AirSpace Season 2, Episode 8

Walking on the Moon Part 1

Emily Martin:
Can I tell you I've never seen the face on the moon. I've only ever seen the soccer player.

Matt Shindell:
Soccer player.

Nick Partridge:
What?

Emily Martin:
I don't know why it's a soccer player, but somebody introduced it to me as a soccer player which is-

Nick Partridge:
Which part of the moon.

Emily Martin:
So I think-

Nick Partridge:
Is the sea of tranquility in the soccer player scenario?

Emily Martin:
Yeah, so the sea of tranquility, where they landed in the sea of tranquility, is a soccer player's backside.

Nick Partridge:
Oh.

Emily Martin:
Welcome to AirSpace. I'm Emily Martin. I'm a geologist here at The Center for Earth and Planetary Studies in The National Air and Space museum.

Matt Shindell:
I'm Matt Shindell. I'm a historian of planetary science in The Space History department at the museum.

Nick Partridge:
And I'm Nick Partridge. And I've been spending most of my museum days the last year, thinking up ways to celebrate 50 years since Apollo astronauts first walked on the moon.

Neil Armstrong:

That's one small step for man. One giant leap for mankind.

Nick Partridge:

Today, we are going to talk a little bit about what we didn't know about our nearest celestial neighbor before we sent astronauts there to walk on its face.

Matt Shindell:

We'll discuss the things we got wrong.

Emily Martin:

Like fears of space germs.

Matt Shindell:

We'll also hear from one of the scientists on NASA's team who was tasked with expanding the Apollo mission from simply a space race to a full scientific expedition.

Farouk El-Baz:

They had to do this with astronauts, they didn't give a damn about geology.

Emily Martin:

What we didn't know about lunar science when we went to the moon, that's coming up next from AirSpace, distributed by PRX.

Buzz Aldrin:

Hey Neil, didn't I say we might see some purple rocks.

Neil Armstrong:

Find a purple rock?

Buzz Aldrin:

Yep. Very small, sparkly fragments [inaudible 00:01:46] that to the, further analysis.

Nick Partridge:

When Apollo 11 astronauts Neil Armstrong and Buzz Aldrin landed on the moon, they spent a good amount of time observing the surface.

Emily Martin:

Putting humans on the moon for the first time was an enormous opportunity for NASA to pursue science that had never been done before.

Matt Shindell:

And putting this in context, before sending humans to the moon, we had already flown robotically by Venus and Mars, and we'd taken really impressive photographs of the lunar surface with the lunar

orbiter spacecraft. And in addition to that, we had crash landed and soft landed a couple of robotic Landers on the moon.

Emily Martin:

The political implications of getting a person safely to the moon surface and back again tends to kind of overshadow all the scientific stuff.

Nick Partridge:

We did get a lot of good science, but that wasn't the impetus for the program. I'm going to paraphrase Mike Collins, who was a command module pilot on Apollo 11 and first director of the museum. You may have heard us mention him before. He said that the elegance of Kennedy's challenge was its simplicity.

John F. Kennedy:

We choose to go to the moon in this decade and do the other things. Not because they are easy, but because they are hard. Because that goal will serve to organize and measure the best of our energies and skills. Because that challenge is one that we're willing to accept. One we are unwilling to postpone, and one we intend to win and the others too.

Nick Partridge:

Where, moon, what, land, when, end of decade. So it was a very clear mandate.

Farouk El-Baz:

Our mandate said, get a man to the moon and bring him safely to the earth. It did not say, and bring back some dirt.

Matt Shindell:

That voice you just heard is one of our former colleagues, Dr. Farouk El-Baz, who spoke with us recently via Skype.

Emily Martin:

And he actually founded the department, The Center for Earth and Planetary studies, which is where I do most of my work. And he is a favorite of the Apollo era, back then and really still today, for his ability to translate complex science into everyday language.

Farouk El-Baz:

I became an expert only because nobody else really was. Nobody has ever been there. We know the earth very well. We know the earth rocks, which ones are older, which one are younger, how they changed with time. But we looked at the moon and we saw dark areas and light colored areas. What are these? No one knew. So none of them knew a lot more than I did. So I jumped in. Emphasize Looking at the details of the photographs, I really learned about the moon from the photographs of lunar orbiter.

