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"Meet a NASA Engineer" #4 — Kim Willis (May 22, 2019)

KIM WILLIS: Welcome, my name is Kim Willis, and I'm so happy to be able to share with you something about the-- something about the Apollo missions to the lunar surface. I was alive, of course, when the astronauts walked on the moon. And so that's one of those dates that everyone says, do you remember where you were? And I certainly remember where I was.

But as a youngster growing up being in fourth, fifth, and sixth grade, I saw these astronauts walking on the moon and I told myself, I have to be a part of that. And so here I am, working at the Johnson Space Center. When I first started working here, I worked in the lunar lab, which I may show you some pictures of the Lunar Lab and talk about that today.

So starting off, on the left, I just want you to know that that is, I believe, a young-- he's not levitating above the surface, he is giving what they call a high five. So he was jumping and that kind of gives you an idea that the gravity on the moon is not the same as it is on Earth. So even in the big bulky suit and everything, he could jump that high and salute the flag.

On the right, you see Andrea Mosey holding a lunar sample. It's what we call a basalt. It's like a volcanic rock, and notice she's got Teflon gloves on because we only allow certain things to touch lunar samples. These are the samples, by the way, that was brought back by these missions that went to the moon. This particular one was [INAUDIBLE] by Apollo 15. And so we only allow things like Teflon, aluminum, stainless steel, and polystyrene to actually touch the samples. So the gloves that she has on, she can't touch it.

Inside those gloves, she also has her clean room garment gloves. She has several gloves before she's allowed to touch a lunar sample.

So like I said, you know, we didn't-- they said we went to the moon. Well, we had six landings on the moon. And if you noticed they were somewhat co-located around the equator, which, except for the exceptions of Apollo 15 and 17, notice that we didn't land around the south pole here. And I mention that because in going back to the moon, one of the landing sites we're talking about is going back to the South Pole. So we're not going back to the same sites. The idea is to go back to different sites.

So these are the six different crews. Apollo 11 on the left, which we are celebrating the 50th anniversary this July, July 20th. And in the center is Apollo 12. They're kind of famous for or infamous because it's like-- just as they started to walk on the surface of the moon, the camera unfortunately was pointed toward the sun and it burned it out. So we got to listen to them on the moon, we didn't get to see them-- watch the live video.

To the right is Apollo 14. The person in the middle is Alan Shepard he's famous because he was the first American astronaut to be put into a-- they call it a suborbital-- [INAUDIBLE]. He just was sort of like a ballistic arc. He went up and he came back down.

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On the lower left is the Apollo 15 crew. They were the first ones to get-- as you can see the lunar rover, which was very popular with all the astronauts. In the middle is Apollo 16, and on the right is Apollo 17, and the gentleman standing is rather unique-- his name is Harrison Schmidt-- because he was the only geologist of that whole group to actually set foot on the moon.

And so here we have the astronauts walking out of the LEM, the Lunar Excursion Module, walking on the ladder and of course, that last step was a doozy, as they said, because they just kind of jumped off that step and landed. Now on the first Apollo 11, there was a particular scientist, Professor Gold, who said that if you tried to land on the lunar regolith, the lunar soil, that they were just going to keep-- that it wasn't hardy enough to hold them. That they were just going to be buried or covered up by the regolith. But of course, that didn't happen.

And then on the right, you see the astronauts with the lunar rover, which, like I said-- now, those tires, on earth, they weren't inflated. But on the moon, since it's basically in a vacuum on the surface, they were inflated enough to give them a somewhat bumpy ride, but like I said, the astronauts really liked that. That lunar rover enabled the astronauts to go a little farther and to collect more samples.

And as I said, that's, I believe, John Young on the left there. On the right, that that's one of the most iconic photos. I believe that's an Apollo 17 view of a very, very large boulder and the way that large boulder got there most likely was from an impact because the moon does not have an atmosphere like the earth. In the earth, the larger meteors, the meteoroids that come through the atmosphere could either explode. It could land, but typically , it has to be really, really big to hit the surface like that. And then to look at that and see the scale of the Apollo astronaut next to it and understand that that was a product of an impact is pretty sobering, I think.

Now when the astronauts were on the moon, they had these suits that were pretty stiff and they couldn't really bend over easily. So there were tools that were adapted from geologic tools that they could use on the moon. And what you see there is a rake, and you notice it has the tines in there because the purpose of that rake was only to pick up samples of a certain diameter. So it didn't want, like, the big rocks, but it wanted more like soil and smaller soil samples. So that's what you see.

