it has been done, why your result is going to be better than the previous results.

Once we get that request we send it out and it gets reviewed by a panel of experts outside of NASA. Then they give NASA an opinion on whether they think it's a good use of sample or not. And then NASA takes their advice under advisement and then decides whether or not to loan the samples.

We get about 60 or so requests a year, for between 500 and 600 individual pieces of the Moon. I would say about 75 percent of the requests are ultimately successful. Not in any one year, but if you are told no, you're rarely told, ‘no, go away, we don't ever want to hear from you again.’ You actually get the kind of feedback to make the process better.

**Emily:** And it's a limited resource, right? And so most of these things, even if you're not going to destroy the sample, the way in which you've handled that sample has sort of tainted it away from that-- everybody in the science world calls it pristine, right? You take a pristine sample and you start handling it, even if you're not destroying it, you're changing, fundamentally what you can reuse that sample for.

**Ryan:** So, all of the Apollo samples have been stored in nitrogen since they returned, until we hand them out to a scientist to do work. Once they've gone to a scientist and come back to us, they've almost always been exposed to air or the laboratory, and so the small percentage of returned samples we have are stored in air in a separate vault, so they can't cross contaminate our ‘pristine samples,’ we call them, stuff we understand the exposure history very well.

But the other, the vast majority of samples are stored inside these nitrogen filled glove boxes. They're stainless steel, they're aluminum, they're Teflon. There's only like those

[8] https://curator.jsc.nasa.gov/lunar/sampreq/requests.cfm

three materials that we allow to be around the samples so that we limit the number of things that have contaminated the samples and so that's how they're stored.

**Emily:** So they're very careful about making sure that they've not only supported the science that can only be done with those precious samples, but also making sure that they're preserving those samples for posterity.

**Matt:** Right. And you might wonder how you would do that, right? They're not just putting them in vacuum sealed bags. They're actually putting them into, you know, storage containers that have an inert gas, right? Nitrogen, in them, and that nitrogen will not react with anything that's, you know, in those Moon samples is why they call it inert, but it will also fill up that whole space so that air isn't coming in.

So, you know, they put them in nitrogen. And then they put them in a freezer and they sit there waiting for the right time. And there are some samples that have never been touched, uh, because the idea has always been that, you know, these samples, some of them should be preserved for later dates when new sampling techniques, new science is available, new instruments that could answer new questions about the Moon rocks.

So you don't want to use them all in one go.

**Emily:** Not all in one go. You got to save a little for later[9]

*Music Button*

**Emily:** Studying Moon rocks, I think also feels really niche, right? Why are there all these people spending billions of dollars to study the Moon? And I think what's really underappreciated, and I talked to Ryan about this a lot, which is that learning more about the Moon in a way that you can only do from samples of the Moon, teaches us about the Moon, obviously, but it's also teaching us about Earth and, maybe less well known, teaches us about other planets and things in our solar system and even kind of our place in space.

**Matt:** Right, we live on a very dynamic planet because of plate tectonics and weather and everything else that keeps this planet habitable, which means that there's not a lot preserved on the surface of our planet that tells the story of that deep history of the formation of the Earth, the Moon, and all of the other planets. But the Moon, because it's basically not got all of that dynamic stuff going on, it has its own dynamism, but it's different. The surface is a record of a lot of what's happened over the course of billions of years in our solar system.

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[9] https://www.sciencenews.org/article/nasa-apollo-anniversary-moon-rocks-preservation

**Ryan:** Most people think of studying the Moon rocks to tell us about the Moon, and that's 100 percent true. So, we know how the Earth Moon system formed[10]. They used to be part of the same planet. We learned all that from the Moon rocks, and that's super obvious.

But what we were talking about, like, understanding the ages of other surfaces of other planets, through crater counting. A lot of that comes from or almost all of it comes from the Lunar samples. So, the Apollo samples have taught us something about every planet in our solar system. And it even has told us about the environment our solar system sits in within the galaxy. So understanding how the environment that our, uh, solar system is exposed to in the 250 million years it takes for our solar system to revolve around the center of the Milky Way galaxy.

The best record we have of that right now is in the Apollo samples. It's not great, but because that is recorded on the samples on the surface of the Moon, and where it's not really recorded on Earth or any of the other bodies we've been able to get to and back. So figuring out that Jupiter didn't form where it did, in part because of the Moon rocks, is not something that most people would think that you would ever use a Moon rock for.

