

30 MINUTES TO MARS

THE JOURNEY TO MARS

NASA

30 MINUTES TO MARS



1
00:00:08,700 --> 00:00:09,700
[Background Music]

2
00:00:09,700 --> 00:00:10,700
>> Good day.

3
00:00:10,700 --> 00:00:12,420
I'm Amiko Kauderer with NASA Public Affairs.

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00:00:12,420 --> 00:00:18,610
Mars is a fascinating planet and NASA's journey to Mars has many challenges and many possibilities.

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00:00:18,610 --> 00:00:23,950
We recently talked with NASA Planetary Director Jim Green and NASA Astronaut Stan Love about

6
00:00:23,950 --> 00:00:27,590
taking a trip to Mars and what it will take to get this us there.

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00:00:27,590 --> 00:00:32,160
Here's more of what we learned about a future trek to the red planet in this special edition

8
00:00:32,160 --> 00:00:35,230
of 30 Minutes to Mars.

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00:00:35,230 --> 00:00:39,660
We get an example of robots and humans working every day as it is now on the International

10
00:00:39,660 --> 00:00:40,660
Space Station.

11
00:00:40,660 --> 00:00:44,890
So for you Stan, and you can better explain some of-- some of that and also what it's

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00:00:44,890 --> 00:00:47,829

like to be living with other human beings.

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00:00:47,829 --> 00:00:49,810

I don't know, what is the size of the crew?

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00:00:49,810 --> 00:00:52,140

Have they even discussed what that might be on Mars?

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00:00:52,140 --> 00:00:54,280

>> They have discussed, of course, the engineers.

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00:00:54,280 --> 00:00:58,450

The ideal number of human crew members as far as the engineers are concerned is zero

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00:00:58,450 --> 00:01:02,070

because it makes the ship so much simpler and lighter if you don't send any people.

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00:01:02,070 --> 00:01:07,740

Realistically you don't want to send too few people to be locked together in a minivan

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00:01:07,740 --> 00:01:12,360

for three years because the social interactions can be bad.

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00:01:12,360 --> 00:01:17,310

So you need a certain size of crew, maybe about six or so, to keep a social atmosphere

21

00:01:17,310 --> 00:01:20,039

that's not going to disintegrate.

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00:01:20,039 --> 00:01:25,549

There's also reason to send more people because the trip to Mars is going to be expensive.

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00:01:25,549 --> 00:01:28,820
We're probably going to have to cooperate
with other nations and other agencies to do

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00:01:28,820 --> 00:01:33,869
it and they are going to be unwilling to pony
up the money if their person doesn't get to

25
00:01:33,869 --> 00:01:34,869
go.

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00:01:34,869 --> 00:01:40,869
So for international cooperation purposes
a crew of four to six is probably about right.

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00:01:40,869 --> 00:01:45,840
If you go back and look at the history books
and see what happened when we were exploring

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00:01:45,840 --> 00:01:51,770
the arctic and Antarctic around the turn of
the last century around 1900 there are cases

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00:01:51,770 --> 00:01:58,069
where very small parties went for very long
times in very harsh conditions and did okay.

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00:01:58,069 --> 00:02:01,329
So I don't think that's a tall tent pole.

31
00:02:01,329 --> 00:02:04,850
Now working with robots, on the International
Space Station we talked a lot about the robot

32
00:02:04,850 --> 00:02:05,850
arm.

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00:02:05,850 --> 00:02:06,850

>> Mm-hmm.

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00:02:06,850 --> 00:02:10,179

>> But that is not much of a robot.

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00:02:10,179 --> 00:02:11,630

It's a manipulator system.

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00:02:11,630 --> 00:02:12,630

>> Mm-hmm.

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00:02:12,630 --> 00:02:16,320

>> The crew commands it and it goes exactly where they tell it to.

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00:02:16,320 --> 00:02:20,459

And there's a great deal more typing than there is hand controller work but that's how

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00:02:20,459 --> 00:02:21,599

you control it.

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00:02:21,599 --> 00:02:26,019

The robots that we're talking about for planetary exploration are smart.

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00:02:26,019 --> 00:02:31,879

They can roll forward, detect a rock, and go around the rock.

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00:02:31,879 --> 00:02:35,580

Our robot arm on space station, the only thing that prevents it from hitting the space station

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00:02:35,580 --> 00:02:36,629

is the crew.

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00:02:36,629 --> 00:02:38,610

It has no intelligence whatsoever.

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00:02:38,610 --> 00:02:45,629

So when we talk about robotic assistance on the surface of Mars we're talking about something

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00:02:45,629 --> 00:02:50,879

far more sophisticated than the jointed manipulator systems that we're using on the space station.

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00:02:50,879 --> 00:02:51,879

>> Sure.

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00:02:51,879 --> 00:02:55,700

>> These things will be able to follow a human along, carry tools, analyze things, be sending

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00:02:55,700 --> 00:02:59,760

back telemetry to the base all the time.

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00:02:59,760 --> 00:03:02,739

And they'll be able to make some of their own decisions, which is not something we see

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00:03:02,739 --> 00:03:03,879

on the space station.