I would also say, if you look at the astronaut suit, he's got a camera that's hanging off the front there. There's a hammer that he has in his hand. And if you look at his suit, you'll see it is absolutely covered in lunar dust. Lunar dust is very sticky. If you look at it through a microscope, you could see it's very angular. It's like volcanic ash, and it has a tendency to stick. Plus it's very dry, of course, and so, you know, it just sticks to everything. And I know this for a fact because working in the cabinets I'll show you in a minute, that was one of the things we had to work with.

You'll also notice from this astronaut's right hand are sample bags. And so these sample bags had little, like, metal tabs on them. And so whatever he collected, he would put into the bag and then put a-- close the tabs and then bring them across, and then they would communicate with the scientist in the back room down on earth and say, you know, this is-- I picked this up here, this is this number. And then

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eventually, later, it would get a number. But that's how they would keep track of all the samples. They didn't just pick it up, put them in a bag, and stick them in their pockets.

So this shows you some more of the tools. The upper left is a hammer again. The cool thing about all these tools is that as the astronauts use them on the surface, they would get feedback. The people who made these tools, manufactured these tools for the astronauts, they'd get feedback from the astronauts and so every mission, they might be just a little bit different. I mean, if it worked fine, that was fine. They didn't do anything else to it.

But the hammer on the left is a really good example of how, in the earlier missions, you know, it had the skinnier kind of head to it. On the later missions, it got fatter because they not only wanted to be able to hit it with the end of the hammer, but they wanted to be able to hit things with the side of the hammer, as well.

You see that scoop in the middle, the one we just saw in the other picture? On the right hand side is what they called the tongs. Remember I said the astronauts had a hard time bending over and the ground-- the folks at Nasa didn't want them to do that anyway. So they had these tongs, and they would pull their hand together, it had two little levers there. And as they pulled it, the tongs would open up, and so they could pick up rocks of a certain size and put them in a bag.

On the bottom left side, you see there, that is a core. So what a core does is you put that-- you hammer that into the ground, which is what the astronaut was doing there, and it will give you an idea of how the soil is layered beneath the surface, beneath what you can see. And so they would pound that in, and then they would close off the ends and-- close off both ends and then bring it back to Earth to the Johnson Space Center in Texas, where a lot of those cores were eventually opened and characterized, and then made it available to scientists all over the world.

Then you can see the rake here, again, a little. On the right is like a scoop or sort of like a shovel, and then on the right, what you see is an astronaut training on earth with these tools so they could get used to it. So when they went on the moon, it wasn't something they had to learn how to get used to. It was something they would have experience with and could use hopefully more efficiently on the moon.

So this was an exciting day here on the left. This was actually in Building 37, I'll show you a picture of that in minute. So it was after the Apollo 11 crew came back. And as you can notice from the gentlemen, they're all kind of sweating and hot. That big white-- what we call an isopod, within that isopod was one of the rock boxes, and we'll show you a picture of that in a moment.

But this was the first rocks actually coming back from-- after they came back from-- the ship came back to Earth on the land, and they eventually got it back to Johnson Space Center. So that's what they're collecting there. Notice that you have security guards all the way around, and it's roped off so nobody could come in there.

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If you went into building 37 on the right, you would see these kinds of cabinets that people would work in. And notice how the gloves are hanging down. The reason for that is inside those cabinets, the idea was, well, you have a vacuum on the moon, so we think we should just imitate that vacuum in the cabinets.

Unfortunately, that didn't work very well. It required a lot of equipment, a lot of upkeep. And quite frankly, they really weren't able to keep the vacuum in the cabinets as precisely as they wanted. So this slide here, remember I said that big white isopod? Well, inside of that isopod was this very shiny, I call it a rock box. They of course being NASA, they had a name for it.

So you can see on the inside, you have a bag where they placed the rocks. And then you had, I believe that's aluminum on the inside of the box and then it had a seal on the outside. And then the top would come over and they could seal it that way. But what they didn't count on was the regolith being as dusty as it was, and so in some of the rock boxes, they did not-- they weren't able to keep that vacuum seal in it because they weren't able to seal it when they closed the box.

But that's what it looked like inside the cabinet when they open these boxes and then started taking out the samples. And what they did is they had a group of scientists there who would do what they call a PET examination, preliminary examination team, and they would start characterizing, you know, is this a [INAUDIBLE]? Is this a rock that's a product of impact? Rock that's made up of other rocks? Or is this a basalt? Is this like a volcanic sort of a rock?