And it certainly wasn't the only thing that went into the new models for how the solar system formed, but it was an important constraint.

**Matt:** And, I mean, meteorites are great for that too, to a certain extent, but they get transformed in the process of their entry through our atmosphere and spending however long they spend on the surface of Earth before they're discovered. So Moon rocks really are special in that they are completely untransformed and are pristine from the moment they're taken from the surface of the Moon to the moment that they are used in the laboratory.

**Emily:** And what makes the Lunar samples even more special is that we know exactly where they came from on the surface of the Moon. So you have a lot of context for what that sample, where it was, what it was doing, maybe all the other kinds of things around it. And that really helps us understand those rocks in a way that we can never understand a Lunar meteorite.

Um, but we have a lot of Lunar meteorites, and we have a lot in the collection here at the Smithsonian. And both the Lunar meteorites and the samples returned from Apollo are not just useful for the science that they're doing. They're also really important for

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10 https://www.nhm.ac.uk/discover/how-did-the-moon-form.html#:~:text=The%20fission%20theory%20suggests%20Earth,size%20of%20the%20planet%20Mars.

outreach and to have the public have access to them. And the Smithsonian plays a really big role in that.

And so we wanted to go hang out with our friends over at Natural History because they also have really cool collections and sometimes the nerds like to hang out together. And so we had a chance to go over to the other side of the mall so we could check out the Apollo samples that they have on display and talk to Dr. Cari Corrigan[11].

**Cari:** My name is Cari Corrigan. I'm the curator of Antarctic meteorites and a research geologist who studies meteorites at the Natural History Museum

**Cari:** Alright, so here are our four Moon rocks.

**Emily:** They're like proper rock size rocks. They're big. Like when people talk to you about Moon rocks, and then somebody shows you a Moon rock sample, you're always like, really?

But these are like proper rocks.

**Cari:** Yeah, and so this one's been sliced, so that's not even the whole thing…*fades out*

**Emily:** Matt, have you gone to see the Apollo samples that they have at Natural History recently?

**Matt:** Oh yeah, I've gone over there every opportunity I've gotten to, to see Cari and to get a tour of the, you know, the meteorite collection, which is really amazing. They have a huge collection of meteorites. A lot of folks might think that we would have the meteorites because we're the National Air and Space Museum. But in fact, Natural History has been, you know, one of the primary repositories for meteorites in this country for many years, and so, you know, they do all of the preserving and, um, maintaining of that collection.

You know, we have six Lunar samples on display in the Air and Space Museum those are loaned from NASA and that's not including the touchable Moon rock. But when we actually were, you know, renovating the Destination Moon[12] gallery that's open now, um, we actually, you know, relied on the Natural History Museum to keep our Lunar samples safe while we were closed down for that time.

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[11] https://naturalhistory.si.edu/staff/cari-corrigan

[12] https://airandspace.si.edu/exhibitions/destination-moon

**Emily:** Right. I think, um, as a not curator, I think what I had heard, right, is initially they thought they were going to take the samples over to our Udvar Hazy Center and store the samples over there until everybody sort of had a collective realization that it was an awful lot easier to, um, go store our Moon rocks with our Moon rock friends just on the other side of the mall, which was an awful lot more simple than lugging everything over to the Hazy Center.

**Cari:** I was told they were going to some warehouse out at Udvar and I was like, I think that's maybe not the best place for them. Why don't they come here? So they were stored in those cabinets for however many years that was four? Three? Four? We also had the big camera, the, what is that camera?

**Emily:** Oh, the Surveyor, Lunar Surveyor?

**Cari:** The surveyor camera thing that was down there

**Emily:** Oh, lucky you. That thing's not small.

**Cari:** No, it wasn't. And we couldn't really get through there, but it was fine. We know it was better for it to move a shorter distance, I think. And, and for the, you know, we have all these rocks in here, they are here for a reason, they are here under security, right, they're protected, you saw how many layers we had to get through to get in here.

Like if you, if you request a Lunar meteorite or an Apollo rock, there are protocols that you have to follow, you have to have them in a safe. If you put one on display, you have to have an armed guard, at all times. So I figured they're probably far safer just coming across the street and being in here where we know they're protected and I can look at them every day.