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00:03:03,879 --> 00:03:04,879

>> Yeah.

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00:03:04,879 --> 00:03:08,459

>> One of the-- It's actually a lander that we're building right now is called insight.

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00:03:08,459 --> 00:03:09,459

>> Okay.

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00:03:09,459 --> 00:03:15,359

>> And it-- It's going to land not very far, actually, from where curiosity is, approximately

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00:03:15,359 --> 00:03:20,989

in the same longitude but several degrees
in latitude higher.

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00:03:20,989 --> 00:03:26,540

And it's designed to make seismic measurements,
going to put a seismometer down on the surface.

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00:03:26,540 --> 00:03:33,690

It's going to drill several meters below the
ground and then look for the heat flow, and

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00:03:33,690 --> 00:03:37,909

that's all about determining how active the
planet really is.

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00:03:37,909 --> 00:03:40,940

Does it have a molten core?

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00:03:40,940 --> 00:03:46,219

How geologically active in terms of Marsquakes,
if you will?

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00:03:46,219 --> 00:03:47,659

We also want to know that.

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00:03:47,659 --> 00:03:53,780

And we know Mars is hit by meteors that are
coming primarily from the asteroid belt, which

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00:03:53,780 --> 00:03:56,970

exists between Mars and Jupiter.

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00:03:56,970 --> 00:04:01,040

And as those impacts occur they're going to
generate sound waves.

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00:04:01,040 --> 00:04:06,860

And then inside sitting on the surface a seismometer will see those and then understand a lot more

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00:04:06,860 --> 00:04:11,269

about the structure, the interior structure of that planet.

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00:04:11,269 --> 00:04:16,900

From a scientific point of view that's tremendously exciting because it gives us an idea of another

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00:04:16,900 --> 00:04:22,150

terrestrial planet and how it's put together and tells us about the early origin of our

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00:04:22,150 --> 00:04:24,870

terrestrial planets here in the solar system.

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00:04:24,870 --> 00:04:31,760

From human exploration perspective knowing how active Mars is will allow them to work

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00:04:31,760 --> 00:04:36,540

in the field without getting knocked down if there are large Marsquakes.

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00:04:36,540 --> 00:04:40,971

And indeed we just don't know how active Mars is and that's-- That will be important to

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00:04:45,160 --> 00:04:42,280

know.

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00:04:45,160 --> 00:04:51,000

Some people call those the space station of Mars, you know, because, you know, there might

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00:04:51,000 --> 00:04:55,210

be an element of that where we go visit Phobos and Deimos first.

77
00:04:55,210 --> 00:04:56,210
>> Yeah.

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00:04:56,210 --> 00:04:57,210
>> Before we get down on the surface.

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00:04:57,210 --> 00:04:58,210
>> Yeah many-

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00:04:58,210 --> 00:04:59,210
>> What are your thoughts on that?

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00:04:59,210 --> 00:05:02,720
>> Yeah many of the technical problems for getting to Mars are landing on Mars and then

82
00:05:02,720 --> 00:05:04,770
launching again off of Mars.

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00:05:04,770 --> 00:05:06,310
Mars is a planet.

84
00:05:06,310 --> 00:05:07,820
It's hard to launch off of Mars.

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00:05:07,820 --> 00:05:12,060
When we launch people off of the Earth we go down to Kennedy Space Center in Florida

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00:05:12,060 --> 00:05:18,510
and there are 10,000 incredibly dedicated people who put those spacecraft together,

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00:05:18,510 --> 00:05:22,620
get them out on the pad, make sure everything is perfect before we launch them.

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00:05:22,620 --> 00:05:27,710

And when you go to Mars and it's time to come home you will do all that work yourself.

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00:05:27,710 --> 00:05:29,610

No dedicated army of people.

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00:05:29,610 --> 00:05:31,270

You will check out all the systems.

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00:05:31,270 --> 00:05:35,500

You will make sure the air-- the spacecraft is, you know, fueled and ready to go.

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00:05:35,500 --> 00:05:39,240

And that's a job we've never had crews do all by themselves before so that's going to

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00:05:39,240 --> 00:05:41,340

be a new one for us.

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00:05:41,340 --> 00:05:48,981

Phobos and Deimos, Mar's two small moons, the larger is maybe 20 miles across and the

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00:05:48,981 --> 00:05:51,720

smaller is maybe 12 miles across.

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00:05:51,720 --> 00:05:55,760

They are much easier to get to than the surface because you don't have to go down in that

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00:05:55,760 --> 00:05:58,110

gravity well and then slow down and stop.

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00:05:58,110 --> 00:06:02,140

You can stay higher in orbit and the job of slowing down and stopping is much easier.

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00:06:02,140 --> 00:06:06,000

And then launching off of Phobos and Deimos
you could do with a good jump.

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00:06:06,000 --> 00:06:09,650

So you don't have to have big powerful rockets
and punch through all that atmosphere and

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00:06:09,650 --> 00:06:14,210

get your five kilometers per second of escape
velocity.

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00:06:14,210 --> 00:06:18,720

That said, they are not easy objects to work
with.