And so they do that very early examination on the rocks that came back from each mission.

I mentioned you saw that the cabinets with vacuums? Well, that was the building here called Building 37, and you notice there are multiple layers in it. That first and lowest layer is where they had administrative offices. The next layer up, they tried to do a bio containment, and then the very next layer up is where those cabinets were.

It it's interesting that, of course, now the samples are kept in Building 31. But sadly, this building here had foundation problems. It's actually-- they built another building for the folks there. No one works there anymore, and they are going to tear it down. Which is kind of sad but I guess that's progress.

This is Building 31 North. This building was completed in 1979. The express purpose of this building was to house the lunar samples. And so up at the top is where the Pristine Vault, which I'll show you in a moment, Pristine Vault and Pristine Lab is located.

Originally, those two big openings that you see, that's where the lunar lab was. But now they have a Genesis Lab, which is another collection that we have. And so this is the Pristine Sample Lab upstairs, PSL, and I can tell you for a fact, and this building was completed in 1979, all these cabinets were specifically built to go inside this building. You'll notice how different they look from the earlier ones that I showed you where, the gloves were hanging down.

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The reason we have these white things on them is because the gloves-- it's nitrogen that's flowing inside the glove boxes, and it's a positive flow. So what does that mean? Well, that means if I took that white booty off, that glove is going to come out like a balloon. If you blow into a balloon and the balloon comes out. It's the same thing with the gloves, when instead of being filled with your air, these are filled with nitrogen.

So as I said, there's only certain things that are allowed in those cabinets. Each cabinet is only allowed a specific mission. So the one closest to you on the left is Apollo 16. The one over there on the right is Apollo 17. And notice the furniture and everything in there is either going to be stainless steel or aluminum.

The things that are hanging up on top of the cabinets, those are balances. So we pull out as much of the electronics as we can and put it on top of the cabinet. Inside the cabinet is that part of the balance that you weigh the samples with, and that's just part of the procedure is before you-- and by the way, the samples are not stored in this lab. They are worked on in this lab to prepare for samples to go out to scientists all over the world. And of course, in the United States.

The way you get samples in and out of there, if you look on the left, you see this round thing right there. On the other side of that is a corridor. So you cut off a bag, you put something in there, it could be a sample. The sample's not exposed to air, it's still in a bag or a container that has nitrogen in it. You purge that for five minutes with nitrogen, then you pull it into the cabinet and you work on it.

Like I said, each one is dedicated to a mission. In Apollo 17, you wouldn't open like a 72275 with a 71175 at the same time, because they were picked up in different places. You don't want to cross contaminate.

A little quick note about the naming convention. Apollo 11, all those numbers started with a 10. 12, 14, and 15 started with a 1. But as I said, with the rover, they could go farther and pick up more samples, and scientists were saying, you know, it would really help to know where in the EVA, extravehicular activity, you picked up that rock, and they would be given numbers like one, two, three, four, five.

And so for example, 72275 is Apollo 17 TVA 2. 275 is the number that was given to the sample later. And so that's the naming convention. And anything-- any lunar sample that goes anywhere is always tracked by the database. You always have two people-- it's very high security. So sometimes people say, well, you know, can you pick one up and walk off with it? No, no you can't.

These are some of the people who work in the lab. Again, that's Andrea up on the top. At the bottom is Francis, Dr. Francis McCubbin. He is the astro materials curator. To the right is Cherise [INAUDIBLE] and Jeremy Kent, and they both have degrees, bachelor's and master's degrees, and they work in the labs. And on the right is Cherise opening up the bank vault door. That is the Pristine Sample Vault, PSV. Those are where the samples are actually stored.

This is Andrea, she's inside the vault. Notice that she has a bin there, and you'll also notice there's a tag on that bin. So if you're going to go into there and, again, each one of those cabinets is dedicated to a

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specific mission. Notice you've got more gloves on this. That's because these cabinets are higher and you have these bins in there.

But in order to open it up and take any samples out, you have to put the whole bin into the airlock, take it out, and then you have to have a NASA person and a contractor there to break that seal. You have to document that in the database. And then you can take out the sample that you need and then close it back up, and seal it back up.

So yeah, and this is all, again, like I said, behind a big vault door. So these are very, very high security areas.

