AirSpace Season 6 Episode 5-Sisters of the Moon

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

Nick: I'm Nick.

Matt: And I'm Matt.
Fifty years ago this December, the last Apollo astronauts left the Moon. And we haven't had boots on the lunar surface since.

Nick: Now, NASA's Artemis missions aim to follow in those footsteps by 2025, and there are tests, and equipment, and training, and astronauts all gearing up right now to make it happen.

Emily: But Artemis isn't just about going back. Artemis is about science and its science goals are built on what we learned from Apollo and the robotic missions that have been to the Moon in the intervening years. We're talking to the mission science lead and walking you through Artemis today on AirSpace presented by Olay.

Music up and out

Emily: The fact that the Artemis missions that are coming up are kind of open ended, I think is part of why Artemis maybe hasn't gotten as much attention as **we** think it should, which is why we want to talk about Artemis today.

Nick: In that sense, the Apollo missions were kind of theoretically open ended. The missions were grounded after Apollo 17, but there were at least three more missions planned at that point. None of them flew. But unlike Artemis, the big, big, big, big deal was landing on the Moon, for Apollo. So landing on the Moon when Artemis does it will **also** be a big deal. But it's understood this time that it's kind of just the beginning. So the idea that the main course, or the main event, or the main act, I don't know, concerts, food, how many metaphors can I throw at this? The main thing this time is going to be what goes on on the surface of the Moon in the medium and long term. And what we discover there, not just putting people there. Although I don't want to understate how exciting it will be to actually have people walking around on the Moon in HD.

Matt: Right. Because the real accomplishment of Artemis, at least the way that it's been sort of planned out so far, is meant to be the sort of sustainability aspect of it. That is going to be a long term human presence on the Moon, which, you know, you can't really make a lot of hype out of,

you know, ‘we're going to stay there a long time!’ But you're right, it's going to be really exciting each and every time we land people on the Moon and especially the first time or the only time that a lot of people in our generation and younger are going to have experienced that.

Emily: If you've spent any time paying attention to the space program, going to space is hard. It's even harder to put people in space. Artemis may seem like a bit of a slow burn. We're not putting astronauts on the Moon until 2025 because there's a lot of technological advancements that need to happen first. And we're talking like soup to nuts. We're not using a Saturn V, right? We have a whole new rocket that's capable of launching people, and a whole new space capsule that astronauts are going to be delivered to the Moon in, and then all kinds of new technologies to deploy on the Moon, including landers, rovers, a base camp among many, many other things. There's been a huge amount of technological development going on with Artemis, which not only shows you how we've really advanced our technology in exploring space, but we've also really advanced our science. And so there's this really cool combination of technology development and scientific advancement that's really making Artemis like way more than 50 years advanced than Apollo.

Matt: I mean, in some ways you kind of have to start the process over, right? We don't make Saturn V rockets anymore. We had to not reinvent the rocket, but build another huge rocket for carrying humans to the Moon. And so now we have this Space Launch System, which is the giant sort of orangey-red rocket with solid rocket boosters attached to the sides that is going to be able to lift these humans up to the Moon in a newly designed capsule.

Emily: So when you actually look at the Orion capsule, if you know what an Apollo capsule looks like, you're going to be like, ‘oh, those, those are genetically related in some way.’ They're not identical. But you can tell that they are related to one another. And they've been designed to do a lot of the same things. What's really different and I already mentioned there's been big technological advancements, but Matt, you mentioned sustainability, and what we mean by sustainability in this context is that the things that get landed on the lunar surface are going to stay there and get used over and over. And therefore sustainable because it's not landing all over different parts of the Moon and that stuff is just throwaway, single use. All the stuff gets linked up together and so that it can continue to be used so that, let's say Artemis 12 gets to the Moon in 2040-something. There is going to be habitat linking up to another habitat linking up to another habitat, kind of like the International Space Station but on the surface of the Moon

Nick: There's also the kind of less brass tacks, less stated idea that all of this technology has to do with sustainability overall. Certainly one of the big things that you learn about space travel broadly is how difficult it is to keep human beings alive in an inhospitable environment. And that has come back to us in lots of different ways, from life support to water recycling to thermal protection. So all sorts of ways that **hopefully** our planet never becomes quite as extreme as the

lunar surface. But there's a lot of technology going into it up on the Moon with Artemis, and there will be a lot of discoveries, innovations, methods that come back to us here. And it's also just a good way of remembering how dang expensive it is to keep people alive where it's not nice outside.

Matt: Right. And then, you know, there's a whole other side of this, which is that NASA also sees the Artemis program and the lunar surface, all of these operations and new tech as sort of a testing ground for the types of habitats and vehicles and other infrastructure that they would need to bring to Mars, that other inhospitable environment where we want to set humans down at some point to either do science or maybe even do more than science to to build another sustainable human presence on an even further away world.