**Matt:** So you can visit the National Air and Space Museum and see the Apollo samples that we have on display, or you can go to the National Museum of Natural History and see their Moon rocks and meteorites and all sorts of other cool rocks but the Smithsonian's not really the only place where you can see Moon rocks, right? You don't have to come to D.C., we don't have a monopoly of all of the lunar samples or the meteorites.

Part of having the rocks on display is to bring people closer to Lunar and space science. And, you know, for that purpose, there's also a set of samples that you could have seen before if you had a cool science teacher when you were growing up.

**Emily:** I had a cool science teacher. I got to see them.

**Matt:** Yeah, I mean, I had a cool science teacher. I'm not gonna, you know, throw shade on my science teacher, but I don't think I saw one when I was growing up.

**Ryan:** So they took six different Apollo samples[13]. They used very large Apollo samples, and they made about a hundred of these disks. And those disks go out to school kids around the country. There's a whole program where teachers can be trained on how to get the disks. Again, they're a loan. And then I can present them to the kids. I think, I think we reach about 100,000 kids a year to either the lunar or, and we also have a set of meteorite disks as well.

**Emily:** As much as I got to see them, as much as I thought they were cool, I don't think I knew that they were from Apollo and I don't think I really knew kind of what Apollo was so while I thought they were really cool because they were Moon rocks and I knew they came from the Moon I, I certainly didn't have all of that context.

But I do remember this like fancy, silver briefcase that like everything was stored in and when I got to see Cari at the museum and hang out in the fancy room with all the meteorites and all the rocks. It was kind of cool because I looked at that silver suitcase or silver briefcase and I was like, gosh, I feel like they haven't changed that in 30 years. I feel like it's the same kind of briefcase. And in my mind's eye, the way these things look is it's kind of this acrylic or like lucite disk that's about the size of a CD, like a compact disk, which now I'm starting to feel like maybe is a weird analogy to use. I don't know if we can use the analogy of a compact disc anymore. Um, what would we say, like the size of …a

**Matt:** …a drink coaster? Or, I don't know.

**Emily:** it's like twice the size of a drink coaster or um, I'm trying to think of something that's culturally relevant

**Matt:** I don't, I don't think CDs are completely out of people's realm of experience yet. Are they? Maybe they are

**Emily:** I just got shade for having a DVD player, Matt. So, like, I'm feeling like CDs might no longer be in the public consciousness. But, anyways, we're talking about something that's about 6 to 7 inches in diameter. And it's about an inch thick.

And on the inside are little pebbles of different kinds of Moon rocks, and then there's a couple that look like little sprinklings of like sand or soil that are in there. So you get kind

[13] https://curator.jsc.nasa.gov/education/lunar-disks.cfm

of all different representations of the kinds of samples that were returned home by Apollo astronauts.

**Cari:** Right, so you've got the anorthosite, you've got a breccia, you've got basalt, you've got some of the orange soil that had little orange glass beads[14] in it, some of the soil from the highlands, which is interestingly dark because it's potentially, you know, should theoretically be made of this, but we know it's all mixed up, everything, and then this is mare soil, so I'm always surprised that these two look so similar.

**Emily:** But let's say Matt, you haven't been to the Smithsonian recently and your science teacher was really, really rad, but didn't have the resources to go through the process of getting Lunar samples loaned to them by NASA. There's other sneaky ways to interact with a lot of these samples and sometimes in places that you're not always expecting them.

**Matt:** Right. So another way that Apollo Lunar science has been shared is through pieces of rock that are called touch rocks[15]. Those are samples that are typically from Apollo 17, because like we said, Apollo 17 brought back the largest cache of samples. And there are a lot of these.

They're not really scientifically important in a ‘we need to study and analyze this kind of way.’ But they're important in a ‘making science accessible’ kind of way, right? These are ways that people can actually touch the Moon. And, you know, it did take a while before those rocks became a way that people got excited about Lunar science. This wasn't something that happened right after the Apollo missions.

**Ryan:** So, so when, you know, in the beginning they were just embedded in plastic. And that was great. They were very wash and wear and you couldn't hurt them. But you also, they were gone. You know, they had been hopelessly contaminated by plastic and then they decided, let's not do that anymore.

