[MUSIC PLAYING]

KAREN FOLEY: So Jan Raack, welcome to the studio. What do you think of our audience's ideas? Aren't they creative?

JAN RAACK: Of course, yes. So I joined the online chat a couple of minutes.

KAREN FOLEY: I hear you've doing very well.

JAN RAACK: Yeah, it was my first time--

KAREN FOLEY: Bringing some sense to the conversation, I hear.

JAN RAACK: A little bit of science, yes, but not so much. Yes.

KAREN FOLEY: No, that's brilliant. No, thank you. What's it like then for you? You're an academic at the Open University. You've been here not since very long. So you started here in March so it's all been quite new.

What's it been like talking with-- and we've got a lot of science students out there. What's it been like as an academic then talking to everybody in this sort of environment? How have you found it?

JAN RAACK: A little bit weird, to be honest, because I was a student a couple of years ago, too. And for me, it's a step further from students to ask questions-- to answer questions. So for me, it's really new and I am excited with it, really, and I enjoyed it. Yes.

KAREN FOLEY: Excellent. You're now doing a lot of research. So you were from Germany and you've now come to the Open University here in sunny Milton Keynes.

JAN RAACK: Sunny, yes.

KAREN FOLEY: Well, not really, is it? We won't lie. And you're looking about surface activity on Mars. So we've just been talking to Rhian about the lander and obviously, this has an impact in terms of what we will know about the surface.

But as Jon was telling us, the Trace Gas Orbiter also has a lot of instruments that are going to take various measurements that will give us more knowledge about the surface. So in terms of

this whole thing and the Trace Gas Orbiter and lander, what can we say then about your specific area of research, in terms of what you're looking at for the surface of Mars?

JAN RAACK: At the moment, not very much because the Trace Gas Orbiter has a very good camera onboard and I'm working a lot with remote sensing data sets from cameras and spectrometers. The camera has a very good resolution, up to five metres per pixel. And it also can get very high-resolution colour 3D images of Mars. But the first images I think will arrive at the Earth in 2018-- so after the break-up. And maybe at this time, I'm not here in Milton Keynes and I have no idea where I'm working then and if I can get these images.

KAREN FOLEY: Wow. So that's going to take a lot longer.

JAN RAACK: Yes.

KAREN FOLEY: Why?

JAN RAACK: Because at the moment, the Trace Gas Orbiter is too fast. And it has to go around Mars and it becomes slower, slower, slower and it takes over one year. And after this, the camera starts and everything is working fine.

KAREN FOLEY: So it's about the phase, as opposed to actually getting the resolution of images back down here. Yeah. OK, excellent.

So can we start talking about what we already do know then, in terms of the surface, because this is something that I guess most people are very interested in, especially if they're looking at whether life on Mars is possible or even has been. So what do we currently know then about the Martian surface?

JAN RAACK: A lot, I think-- we know a lot of the history of Mars. But I will say the history of Mars is like you read a book and you read a book not page by page or sentence by sentence. You read it on page 100, sentence two and then page 50-- so not in the right order. At the moment, we are putting in all the things together to get the history of Mars, to read the book completely from the beginning to the end.

And with every single image, with every single Mars mission, we get more information and to have a better clue about what's going on on Mars or what's happened on Mars billions of years ago. So this is what we are doing. We are scientists who put the puzzle together.

KAREN FOLEY: One thing I know about Mars is it's called the "Red Planet." So what's all this redness about and what's that got to do with the history of the climate and surface?

JAN RAACK: Normally, the rocks are not very red. So the surface is red. This is oxygen because of the interaction of the rock with the atmosphere. And when you could grab on the surface, it's grey under the reddish surface colour.

KAREN FOLEY: OK. So it's--

JAN RAACK: So like the Moon maybe, there.

KAREN FOLEY: Yeah. So it's mainly grey but the bits of red, they're there to do with the rocks and things.

JAN RAACK: Yes.

KAREN FOLEY: And then I guess we've been talking a little bit about how we interpret and have these various ways. Is the redness then just a media concept of Mars then?

JAN RAACK: Say what?

KAREN FOLEY: Just thinking about how we were talking about how important it is for media to represent space in certain ways-- so we were talking about extraterrestrial life and *The Martian* and whether being blown away was an indication. Mars, the Red Planet-- is that more a media interpretation to make nice models and to say that as opposed to the reality because a lot of it is grey, as you say?

JAN RAACK: I am not really clear what you meann--

KAREN FOLEY: No, that's fine. No, no. No, gosh. No, no, no, it's fine. It's more just a point, I guess, about how sometimes, I think, especially if we're looking at things, we cotton on to something very small and often not very accurate when we're describing something. And maybe that's the case with Mars being called the Red Planet. We know more.

JAN RAACK: It is red, but only on the top surface.

KAREN FOLEY: Only just on top of the surface-- so it's not really, really red. Yeah. No, perfect.

OK. We've also been talking about what it might be like to exist in that atmosphere and that it's generally very cold. We've talked about the carbon dioxide and the air quality not being so good, et cetera. So we also know then that there have been lots of volcanoes and craters and

things happening over time. What do you think then is most interesting about that Martian surface?