So I just want to give you an idea of the kind of samples that you find in our labs. On the left is anorthosite. It's a white rock. We have anorthosites on earth, but they tend to look a little more gray. It's because on earth, they're weathered. We have flowing water, and an atmosphere, and all sorts of weathering going on which you don't have on the moon.

But the reason the anorthosites, which are pure plagioclase, which, again, is a very white mineral. The reason astronauts are very excited about that is they believe that these were examples of the original crust on the moon. And so these come in as very, very old rocks.

The one in the middle, again, is a volcanic rock and what we call is a particular moray basalt and the reason you see the holes in it is because below the surface they're under a higher temperature and a higher pressure and during the late heavy bombardment you had a lot of the Murray those dark areas that you see on the moon formed. And it cracked places in the crust. And so the magma was able to come up to the surface and flow out. And so when it did that, it cooled, and it was less pressure. So the gases that were in the magma were able to come out, and that's why you have the holes there. And it can make some really pretty rocks.

The rock on the right is an example of what we call an impact breccia. So you can see dark rocks in the lighter matrix. On earth, we have breccias too. But typically, breccias will have rounded fragments of other rocks in it. Of course, again, on the moon, you don't have weathering. You have this very violent impact event. And because of that high temperature and high pressure, you have these breccias-- these rocks-- made of other rocks that form.

So all total, we brought back about 382 kilograms of rocks. It's about 840 pounds. We started off with almost 2,200 original samples. We have well over 100,000 now because you start off with comma zero. And every time you make a split, that's comma one, comma two, three and comma four. And so now we have over 100,000.

85% by weight remains pristine. What does that mean? Well, that means it hasn't been exposed to air. We've kept it in the nitrogen atmosphere. And we have a class 1000 clean room. So as you saw with Andrea, and Jeremy, and Cherise, they're all wearing-- we call them bunny suits-- but they're actually clean room garments.

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And it's not even the cleanest kind of lapse that we have. But how do we know they're clean? Well, we come in, at least, once a week, and we measure the particles that are in there. So it's not that it's sterile clean. It's that it's particle or contaminant clean. I think that was the last one.

SPEAKER 1: OK, thank you, Kim. I think since we only have a small number, why don't we just-- will everybody be unmuted. And you guys directly ask questions with Kim. [INAUDIBLE] Go for it, Quincy.

KIM WILLIS: We're all yours.

SPEAKER 1: Can't hear you.

AUDIENCE: Can you?

SPEAKER 1: Yeah, now we can hear you.

SPEAKER 2: Oops. We lost her again.

SPEAKER 1: We lost you again, Quincy. Still can't hear you.

SPEAKER 2: She's looking to, maybe, have someone else go first since she's trying to work out her technical difficulties. Or you can read the questions.

SPEAKER 1: All right. Does anybody want to talk to Kim? Don't be bashful. E073902, you want to ask a question?

AUDIENCE: Testing.

SPEAKER 1: Yeah, I can hear you.

AUDIENCE: What is the coolest rock you found, where did you find it, and when did you find it?

KIM WILLIS: What is the coolest rock that the astronauts found? You know, that's kind of like saying, what's your favorite race car? I mean, all the crews had different ones. The one I remember the most is what they call a genesis rock, the Apollo 15 astronauts. And that's because it was a pure plagioclase, a pure, white rock sitting on top of another rock.

And the Apollo 15 astronauts were so excited because they were told that if you find this white rock, you will unlock the mystery of the creation of the moon. It turns out that wasn't exactly true for that particular rock. But the cute story behind it is that the Apollo 15 astronauts were so interested in geology. I mean, these were fighter pilots, but they were so interested in geology, and they were so excited to find these rocks and continue to come to conferences afterwards and talk about the samples.

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So exactly when was that found, again, that was Apollo 15. So I'm guessing it's, what, '70, '71?

SPEAKER 2: Apollo? Yep, '71.

KIM WILLIS: '71. And Jim Irwin actually brought his mother into the lab to see that genesis rock in 1984 or '85. So it made a big impression on him. So that's one of my favorite. The second one is what we call the green clod because it actually was green. And if you listen to the transcripts on Apollo 15 between Dave Scott and Jim Irwin, Jim Irwin was a very proud Irish of Irish descent.

And he told Dave Scott, I found a green rock. And Dave Scott said, no, no, no. That's your visor. You know, that gold visor, it makes everything look green. He says, no, no, no. It's really green. So he finally got Dave Scott to look at it, and Irwin couldn't have been more proud to have found that green rock.