And they started putting them in these glass cases. And those were great. They were very fragile and they kept everyone at like literally hands hands width away at least. And I think that just like science has evolved over time, I think how things work in museums has evolved over time, and I think it was recognized that making things more tangible, that you can smell them, you can touch them, you can taste them.

Don't lick the Moon rocks, please.

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[14] https://curator.jsc.nasa.gov/lunar/lsc/74220.pdf
[15] https://www.smithsonianmag.com/air-space-magazine/few-ounces-knowledge-180973592/

But, like, you know, like, that became recognized that that was an important thing, that that made it more real for people, because people are very skeptical, and they were like, oh, sure, it's a Moon rock. And so I think they decided that it was worth the amount of material that would be essentially destroyed, or at least destroyed to science, to make these touch stones.

Now, at the very beginning when we talked about how much material, I said we have 83 percent left. That's because there are a few very large samples. There are some samples that weigh, uh, 8, 9, 10 kilograms each. And I mean, that's 20 pounds plus. And so you can use up half a pound of that, for these type of outreach and not affect the science that can be done with that.

And so they found a really hard basalt, something that people couldn't pick at, ‘cause it's the first thing everybody tries to do is try to pick a little piece of the basalt away. And then they made these and they've been spread around the country and a little bit around the world. So we have one in Canada, we have one in Mexico City, we have about eight or nine in the U.S. and I think touching it just makes it more real for people.

**Emily:** But what I love about these lunar touch rocks is they got distributed really widely and I feel like I’ve run into them in a lot of places when I wasn’t expecting them, and, and I, I touch the Moon rock every time. It's not like, ‘ah, I've done that.’ It's always cool.

**Matt:** Yeah, I mean, why would you pass up the opportunity to touch a piece of the Moon. Even if you've touched another piece of the Moon before, right? You can't, you can't have too many, as you said in the beginning, right? You can always build on your Lunar experiences.

*Music Button*

**Emily:** So up until this point, the Moon rocks returned from Apollo we've talked about have been owned by the U.S. government. And they're only being loaned out to scientists or institutions for the purposes of research or outreach. But there's a subset of the Apollo samples that were kind of set aside and made into gifts.

**Ryan:** You asked who can own an Apollo sample. No one. Only the U.S. government is allowed to possess an Apollo sample with one exception that I'll talk about in a second.

If you are, you as a scientist, wanted to study them, I would loan you a sample, but we would sign paperwork and that would be a loan and whatever was left when you were done is required to come back to us. That's mostly because we want to reuse it, but it's also because we don't want there to be a market for the samples.

But after Apollo 11, uh, they took a small portion of one of the large soils that weighed over four kilograms, and they separated out like a hundred grams of it, and they embedded those in lucite-- in plastic and acrylic.

And then they took a flag that they had flown to the Moon on the mission, mounted those, and then they were gifted to every country in the world and every state in the Union in 1969, 1970, and then they did the same thing after Apollo 17. So there are these two sets of what we call goodwill samples[16] that were gifted to those countries and states, so that those do not belong to the U.S. government. Those were full-on gifts and you will travel around the world and you'll run into them sometimes in places you expect like the, the Natural History Museum in London and sometimes in just a random science museum in Nepal.

**Matt:** So these diplomatic gifts were given to the different states of the United States. They were given to countries, with the exception of a single small sample that we got to visit recently.

*Cathedral Nat in and under*

**Emily:** Today we are at The Cathedral Church of Saint Peter and Saint Paul[17] usually called the Washington National Cathedral, which is an Episcopal cathedral in Northwest D.C.

**Matt:** And the reason we're here is because one of the stained glass windows has a Moon rock in it, and we want to know why and we wanna know how

**Elody:** Yeah, so the weight of this particular rock is 7.18 grams two and three-eighths inches in diameter. It's opaque, edges left jagged, not trimmed to perfect roundness. And this is rock number 10,057, piece number 230[18].

Hi, I'm Elody Crimi and I'm the photo curator in the archives department here at the Cathedral

So welcome to the National Cathedral and I'm so glad to see you, have you here, and to have you witness this beautiful window that we've had that was created by Rodney Winfield[19]. It was started in 1971 and completed in 1973, a year before it was then

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[16] https://phys.org/news/2019-06-apollo-goodwill-moon.html
[17] https://cathedral.org/
[18] https://earthsky.org/human-world/moon-rock-washington-national-cathedral-stained-glass-window/
[19] https://rodneywinfield.com/Home.html

dedicated, because it was dedicated on the 5th anniversary of the Apollo 11 Moon landing.