JAN RAACK: At the moment or in general?

KAREN FOLEY: In general.

JAN RAACK: In general-- now, there are two parts which are very important. So the first part is the search for life, of course. It's the most important thing. And when we do the search for life, we have to look at the very old rocks where we can maybe find some microfossils. So we have to look at the old rocks on Mars and we can find it on Mars.

On the other hand, it's also very interesting to look on what's happened on Mars now, not in terms of life but in terms of activity. And we have activity on the surface on Mars but it's only recognised in the last couple of years because we need, for example, a lot of images to cover and to see this activity on Mars today. Yes.

KAREN FOLEY: These rocks then, some of the old or new ones, how do we know if they're old or new? And do we need to drill to get hold of any or are they on the surface?

JAN RAACK: They are on the surface but it's very difficult to know if this is old or new. We cannot go there and say, OK, this is an old rock or this is a new rock or whatever. So the interpretation is more like the age of the surface.

So we look at the surface. We count the craters on the surface and then we can say, OK, it's an old surface with a lot of craters. It's a young surface with less craters. There are some equations where they can fill in these data sets and then you can say, OK, this formation of rocks is maybe two billion years old. Then we can find maybe something more on it.

KAREN FOLEY: Because one of the things that I know you wanted to talk about was the historical overview because we've created these wonderful names for these various periods throughout the history. And you've got the Noachian Period, the Hesperian Period, and the Amazonian Period. So can you tell us-- those are categorised by quite different environmental changes, aren't they?

JAN RAACK: Yes.

KAREN FOLEY: So there were differences in terms of the atmosphere and we've already seen that the

atmosphere's dramatically changed. So it was a lot more like Earth's environment than it is now. Could you talk us through some of those? What's most interesting about those periods and how does that translate?

JAN RAACK: Interesting is every period of time. So the first period is from, I think, 4.5 billion to 3.7 billion years and for the search of life, it's the most interesting period of time because Mars was habitable in these early days of Mars or early years of Mars. There was water stable on the surface. The atmosphere was denser than today. Mars had a magnetic field so it shields it from the Sun's radiation and it was very comparable to the early Earth.

So like Matt told us in the introduction, it is possible that lifeforms existed in the first time. But then something changed Mars. In the Noachian time, something changed. Then we have a lot of volcanic eruptions all over Mars. We have the loss of the magnetic fields and because of this, we have the loss of a lot of the water. And the atmosphere was full of sulphur.

This stopped, I think, three billion years ago. And then normally, the scientists say that from this on, Mars was a dry and cold and dead planet. But this is not true because in the last couple of years, we saw activity or we see actual activity on the surface. So yes, it's a dry and cold desert planet but it's not dead. So we see something happened.

KAREN FOLEY: So why those changes-- on Earth, when we look historically at the Earth's environment, we have ideas about what may have happened to cause massive shifts. Are there any theories around any of those changes?

JAN RAACK: I'm not sure, really.

KAREN FOLEY: No?

JAN RAACK: No.

KAREN FOLEY: No. But they were just very, very different and we've seen massive, massive changes over time.

JAN RAACK: Yeah.

KAREN FOLEY: One thing I wanted to ask you about is some of the reservoirs. So we've been looking at some. We've talked a little bit before and I don't want to repeat about some of the lakes, et cetera, or anything. But the last reservoirs are volatiles at the poles and polar caps. There are massive

changes going on there at the moment, aren't there?

JAN RAACK: Yes, seasonal changes, like on Earth. So it's like the breathing of Mars. So we have an annual waxing and waning of the polar caps. So we have two types of polar caps. We have the residual polar cap, which is stable and it lasts every time and we have the seasonal polar cap.

So ice sublimating, going to the atmosphere, travelled around Mars, settled down from the south polar to the north polar regions-- settled down. And then when the winter came, it sublimates, too, and so on. So we have a very good volatile circle on Mars, which is completely different on maybe the Moon, where there's nothing.

KAREN FOLEY: We've been talking a lot about the Red Planet-- sorry to trigger such a conversation about that-- and these dust storms are clearly important. But also, I wanted it to conclude by talking about some of these dust devils, which is an area of work you've been very interested in. They leave dark, bright tracks on the surface of the Moon. So what are they? They're an unsolved mystery, aren't they?

JAN RAACK: It is solved now.

KAREN FOLEY: Oh, you solved it now?

JAN RAACK: Yes.

KAREN FOLEY: OK.

JAN RAACK: Dust devils are very weird. So dust devils are known on Earth since hundreds of years. So everybody knows dust devils. There are small whirlwinds on fields or whatever. And on Mars, it's a very funny story because on Mars, in the '70s or '80s, they detected some weird structures on the surface-- so bright tracks and dark tracks and they have no idea where they are coming from.

Later, in-- I have no idea when-- 2000 or so, 2001, with a better and better camera resolution, they saw, OK, they are dust devils on the surface of Mars and they leave tracks. Yes, but it was a mystery why are there bright and dark tracks on the surface because on Earth, there are no tracks or there were no tracks.