Emily: So we really wanted to talk to scientists who are involved in the Artemis mission and helping to define what those scientific goals are and how to carry out scientific experiments. And a lot of scientists are working on many different parts of Artemis, and we don't have enough time to talk to all of them. So we decided to talk to the person in charge.

Dr. Sarah Noble: I'm Dr. Sarah Noble, I'm the Artemis Science Lead. So I'm in charge of putting together the Artemis Science teams and making sure that science is infused in every possible way into the Artemis program.

Nick: So in 1961 when President Kennedy first committed the nation to go to the Moon and then in 1962 when he said ‘we choose to go to the Moon’ in a more memorable speech, there wasn't a big community of lunar scientists. Now after six Apollo missions brought back about 800 pounds of Moon Rocks. And landers and orbiters and observations have given us much, much, much, much more information about our closest celestial neighbor. There is a huge community all over the world of people who study the Moon like they're lunatics for it. The Artemis missions returning to the Moon is what they've all been waiting for.

Emily: I mean getting humans to the Moon in the 60s is essentially what invented lunar geology and therefore planetary geology.

Sarah: We had a lot of time since Apollo. Right? So 50 years since Apollo, we brought back all of these samples and did all this great science during Apollo. We’re still studying those samples today, still learning new things from those samples. And in the meantime we sent all these orbital missions to the Moon, so Lunar Reconnaissance Orbiter, and GRAIL and LADEE and a number of other missions so that we could sort of get a big global picture of the Moon which we didn’t have during Apollo, we pretty much focused very much on the places where we were landing. But now with all this new data we have a sort of global understanding of the Moon and it’s really changed the way we think about the Moon. And all the places we went during Apollo are all sort

of in the same part on the Moon. So with Artemis we're actually going to the South pole which is very far away from all the places we landed during Apollo and so now we have an opportunity to go to somewhere new and with our global understanding of the Moon we have better understanding of what questions we want to ask and how, what kinds of things we need to pick up to answer those questions.

Emily: I mentioned that the big difference, one of the big differences is that sort of everything that Artemis lands on the Moon is going to be used again. Kind of imagine it like a space station on the Moon where everything just kind of keeps getting linked up to one another. This is possible because rather than landing in all different kinds of places with every mission, they're really focused on the South Pole.

Sarah: The South Pole is actually special in a number of other ways, too. It is, uh, it is a different environment. We think about Apollo, we think about like the sun bright overhead and whatever. And that's not going to be the case when we go to the South Pole. The sun is very, very low on the horizon. In fact, it's so low that the craters near the South Pole never see the sun. The sun just, like, glints over the top of them, it never gets down into the bottom. And so they're very, very cold. It's like some of the coldest temperatures we've measured anywhere in the solar system. It's colder than Pluto. It's really cold. And so what happens is things that are bouncing around the Moon, molecules bouncing around the Moon, get trapped into these cold places and it can't get back out again. Because it's just too cold. So stuff accumulates there. And one of the things we think accumulates there is water. That's not the only thing. There's plenty of other random molecules and weird organic things, and who knows what they get trapped into these polar cold traps. And so we're really excited to sort of understand what is there from a scientific perspective. It will help us understand how the Moon formed. Where did that water come from? Was it from, like, volcanoes from the early Moon? Is it from interactions with the solar wind? Is it stuff that comets and asteroids have brought to the Moon? There's all sorts of ideas about where that water may have come from. And so we're really excited to go and sort of explore that and sort of understand how water moves around the solar system, how water evolves over time.

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Matt: We've done episodes on this show in the past where we've talked about how the astronaut corps has become increasingly diverse over the years, going from an all male, all military test pilot Astronaut Corps, to a corps that involved more scientists. But also, you know, started to move away from that white, male astronaut persona to where, you know, we've done episodes about Sally Ride, for example, and other women who have flown on the shuttle program and on the International Space Station. And, you know, there's also increasingly more people of color in the Astronaut Corps. Mae Jemison is a wonderful example. She's one of my favorite astronauts. I think she's one of everybody's favorite astronauts, an artist as well.

So it's no surprise, I think, that Artemis, or that NASA through Artemis, is trying to continue that trend. We've only landed white men on the Moon in the past and this first Artemis mission intends to start changing that. And NASA's said anyway that they want to land the first woman and the first person of color on the Moon as part of the Artemis program.