And you notice as you're looking at the window itself, see right there, um, in the center of that red circle, that is the Moon rock[20].

**Matt:** So, of course, that begs the question, how did the Cathedral manage to get a Moon rock?

**Elody:** So Dean Sayre[21] who was the Dean for like 27 years here, here at the Cathedral. He was the Dean at the time when the decisions were being made as to what windows were going to be put in place and what they were going to look like. And he was working very closely with, um, Thomas Paine[22], the NASA administrator.

Because Dean Sayre really felt that he wanted to have something special here in the Cathedral that no other church in the, in the country or the world had. He wanted something that was American art that would tell a good story, and that was also very special.

So, he was going to approach Nixon to get permission to get a piece of the Moon rock, but Sayre had some political issues. He had marched against the Vietnam war. He was against McCarthy. He did the Selma march. And in, uh, a sermon one day, he also spoke against the White House and Nixon about the Cambodia bombing. So he writes his letter to Nixon and Nixon vehemently said, 'No, declined.'

So then Paine, the NASA administrator, he got involved. And then, along with Dr. Fletcher[23], also from the next NASA administrator, the letters started going back and forth. Okay. And it just wasn't happening till finally, Dr. Fletcher said, this is a church of prayer for all people[24]. Okay. That Woodrow Wilson was buried here. Dwight Eisenhower had his funeral here and that this is not just an ordinary church.

And that was the deciding factor that Nixon finally said, 'yes, okay, you may have your Moon rock.'

**Emily:** And the most surprising thing I found about this Moon rock is that when we talked about which Apollo missions brought back different quantities of rocks, Apollo 11

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[20] https://cathedral.org/discover/art-architecture/the-space-window/
[21] https://en.wikipedia.org/wiki/Francis_Bowes_Sayre_Jr. Not to be confused with his father, Francis Bowes Sayre Sr. A career diplomat
[22] https://www.nasa.gov/people/thomas-o-paine/
[23] https://www.nasa.gov/people/james-c-fletcher-2/
[24] https://cathedral.org/about/mission-vision/

was the one that brought back the least. It brought back 48 pounds. So to imagine that there's 7.18 grams of Apollo 11 sample in a stained glass window is actually really hard to fathom because that's a really precious sample. And that's a really big one at that.

**Matt:** Right, and all of the samples that are at Natural History, and all of the samples that we have at the Air and Space Museum, are from Apollo 15 through 17, because, right, like we said, those missions brought back the most rocks. But with the piece in the window, and one set of the diplomatic samples, Those are all from Apollo 11.

So those are very special samples that really are being used in a very different way, kind of signifying the fact that this mission belonged to all of the world and not just to the United States of America or the scientists and engineers or what have you, but that this was really, you know, in the words of Apollo--for all mankind[25].

**Emily:** And I feel like because of the vintage of this window and when it was completed, I think a little history lesson is kind of really important, right? Because, because the window wasn't installed until 1976, which is a couple years after the Apollo 11 landing. And, um, the National Cathedral wasn't completed until 1990[26].

And so I think it's worth kind of going through sort of that quick timeline of when the Cathedral was first sort of imagined up until sort of this moment in time

**Matt:** Yeah. And it's actually this saga. That begins with Pierre Charles L'Enfant[27], who is the namesake of L'Enfant Plaza here in DC, who was the original city planner, uh, for the district. And in 1791, he envisioned a great church for national purposes. And Congress granted that charter to establish the church in 1893.

L'Enfant had this vision, and that first foundation stone wasn't laid until 1907. So from 1907 to 1976, when that window is installed, that's already a long period of time.

And then 1990, the completion of the Cathedral, right? That is a pretty long time to be working on one building. But I guess that's, you know, where the expression comes from when people talk about building cathedrals, it's the grandchildren of the original stonemasons who finish the actual structure.

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[25] https://www.youtube.com/watch?v=xSdHina-fTk
[26] https://cathedral.org/discover/history/timeline/
[27] https://www.smithsonianmag.com/arts-culture/a-brief-history-of-pierre-lenfant-and-washington-dc-39487784/

**Emily:** So the Moon rocks from Apollo 11 were returned in 1969 and the windows weren't completed and dedicated until 1974, but we had to wait until the nave was completed before that Moon rock could be safely installed in 1977.