So then something happened that the scientists are looking at the surface on Mars-- on Earth and look for dust devil tracks for the first time. And they found some dust devil tracks on the

Earth, too. So they found something new on Mars then looked onto Earth, found it, too, but it was in Niger, where the civil war is. And you cannot go there and make signs.

So one year later, they found the proposed mechanism of the dust devil tracks on Mars with the Rover. So the Rover drove over the surface, found a dust devil track, put the microscopic camera on it, and saw, OK, there is less dust in the dust devil track. So the dust devils blow away the dust on the surface and it is seen by the tracks.

And then on, it was my colleague Fermi and me. We are looking again at Google Earth images on the Earth and we found also dust devil in China. And we packed our backpack to go to China in the desert and detected the dust devil tracks for the first time ever on Earth. And we can prove the proposed mechanism for Mars and for Earth. So it was the first time, I think, that something very new was observed on Mars and then we put our knowledge from Mars to Earth.

KAREN FOLEY: Excellent-- so very, very comparable in terms of the planets, as well, and Mars actually adding something that we could then use to investigate here and then apply.

JAN RAACK: Yes, on Earth.

KAREN FOLEY: Excellent. That's brilliant. We'd asked our audience, is it true that space missions to Mars failed because some engineers used metric measurements for their calculations and others used imperial measurements? 67% of them thought that was true. Is that right?

JAN RAACK: Yes, that's true. It's sadly true. It was in 1999 where the NASA mission-- it was the Mars Climate Orbiter, I think. Yes-- where the NASA scientists are working with the metric system but Lockheed Martin, the company who built the navigation system, are calculating with miles and so on. And what happened? The Mars Orbiter crashed completely into Mars and that was all.

KAREN FOLEY: Oh.

JAN RAACK: So since then, everybody is calculating in the metric system.

KAREN FOLEY: The metric system won out, did it?

JAN RAACK: Yes.

KAREN FOLEY: Yes. No, very important. Especially when there are so many different nationalities working with

different conventions, it must be very important to have standardised measures so that--

JAN RAACK: Yes, of course.

KAREN FOLEY: Yeah, so you don't make errors.

JAN RAACK: That's the reason why we have this now.

JAN RAACK: Excellent. Jan Raack, that's all we have time for but thank you so much for coming on. We're going to take a look at what you thought about extraterrestrial life. So this time, we've asked a various range of questions about whether you think that yes-- this is specifically, I guess, in terms of life-- "yes, they visited Earth or live on Earth," "yes, there was or is life on Mars," "yes but not in our solar system," or "no." So we'll see what you thought about the answers.

And if you haven't voted on those interactive widgets, you can just select them. Touch on the option that appeals most to you, decrease the screen, and you'll be able to see what everyone else has also and we'll have the results from that now, actually. So in the lead, we've got "yes, but not in our solar system" with 47%. And I guess a lot of this depends on the interpretation of life, whether we mean Martians or organisms or plants or et cetera-- so very interesting there.

Our next guest coming into the studio is Matt. But before we do that, Sophie and HJ, how's it all going on the Chat? Are things a little bit more sensible now?

SOPHIE: No. I think we've hit a new low. We've started talking about *My Little Pony* and I'm actually quite worried about how much HJ knows. So I've got a little sister.

KAREN FOLEY: It's all for kids.

SOPHIE: She's six. Oh, well, that would explain it but--

HJ: I never have any enjoyment watching that show.

SOPHIE: Knows all the characters and--

[LAUGHTER]

And you even have a favourite, I believe. Well--

KAREN FOLEY: Which one? I know all about *My Little Pony,* as well. Which one?

HJ: Well, I think everyone has to know that Applejack's kind of cool. So yeah.

KAREN FOLEY: She's a monkey. She's always getting--

[LAUGHTER]

HJ: Maybe I relate somehow.

KAREN FOLEY: Why are you talking about *My Little Pony?*

SOPHIE: I'm not even sure how we got there. I'm really quite confused. There have been some really good questions in the midst of all this madness.

KAREN FOLEY: Oh, yes. I have one, actually, I'm going to talk to my next guest about, which was about this whole idea, well, of Brexit and the impact in terms of involvement in ESA that I think will be ready to start talking about. So everyone's happy, are they, in the Chat?

SOPHIE: Yes.

HJ: And I think we are ready to talk about the future, as well. Grounding ourselves again, Davin's talking about, "If we had a colony on Mars, would resources like metals and minerals be usable with all the radiation reaching the surface?"

SOPHIE: Paula's asked a really good question, actually, about whether a magnetic field could be placed back on Mars using technology. And she's also asked whether humans, if they were born on Mars, could they then evolve to live outside of a habitat that we place there? For example, would they be able to evolve to live on Mars without the necessary scientific--

HJ: I think someone else brought up, interestingly, about the psychological stamina required to go to Mars and live on Mars in such a harsh climate. So there's all interesting stuff and I think we're very interested and excited to start this.

SOPHIE: In the midst of our madness, there was--

HJ: Yes, there is some sensible stuff--

SOPHIE: There are some people there who are keeping us grounded this time.

[MUSIC PLAYING]