Emily: So when we talk about Artemis wanting to really change how we see astronauts and planetary explorers, the latest class of astronauts that were selected specifically to participate in the Artemis program is really reflecting that. I mean, if you're talking about binary gender, we have a 50-50 split between men and women. Over half of the Astronaut Corps, or at least half the Astronaut Corps identify as people of color. And then we've started to see a shift in folks background and expertise we don't necessarily have a dominant military presence. There's six astronauts that have no military experience. Of course, we still have test pilots. Flying things are still a really important part of being an astronaut. But we're also seeing medical doctors, people with deep scientific training, other kinds of engineers. I mean, you're starting to see that this diversity of expertise is really important for a sustained presence on the Lunar surface because we're not talking about a quick trip home. We need to have resources on the surface of the Moon. And if we're using this as a test bed for longer trips to, say, Mars, we really need to have a diversity of expertise. And the Artemis Corps is really starting to reflect NASA's goal and frankly, the global goal, if you will, of really creating diversity in all aspects of the teams that we build to create the best outcomes and to create the best deliverables. And so that's one of the really exciting things to me about what's going on with the Artemis mission and sort of continuing to reflect the global population and the people that are going to the Moon.

Matt: So if you're going to send people to the Moon and ask them to do science there and in particular to study the rocks there, it's kind of nice if you actually have them be trained in geology. Right?

Sarah: There's also training, right? And these these astronauts, they are all incredibly smart and they are all really dedicated to what they're doing and very excited about training. And so we have been working, you know, this isn't this isn't something new we've been working on for several years now to get basic geology training to make sure they get out in the field, to give them opportunities to even go out with scientists who are doing field work, and so they get some opportunities to see how geologists really do things in the field. And we'll be ramping that up, of course, as we head towards, towards Artemis so by the time these guys are are fully trained, they essentially all will be geologists.

Nick: So in addition to all of the training that the astronauts are getting on geology and other topics and how that's probably more sophisticated than what was going on with the Apollo missions, the experience of being on the Moon will be different. You'll be able to communicate more freely, communicate more privately. And for us here on Earth, our ability to film things has

obviously gotten… Well, I don't want to say better and throw shade at people in the 1960s. There were some great movies then, but cameras have certainly gotten more ubiquitous. So I think we all stand to see the Moon in living color and granular detail like we hadn't seen before.Those of us who are around for it, which is no one in this room.

Emily: Well, and what I love about this Nick is that because communication has gotten so good and because obviously all astronauts need to be trained in geology because it's clearly the most important skill you'll ever have as an astronaut. What's really exciting is that by tying those two things together, all the astronauts who are going to be doing Moon walks and running science experiments out on the surface of the Moon have direct communication to an entire team of geologists back on Earth when they're out there doing those Moon walks. And that's even more powerful because while they'll be highly trained in doing geological field work, they'll have this whole bank of people who presumably are going to see what they're seeing and can talk to them in the ear and be like, 'Hey, hold on, that rock over there is going to be really awesome. You should go pick it up.'

Sarah: We have tests planned, particularly this summer, and this fall, we're going to go and do some, some sort of analog testing or we're going to, you know, from my side, from the science side, right where we're going to set up like a science back room. It's all scientists who are, and try to understand, you know, we'll have people out simulating spacewalks out, out, out on the Moon, Moon of Arizona. *Sarah and Emily laugh*
At night, you know, trying to walk out and do geology and we'll have our science back room set up, you know, in Houston and try to understand how those communications happen. So very different, you know, I mean, they did that clearly during Apollo, but, you know, during Apollo, they kind of had like one camera. *Laughs* Right? It was a sort of grainy camera that could look at one thing. And we're going to have, you know, like, you know, much more sort of modern tools and communication structure. And so we gotta figure out how all that works.
They're going to be very, very well trained. They're all going to be geologists by the time they get to the surface of the Moon. And we want them to be able to, you know, do the geology right but I feel like it's like having I always say this, it's like having, you know, like a dozen geologists in your pocket that you can just pull out if you need them. *Sarah and Emily laugh* You know, so it's handy.

Emily: So the Artemis mission, the whole plan of the Artemis mission was announced in 2017. You're going to be hearing in the coming months talk about launches and testing and all that kind of stuff. For the first few Artemis missions, it's worth noting that Artemis I is going to be an uncrewed task out of essentially the rocket, the Space Launch System. So keep your ears open for that. The goal for Artemis II is to essentially repeat, in a way, Apollo IIX where it's a crewed launch and it's essentially a test of going out and around the Moon but not fully landing on the

surface of the Moon. So Artemis II is going to have people in it and it's going to go to the Moon. It's just not going to *land* on the Moon.

Nick: We don't actually know yet which part of this mission will land on the Moon, but right now NASA's planning to put humans back on the lunar surface sometime in 2025.

Emily: A lot's going to happen between now and then. This is hopefully this primer, this broad brush overview of the Artemis mission is going to give you the tools you need to be pumped up about the headlines you see coming out about Artemis

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Matt: AirSpace is from the Smithsonian's National Air and Space Museum. It is produced by Katie Moyer and Jennifer Weingart, mixed by Tarek Fouda.
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