Emily Martin:

The lunar orbiter was a repurposed surveillance satellite that had a robotic camera onboard. And over the course of a few missions, took extensive photographs of the moon surface. And these photos really help determine where the first astronauts were going to go and land on the moon surface.

Matt Shindell:

And the thing about Dr. El-Baz is that he had a specialty that not many people had at that time, which was, he actually was a specialist in orbital geology, doing geology from orbit, using photographs sent back by spacecraft.

Emily Martin:

We sometimes call it photo geology.

Matt Shindell:

Yes. And photo geology actually existed even before spacecraft, using airplanes and other aerial methods.

Nick Partridge:

I actually created my Instagram account just to post a picture of me and Dr. El-Baz.

Emily Martin:

It's true. If you go to Nick's Instagram, actually we should re-gram. Is that a thing?

Nick Partridge:

Re-gram? Yeah-

Emily Martin:

Re-gram.

Nick Partridge:

Yeah. We'll re-gram it.

Emily Martin:

We'll re-gram the very first Instagram post that Nick ever posted, so that he could brag about meeting Farouk El-Baz.

Nick Partridge:

Yep. I got him to sign a map of the moon for my daughter.

Emily Martin:

I know.

Nick Partridge:

Yeah.

Emily Martin:

He's just the nicest. [crosstalk 00:05:39] He's the nicest.

Nick Partridge:

He's the best guy.

Matt Shindell:

So El-Baz was instrumental in arguing for the importance of geologic training for the astronauts, but he wasn't alone. There were actually a lot of people who were pushing science in the Apollo program. And one of them was Homer Newell, who was the Associate Administrator of NASA. But really in a lot of ways, he was like what we would think of today as their chief scientist. He was originally interested in atmospheric science and in using rockets to study the atmosphere and especially the upper upper atmosphere that had never really been studied by scientists before. But now that NASA had turned its sights to the moon, obviously he had turned his scientific sights to that as well. And then also we have other geologists like Eugene Shoemaker, who actually had had the foresight in the early years of NASA, as he saw NASA getting so much public money and saw them starting to turn their interests more towards science and towards the moon, had the foresight to think, the US Geological Survey could really get into this business if it just founded a branch that was devoted to the study of other planets and other bodies.

So he founded the USGS's Astrogeology branch. And from that position got a lot of geologists involved in lunar work and specifically in training the astronauts and how to do field work out in the desert, visiting sites in the US and also around the world, that were similar to lunar landing sites.

Emily Martin:

That USGS still exists out in Flagstaff, and it is teaming with geologists and scientists and computer scientists who still support the work that planetary geologists do. They are in charge of the geologic maps that get created and making sure that they are all kind of up to snuff, but astronauts are still trained in geology and geological field techniques, even though they're spending most of their time on the international space station.

Matt Shindell:

I should say, not all scientists were that excited about the astronauts getting geological training.

Emily Martin:

Why, how? Very important.

Matt Shindell:

I agree. I agree.

Emily Martin:

And very biased.

Matt Shindell:

And I think that even the scientists who criticized it at the time would agree today. But for example, the geo chemist, the isotope chemist turned geochemist, Harold Urey, believe that geology was absolutely the worst training you could take to the moon, because he said geologists learned basically to look at the earth, and they learned all of the processes that are at work on the earth in shaping terrestrial

terrains. He said, "The moon will be nothing like the earth and you can't bring your earthly assumptions to the moon."

Emily Martin:

I can't believe you wrote a whole book about that man. [crosstalk 00:08:21] Geology hater, no thank you.

Nick Partridge:

A regular, single-volume.

Matt Shindell:

Coming this fall, yeah.

Nick Partridge:

Yeah, single volume biography of [crosstalk 00:08:26] Dr. Harold Urey.

Matt Shindell:

The life and Science, Dr. Harold Urey, yeah.

Emily Martin:

So training astronauts to care about lunar science really meant that scientists had their work cut out for them because they were training a bunch of test pilots to care about rocks. And Dr. El-Baz described what it was like training these early astronauts.

Farouk El-Baz:

The first one that I talked to just told me straight out in my face, that I don't want to touch a geologist with a 10 foot pole. They didn't give a damn about geology. And so I knew, so I knew that I had to talk their language. I had to convey thing to them, become better at their flying machine.