**Elody:** And when we were given the rock, because it was dedicated at the same time as the window, but we couldn't put it in place because the Cathedral wasn't finished yet.

The Cathedral ended right there. So even during the dedication service, nobody really could, it was all blocked off. You really couldn't see anything. So this would have been July 21, 1974, that they had the dedication. That's when, um, the three astronauts were here. It was like a big deal.

*Organ music*

**Dean Francis Sayre from Dedication[28]:** When the astronauts of Apollo 11 and the brave men who followed on succeeding missions to the Moon brought back some chunks of Lunar material, it was not just rock that they returned to Earth but in an exciting way the very horizon of eternity.

**Emily:** That's the voice of the Cathedral's Dean, Francis Sayre, at the dedication service in 1974.

**Elody:** So where the rock was supposed to go, just had a piece of black paper there. And it was kept in the Rare Book Library downstairs, um, for three years until 1977, and then it was put into place.

**Matt:** So if you're working with something as, you know, unique as a piece of Lunar rock, you're going to get the most experienced stained glass window maker in the world to make it, right? No. That's not quite true. I mean, the artisans who worked on the window knew what they were doing, but the artist who designed the window, Rodney Winfield, had actually never done a stained glass window before, and it was a bit of a process to get his design approved.

**Elody:** So initially those powers that be on the building committee, they wanted an astronaut. They wanted a spaceship. They wanted things that told the story of man in space. And so, Rodney, they're kind of small, I have bigger ones upstairs, okay? But you can see that, you know, you've got a lot of things going on in the iconography.

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[28] https://www.youtube.com/watch?v=y1M2vHhDM-0

And there were all these designs that Rodney did, but he was never happy, because he just didn't want all of these elements in his window, and he was getting frustrated to the point. He was almost gonna stop, but he goes ‘no, no, I'm gonna do a couple more of the way I want to see it. I don't want to have any element of man. I just want it to be God's creation, okay, and so therefore voila that is finally what the building committee did eventually accept. They picked four of these and initially showed them, um, to a couple folks and they were like, no, no, no, no, no. And then finally they just went ahead and said yes.

**Matt:** But once that design was approved, Winfield worked with master stained glass artisans to create the window and then install it. And the Moon rock was installed later.

**Elody:** It's sealed between two pieces of tempered glass, circled with a band of stainless steel. Uh, completed mounting is three and a half inches in diameter five and 5.8 inches thick. The sealing was done in nitrogen environments so that any void space between the two pieces of glass is filled with nitrogen rather than air. This will prevent moisture and oxygen from contacting the sample and possibly degrading it.

**Emily:** Yeah, there's a lot of iron in basalts. So you can get a lot of oxidation.

**Elody:** So when they gave it to us, it was, it was already sealed. It was already in this case. So when Dieter Goldkuhle[29], the, the installer and he was the fabricator actually for the Moon rock. So it was already in place and he just had to set it in and then do the leading.

**Emily:** The National Cathedral has 215 amazing stained glass windows. And, I'm not surprised by this at all, the space window is the most popular. And it's not hard to see why. Obviously, I'm biased, but when you walk into the Cathedral and you look at all the stained glass windows, the space window is dramatically different from all the other windows that you're going to see in there.

**Matt:** It really is. I mean, when I look at this window, I see so much going on. On the one hand. It's kind of reminiscent in its use of geometric shapes, particularly circles, of stuff that you might see from medieval illustrated manuscripts, right, where the heavens are depicted as a set of nested spheres[30], but in this case, the spheres are not nested, they're arranged in a way that's still not, you know, quite the way they're arranged in the solar system, but none of the spheres is also actually representing a very specific planet either. It's more the idea of these spheres floating in space.

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[29] https://ket.org/program/good-work-masters-of-the-building-arts/meet-dieter-goldkuhle-stained-glass-artisan/

[30] https://expositions.bnf.fr/monde-en-spheres/en/spheres-in-medieval-western-europe/index.html

There's a lot of color used, you know, it's a very modern looking piece, uh, that really stands out among all of the other windows which have a much more traditional look and feel to them.