Now, why did he find a green rock? Well, it was part of the, they believe, lava fountaining on the moon. And they were little, tiny glass beads in it. And that's what gave it the green appearance. Each crew, of course, wanted to pick up the biggest rock. Apollo 14, I think they had one they called Big Bertha. So you know, they weren't competitive or anything, but it depends on who you talk to is what's the coolest rock.

SPEAKER 2: And you showed the genesis rock in your last slide. It was that whitish color rock on the left. That was the genesis sample that's, probably, 4.4 to 4.5 billion years old. So pretty cool.

SPEAKER 1: Does somebody else want to ask a question? [INAUDIBLE] with a E. Don't know who you are, E073902, but you want to try a question? You're unmuted. Talk to us on chat if you can't get it to work. All right. You're gonna be bashful? All right, Quincy, you got another one.

AUDIENCE: It's still working?

SPEAKER 1: Yep.

AUDIENCE: OK. What type of degree is required to work at NASA?

KIM WILLIS: Well you know, actually, NASA hires all kinds of people, specifically if you wanted to work in curation. The people who work here have degrees in geology, in chemistry. We have people on the research side of the house that have degrees in geochemistry, chemistry, physics.

But you know, we also have people who work on many other things who don't have a degree. One person keeps this building up and running and knows every part of it.

SPEAKER 2: And he's got what kind of degree?

KIM WILLIS: A high school degree.

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SPEAKER 2: A high school degree.

KIM WILLIS: He's brilliant. I mean, he's fantastic. We couldn't do this without him.

SPEAKER 2: And I'll add to that, through his hard work and perseverance with things, he's just grown up the chain. He didn't come in as a building manager. And when we say a building manager, I mean, we're talking about a place where we have lunar rocks, meteorites from space, we have cometary particles, we've got particles from asteroids, we have specialized laboratories with million dollar equipment, and so there's so many different amazing aspects of this building.

And to have a fellow like him, in particular, with just a high school degree-- but getting those college degrees, wouldn't you agree, Kim, allows you to progress further, especially in the sciences. So we even have cleaning room techs.

KIM WILLIS: We do.

SPEAKER 2: So that are actually there to clean the materials and the tools that are used to curate, or take care of, and work with these lunar samples. So it's amazing.

KIM WILLIS: Yeah, and we're somewhat biased and rightfully so. But we also have biology and astrobiology components [INAUDIBLE]--

[DOG BARK]

--with the degrees in biology. So you know, whatever degree you get in, you probably could find a place to work at NASA, if that's what you want to do.

SPEAKER 2: And the other thing I'll add is we have had-- Cherise is an engineer.

KIM WILLIS: Yeah.

SPEAKER 2: She started out as an engineer. And then, we took her over in science. And actually, she went back to school to get a additional degree in science. So you never know where your interests could lead you. But schooling really helps diversify you as a whole.

KIM WILLIS: That's right.

SPEAKER 2: Great question, Quincy.

SPEAKER 1: Thank you. OK, I think we'll do one more question because we only have a small audience. And then, we'll call it good for today. So last question, Quincy. You got it.

SPEAKER 2: Make it a good one.

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AUDIENCE: OK. I'm gonna try and go back to all my questions. These two questions are, kind of, linked with each other.

SPEAKER 1: [INAUDIBLE]

AUDIENCE: What type of moon rock is the lightest, and what type of moon rock is the majority of the moon?

KIM WILLIS: Ooh, that's a good question. What type of moon rock is the majority of the moon? If you ask a planetary geologist that question, they will say, well, what do you mean? On the surface or compositional speaking?

I would say, if you're looking at the surface, the type of rock that you see the most is, probably, the [INAUDIBLE], the highlands kind of material. Those lighter colored earlier kind of rocks. Younger rock. I mean, older rock. Sorry.

SPEAKER 2: And the lightest? Can you even [INAUDIBLE]? That's a tough one.

KIM WILLIS: That's a tough one, yeah.

SPEAKER 2: [INAUDIBLE] pick up rocks of different sizes and their masses. That's a tough one to answer.

KIM WILLIS: Yeah.

SPEAKER 1: All right. Well, thank you for your time, everyone. And we'll post this on our YouTube channel, as always. We have just posted last week's talk by George. And so we'll post this one up, probably, next week. And hopefully, we'll see more people next week, or see you guys on the YouTube channel. Thanks much, guys. Appreciate your time.

SPEAKER 2: Thank you. Thanks, Quincy and everyone else who might have joined in. Thank you.