Emily Martin:

In other words, Dr. El-Baz realized he had to master his own understanding of flying and how satellites orbited planetary bodies in order to frame the geology lessons for these test pilots, in ways that they would understand.

Nick Partridge:

And the way that he started with that was by teaching them how to look as a field geologist, what the colors and shapes and patterns were-

Matt Shindell:

Like those purple and sparkly rocks that we heard Neil and Buzz remarking on early.

Emily Martin:

Right. And one of the techniques Dr. El-Baz used was that he would start by showing astronauts a map of the surface of the moon and would sort of work from that.

Farouk El-Baz:

Do we have a map with seven landmarks? And astronauts are not so supposed to pick at least three. And when they look with an enlarger, that they look at it as if they were looking through a microscope. They love it, and then they say mark, when they have that point in the crosshairs.

Emily Martin:

He really encouraged them to get really creative with their descriptions as they kind of pointed out those landmarks.

Farouk El-Baz:

The guy would look at him and they say, "Yeah, that's it. Look at these two craters." And I said, "That looks like a doublet," because there are two creditors that hit each other. I said, "Great, let's call it a doublet."

Nick Partridge:

A double is one of those words that was probably more commonly used in the 1960s. It just means a pair of something.

Emily Martin:

Right. And there were other memorable landmarks that the astronauts came up with while working with Dr. El-Baz, like the snowman.

Nick Partridge:

He was happy to embrace just about whatever the astronauts thought they were seeing in the patterns of craters from those photos on the moon.

Farouk El-Baz:

If you teach a whole bunch of craters in a pattern, they say, "What pattern is it? Is it the snowman?" I said, "Great, let's write snowman." And I actually put it on the map and they put it on the map they take with them. Write snowman because he would remember that.

Matt Shindell:

Farouk El-Baz and the other scientists really had to fight NASA to schedule time with the astronauts for study. The entire program was rushing, it was sprinting to try to get to the moon as quickly as possible. And any time spent on geology and the other sciences was a struggle to secure it.

Nick Partridge:

Dr. El-Baz said everything changed when he was approached by astronaut Stu Roosa and asked whether he was the guy that taught Ken Mattingly, everything he knew about lunar geology.

Emily Martin:

Gary Sinise in the movie.

Nick Partridge:

Right.

Emily Martin:

Ken Mattingly, maybe best known as the astronaut who didn't fly with Apollo 13, but he did eventually fly to the moon on Apollo 16.

Matt Shindell:

Right?

Nick Partridge:

So Dr. El-Baz said that he could help Roosa be just as smart and Rosa said this in response.

Farouk El-Baz:

"Hell no, I want you to make me smarter than Ken. My name is Stu Roosa, I'm going to be the Apollo 14 command module pilot. And I want you to start my training." Henceforth that moment I thought, "Oh my God, that's it. They got it. They're going to begin to compete, because there are very competitive people, exceedingly competitors with each other. And from now on, we don't have to push them. They will push for science time and training time."

Matt Shindell:

So famously in the Mercury and Gemini programs, those astronauts were incredibly competitive. Not just in flying and not just in their rankings within the astronaut program, but around Kennedy space center, they were racing cars with each other. They were trying to out drink each other. They were just basically competing with each other in every way they could possibly imagine.

Nick Partridge:

Yeah, it should be noted that although Buzz Aldrin is not a geologist himself, he does have a PhD in orbital mechanics. These guys, these were really smart guys who just happened to have not yet studied geology.

Matt Shindell:

Yeah, they were just as much egg heads as the scientists and engineers that were making these things fly in the first place.

Emily Martin:

We're going to take a short break. When we come back, we'll talk all about the actual science that the Apollo 11 mission set out to accomplish when humans stepped down onto the lunar surface.

Matt Shindell:

No humans had obviously ever been to the moon before that we know of, but NASA had really invested a lot in sending robotic spacecraft to the moon, which began with crash landing on the moon with the Ranger spacecraft and then soft landing on the moon with the Surveyor spacecraft. And then finally orbiting the moon with the Lunar orbiter. And all of those missions sent multiple robots to the moon. And so by the time we landed the Apollo spacecraft, we had actually developed a little bit of experience with going to the moon and landing things on the moon.