**Emily:** Yeah, and I think you do a really good job of describing it, Matt, and I think for all the complexities that you see in the window, the longer you look at it, the more you notice. It's also very, to my eye, it's very geometric and it's very kind of mid century modern, right? Like, it's got this kind of really geometric simplicity to it that you kind of get in that mid century design.

But the more you look at it, the more you see, and the more that kind of pops out to your eye. But you're totally right. Compared to the other windows that are very traditional stained glass work, or feel very traditional next to it, it feels really simple in comparison, because of these big circles.

**Matt:** Yeah, I mean, simple in some ways complicated in others, right? Like there are stars that seem to shine through the dark blacks and blues of the window. There are very vivid colors and then within those colors kind of gradients and seems like sort of flowing. I don't know how to describe it. Almost like ethereal,

**Emily:** It’s almost a Starry Night vibe

**Matt:** yeah, like a Starry Night vibe, yeah

**Emily:** Starry Night was done by a mid century modern artist.

**Matt:** Yeah, and the only real nod to the Apollo program in it, it's not like you see an astronaut floating there or an Apollo capsule, is the rock itself and then the this, you know, figure eight or infinity symbol that's circling two of the, um, of the circles, which is essentially the Apollo trajectory of going from the Earth to the Moon and back again.

**Emily:** All this talk about Moon rocks, Matt, has me really excited for this big shift that we've seen in planetary science, where we've been really moving in the direction of increasing the amount of work we're doing on sample science. We've learned so much about our solar system, not just the Moon, from studying the Apollo samples and Lunar meteorites. There's been this huge focus and this huge push to return more and more samples from outer space from asteroids, from Mars, hopefully soon.

It's really, really important for learning everything it is that we are curious about in our solar system. And this is what I think makes the Artemis missions[31] really exciting. And we've talked about Artemis on the podcast before, but the return of humans to the Moon to collect more samples with 50 years of science in our back pocket now is a really exciting opportunity.

**Cari:** And part of it is you don't know until you get the Artemis samples back and know that yes, they're the same or just from a different spot or no, they're completely different and we need to treat this and revamp everything we think about the Moon, right? You could, you could go from, this doesn't change much about what we think to this changes everything about what we think.

**Matt:** Yeah, we know a lot more about the Moon today than we did in the 1960s. I mean, at the time that the astronauts first walked on the Moon's surface, even at the end of the Apollo program, there was no sort of shared consensus theory about how the Moon formed. Right? We now are in a position where we have, pretty commonly accepted story of the Moon's origin. There's still arguments about how it happened, when it happened, exactly what happened, but you know, that part of the story is a little bit more fine tuned than it was in the sixties.

And like you said, we've brought home samples from comets, from asteroids. Um, and hopefully one day from Mars, you know, that will supplement the information we've already gotten from rovers and landers and from the Mars meteorites that we have access to. So like this story of our solar system and the chemistry of the solar system and its history based on the history of impacts and, and geologic events on these other bodies is really much more complete and nuanced now than it was back then. And, you know, excitingly, we're even already getting samples from the far side of the Moon from Chinese missions like Chang'e-6[32].

**Emily:** These samples that the Chinese National Space Agency returned are really exciting because they're the first samples that we've ever gotten from the far side of the Moon and when you add on top of that the fact that the Artemis missions are going to start returning samples from the South Pole of the Moon, we're entering a really exciting time in planetary science where we're returning all of these really exciting samples. We're gonna learn so much more about the Moon and our solar system.

*AirSpace theme up then under*

**Matt:** AirSpace is from the Smithsonian's National Air and Space Museum.

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[31] https://www.nasa.gov/humans-in-space/artemis/
[32] https://www.cnn.com/2024/06/25/china/china-change-6-moon-mission-return-scn-intl-hnk/index.html

It's produced by Jennifer Weingart and mixed by Tarek Fouda. Production help by Erika Novak and Sofia Soto Sugar. Our social media manager is Amy Stamm.

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*AirSpace theme up and out*

**Matt:** Right. Some people like puppies or kittens. Uh, we're into Moon rocks, right? And puppies and kittens. I mean, I'm not going to lie.

**Emily:** And pup…I was like, don't make us a monster, Matt. I'm also into puppies and kittens. I'm here for the rocks and the pets.

*PRX Audio Logo*