Nick Partridge:

Other than making sure that you can land a spacecraft with a person aboard on the moon, what were the fundamental questions that they were hoping to answer? What were they exploring? What if you were a lunar geologist in 1961, did you hope people didn't ask you in bars because you didn't know the answer.

Speaker 1:

This is the year of Apollo, when men may first set foot on the moon.

Emily Martin:

I think your question kind of gets at this really great quote from Carl Sagan, because nobody had ever been to the moon. So how do you know what kinds of questions you should ask?

Carl Sagan:

Astronomers worry about two very large questions. How does the universe work and where did it come from?

Nick Partridge:

So where did the moon come from? What did we think then?

Emily Martin:

That's, I mean that's the question, right? And there's the three different places it could have come from are the places that planetary bodies come from. One, they formed out of the original, massive gas and dust and junk that everything in the solar system formed out of, and the moon formed, as we say, in situ, around the earth and that the earth and the moon just formed as separate bodies in their own little gravity bits.

Nick Partridge:

Protoplanetary medium.

Matt Shindell:

Yeah.

Emily Martin:

Sure. You could call it that.

Nick Partridge:

Sure.

Emily Martin:

The other place could be that the moon was a captured object. So Mars has two moons, Phobos and Deimos. They are asteroids, they're very potatoey shaped. They were captured by Mars. And then the third is some kind of catastrophic event.

Nick Partridge:

Meaning what?

Emily Martin:

Meaning some kind of large impact event where something really big, maybe the size of Mars hit the earth, and all of that debris that got created eventually formed the moon.

Nick Partridge:

Came out of the dust, captured out of space-

Emily Martin:

Sure.

Nick Partridge:

Giant impact.

Emily Martin:

Yeah.

Nick Partridge:

Question. If fighter pilots are the jocks of the aviation world, were we just going to send jocks for rocks, and then what did we hope to learn from them when they came home?

Matt Shindell:

Well, they didn't just bring back rocks, right? So they actually set up scientific experiments on the moon that had been designed to just basically be able to be deployed and switched on.

Nick Partridge:

Like what?

Matt Shindell:

At the beginning of the mission they deployed this sheet of aluminum foil that was on a pole.

Emily Martin:

I think we talked about this in our space agencies across the world, that the first technically sort of, kind of the first flag ever deployed on the surface of the moon was actually from Switzerland and not the American flag, which is a little bit of a misnomer, but the solar-wind experiments that they were trying to understand the environment that the moon is in, moon doesn't have an atmosphere.

Matt Shindell:

Essentially. And then at the end of the mission, they rolled up that foil, put it in a airtight container and brought it back to earth.

Emily Martin:

And I have three others that I really want to talk about 'cause I'm really excited about them.

Nick Partridge:

Go.

Emily Martin:

One of my favorite thought experiments about what people were concerned about when the Apollo astronauts landed, was that they didn't know what the nature of the lunar regolith or the soil or dusty stuff at the top of the surface.

Nick Partridge:

Moon dirt.

Emily Martin:

Moon dirt. They didn't know what that was going to be like and they were actually kind of worried. There was a couple of holdouts. People were really concerned that when Apollo landed and especially when the astronauts got out, that there was so much of this fluffy moon dirt, that rather than sort of like stepping down off of the Lander and being able to walk on the surface, they would just sort of, into the lightening sand in the fire swamp.

Nick Partridge:

Sink down immediately.

Matt Shindell:

And that's why the Lander's feet are actually larger than they really need to be. They were trying to be very cautious. And that's also why the first step that Neil Armstrong takes when he gets off that ladder is not onto the lunar soil, but onto the footpad.

Emily Martin:

It's sort of shaped like a big dinner plate.

Matt Shindell:

Yeah.

Nick Partridge:

So doesn't he describe how far down the foot pad-

Emily Martin:

He does. If you listen past his famous first words when he stepped out onto the surface of the moon, he actually starts getting into a description of that sort of lunar dirt.

Neil Armstrong:

One giant leap for mankind. The surface is fine and powdery. I can pick it up loosely with my toe. The dirt adhered in the fine layers, like powdered charcoal to the sole and the sides of my boot. I only go in a

small fraction of inch, maybe an eighth of an inch, but I can see the footprints of my boots and the treads and the fine sandy particles.

Nick Partridge:

Besides checking to see whether or not we were all going to sink into the moon dirt, what other science experiments were done on the lunar surface?

Emily Martin:

There was a passive seismic experiment. We use seismometers here on earth to help us detect earthquakes, but they also tell us about things like the structure of the interior of our earth. Like we have a metal, iron metal core in the center of our earth and we have this liquid outer core, which is why we have magnetic field, which protects us from all the sun's stuff. However, we don't know that about the interior of the moon, because that was, that's still a really hard thing to do. So they put seismometers on the surface of the moon, hoping that they could start to get a sense of how the interior of the moon was structured.

Nick Partridge:

And did they?

Emily Martin:

Yeah, actually they did. They were able to find out that the moon has a core. That's not, I mean, we take that for granted here on earth, but that's not a trivial conclusion.

Nick Partridge:

Not a foregone conclusion. There's no magnetic field or anything.

Emily Martin:

You can't just slice it open.

Nick Partridge:

Right. And you can't see evidence of a core from here.

Emily Martin:

Right, exactly.

Nick Partridge:

Right.

Emily Martin:

And then the last one I really want to talk about, is one that still kind of, we still use it today. They put essentially giant mirrors on the surface of the moon, and from earth, we shoot lasers.

Nick Partridge:

Pew, Pew, Pew.

Emily Martin:

Off of the mirror.

Nick Partridge:

Zap.

Emily Martin:

The lasers reflect back to us and we can actually measure how far away the moon is, very precisely from earth. What's really cool about that is we found out that the moon is moving away from us.

Nick Partridge:

Oh no.

Emily Martin:

Oh no.

Nick Partridge:

It doesn't like us.

Matt Shindell:

Very slowly.

Right, it is very slowly. But, so that's not all the experiments that they put out on the surface of the moon. They did a lot more stuff there. But in addition to doing all of that, they brought back a bunch of rocks in boxes. Box of rocks.

Nick Partridge:

Here's a bonus, we got you a box of rocks.

Emily Martin:

Yeah. Hey, for geologists, that's a win.

Nick Partridge:

So what did Neil and Buzz bring back, if we had never gone back on subsequent Apollo missions, what lunar material would we have from their forehands on the moon, what they grab?

Matt Shindell:

They grabbed about 44 pounds worth of rocks, 20 kilograms in scientific speak.

Nick Partridge:

Mm-hmm (affirmative).

Emily Martin:

But to put that into context, Neil Armstrong was out on the surface of the moon for about two and a half hours.

Nick Partridge:

Mm-hmm (affirmative).

Emily Martin:

Buzz Aldrin was on the surface of the moon for two hours. So in four and a half hours of human work hours, they deployed at least if not more than five scientific experiments and collected 44 pounds of rocks.

Matt Shindell:

And took a ton of great photography.

Emily Martin:

And took an enormous number of photos.

Nick Partridge:

So I guess that's actually a pretty good yield from your summer vacation.

Emily Martin:

this is not how fieldwork works in the real world.

Matt Shindell:

Yeah.

Emily Martin:

You spend two days driving around trying to find field sites. You spend another couple of days hoping the weather will clear up so that you can actually do your experiments. Then if you're lucky, your hypothesis was close enough that you can collect data that gets you maybe a third of the way to the answer you were looking for.

Matt Shindell:

Yeah.

Emily Martin:

So of the total six Apollo missions, and of course each Apollo mission got just a little bit longer and they were able to get further and further away from-

Nick Partridge:

Of the ones that landed on the moon.

Emily Martin:

Of the ones that landed on the moon. They started to be able to explore further away from the Lander and spend longer durations on the surface and have longer missions. How many pounds of rocks were they able to bring home total?

Nick Partridge:

842.

Emily Martin:

842.

Nick Partridge:

Yeah, almost 850. [crosstalk 00:22:28] Almost 900.

Emily Martin:

No you should be precise.

Nick Partridge:

Yeah. 842 pounds.

Emily Martin:

Here's some tape of Buzz and Neil hard at work.

Neil Armstrong:

Here and there where I plugged with the sample collector, I run into a very hard surface, but it appears to be a very cohesive material of the same sort. I've tried to get a rock in here. Took the sample.

Matt Shindell:

In exchange for all those moon rocks, we left 413,000 pounds of hardware on the moon.

Emily Martin:

That's a lot, that's a lot.

Nick Partridge:

That is a lot.

Emily Martin:

And one of the things that I make everybody who wants a quote and quote, behind the scenes tour of The National Air and Space museum that comes to ask me, the thing I make them do is actually touch a piece of one of the moon rocks that was returned home from the Apollo missions that you can go touch.

Nick Partridge:

And there's a photo of that rock on the moon, with an arrow, this rock was here and now it is here in front of you and you're touching it.

Emily Martin:

Dr. El-Baz really fought hard and of course the Apollo missions were paid for, from the federal budget, from taxpayer dollars. And he felt like it was really important that we had an opportunity to kind of connect with those missions in a really special way. And having a piece of the moon that we could actually touch was something that he felt really strongly about.

Farouk El-Baz:

If we tell you with pictures and we tell you all kinds of things, could not last with you. But if you touch it, it will remain with you forever. So I thought, [inaudible 00:24:01] we should have a piece of the moon for all visitors to The National Air and Space museum to touch.

Emily Martin:

And we have it here and it's great. And every time I walk by it, I stand in line.

Nick Partridge:

You want to talk about moon germs? How many millions of people a year touch that rock?

Emily Martin:

It's been swabbed.

Matt Shindell:

That is the germiest moon rock ever.

Nick Partridge:

What else did we find out that was wrong? What are the theories before we went to the moon that didn't pan out, not [inaudible 00:24:29].

Emily Martin:

There was a really big concern that astronauts were going to bring home some kind of foreign contaminant of a biological nature and space germs if you will. There is an Airstream trailer that was retrofitted to be a quarantine for astronauts when they came home to make sure that they didn't bring home any kind of additional airborne space germ or something.

Matt Shindell:

Yeah.

Nick Partridge:

Which is why, when you see the photo of Nixon congratulating the crew of Apollo 11, they're all crowded around the window of an Airstream trailer and he's standing outside kind of leaning over them, awkwardly, watergatingly.

Matt Shindell:

Nixon style.

Emily Martin:

Yeah. And don't be confused either. I mean, astronauts still get quarantined, but they get quarantined before they go up to make sure that they don't have any kind of lingering germies that are going to manifest themselves into, let's say mano, before they get aboard the International Space Station.

Nick Partridge:

Right.

Matt Shindell:

Yeah.

Emily Martin:

I want to talk more about what we're learning about the moon today.

Nick Partridge:

Oh.

Emily Martin:

But I think that's it-

Nick Partridge:

Is that, do we have time?

Emily Martin:

For this episode of AirSpace.

Nick Partridge:

We don't have time.

Emily Martin:

No.

Nick Partridge:

We'll have to do another one.

Emily Martin:

It's my teaser.

Nick Partridge:

Okay.

Emily Martin:

My teaser trailer for next time.

Nick Partridge:

We'll have to do it a whole other episode on what we're learning now.

Emily Martin:

Yeah. So that's it for this episode of AirSpace,

Nick Partridge:

We'll be back in two weeks with the second episode in our special Apollo anniversary series.

Emily Martin:

Next time we'll talk about how some of these 842 pounds of moon rocks gathered during the Apollo missions continue to be at the center of new research. We'll talk with one of the teams selected to work with these pristine samples for the first time.

Nick Partridge:

AirSpace is produced by Katie Moyer, Jocelyn Frank and Ellen Rolfes.

Emily Martin:

Mixed by Tarek Fouda.

Matt Shindell:

Special, thanks to Jason Orfanon, Genevieve Sponsler and John Barth.

Emily Martin:

You can follow us on Twitter @airandspace, or you can follow us on Instagram @airspacepodcast.

Nick Partridge:

On the moon.

Emily Martin:

On the moon. Come on Matt, be a team player.

Nick Partridge:

On the moon.

Matt Shindell:

You said that already.

Emily Martin:

Forget it.

Speaker 2:

From PRX.