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00:06:18,720 --> 00:06:25,820

So first of all they're so small that their
gravity is, well, every hundred pounds of

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00:06:25,820 --> 00:06:32,120

weight you have on Earth gets you one ounce
on Phobos and one half an ounce on Deimos.

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00:06:32,120 --> 00:06:36,940

And when we practice our space walks under
water in the neutral buoyancy lab and our

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00:06:36,940 --> 00:06:44,010

150 or 200 pounds of person plus 350 pounds
of space suit perfect weigh out in the NBL

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00:06:44,010 --> 00:06:47,740

is plus or minus one pound and that feels
just like being in weightlessness.

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00:06:47,740 --> 00:06:51,950

Your weigh out on Phobos and Deimos will be
an ounce or so.

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00:06:51,950 --> 00:06:57,550

So it's a better simulation of zero gravity than the simulations we use to train for zero

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00:06:57,550 --> 00:06:58,680

gravity.

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00:06:58,680 --> 00:07:02,450

So essentially you're on a natural object covered with rocks and dirt and dust that

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00:07:02,450 --> 00:07:04,060

has no gravity.

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00:07:04,060 --> 00:07:06,160

every time you touch it stuff is going to float away.

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00:07:06,160 --> 00:07:09,970

If you just touch that with your finger off you go.

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00:07:09,970 --> 00:07:12,000

And it could be hours before you fall back down again.

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00:07:12,000 --> 00:07:14,020

You will not walk on Phobos and Deimos.

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00:07:14,020 --> 00:07:18,170

Your legs are much too clumsy and strong.

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00:07:18,170 --> 00:07:22,260

You will barely touch Phobos and Deimos and then you will go drifting off to the side

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00:07:22,260 --> 00:07:27,360

and it may be 10 or 20 minutes before you can touch Phobos or Deimos again.

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00:07:27,360 --> 00:07:30,470

So we don't know how to operate in that environment yet.

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00:07:30,470 --> 00:07:34,720

Our weightless environment that we practice in in Earth orbit, the International Space

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00:07:34,720 --> 00:07:36,890

Station, is covered with handrails.

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00:07:36,890 --> 00:07:41,130

And if there's no handrails we don't go there because we need something to hold onto.

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00:07:41,130 --> 00:07:43,130

Phobos and Deimos it's just rocks and dust.

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00:07:43,130 --> 00:07:48,140

If you feel yourself drifting away you grab a rock and the rock comes with you and drifts

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00:07:48,140 --> 00:07:51,040

away, whereas on the space station if we're moving away we just grab the handrail and

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00:07:51,040 --> 00:07:52,040

pull ourselves back.

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00:07:52,040 --> 00:07:53,040

>> Pull yourself back.

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00:07:53,040 --> 00:07:54,040

So how-- What are we going to do?

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00:07:54,040 --> 00:07:55,600

How are we going to learn how to do that?

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00:07:55,600 --> 00:07:56,750

>> Good question.

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00:07:56,750 --> 00:07:58,010

We're working on it right now.

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00:07:58,010 --> 00:08:04,200

So one thing you could do if you can figure out how to fire a harpoon into that dusty

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00:08:04,200 --> 00:08:07,380

rocky surface, not a guarantee that it'll work.

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00:08:07,380 --> 00:08:10,910

You could stretch out ropes and crawl around on the ropes.

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00:08:10,910 --> 00:08:13,080

We're not sure about that.

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00:08:13,080 --> 00:08:16,071

We've looked at techniques for smaller asteroids where you just take the whole asteroid and

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00:08:16,071 --> 00:08:18,880

put it in a fishing net and crawl around on the fishing net.

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00:08:18,880 --> 00:08:21,380

Phobos and Deimos are too big for that.

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00:08:21,380 --> 00:08:22,630

>> Hmm.

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00:08:22,630 --> 00:08:26,560

>> You could carry a little jet pack to push yourself back but then the fuel requirements

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00:08:26,560 --> 00:08:28,360
get pretty big after you've used it a few
times.

143
00:08:28,360 --> 00:08:32,930
You know we have a tiny little jet pack that
we carry for self-rescue on the International

144
00:08:32,930 --> 00:08:34,060
Space Station.

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00:08:34,060 --> 00:08:35,060
>> Mm-hmm.

146
00:08:35,060 --> 00:08:38,720
>> We would run that out of gas in probably
five minutes of work on Phobos and Deimos

147
00:08:38,720 --> 00:08:41,020
so we need something a little more capable.

148
00:08:41,020 --> 00:08:44,430
So you save the problems of having to land
on Mars and take off again but you've signed

149
00:08:44,430 --> 00:08:48,990
up for a whole other pile of interesting technical
problems that you have to solve.

150
00:08:48,990 --> 00:08:49,990
>> Sure.

151
00:08:49,990 --> 00:08:51,172
And so are we talking to one another?

152
00:08:51,172 --> 00:08:55,430
I mean are we gathering the information that
you guys are discovering so that we understand

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00:08:55,430 --> 00:09:01,280

better what we need to know in order to live
off the land and get there and leave and survive

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00:09:01,280 --> 00:09:02,280

and that sort of thing?

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00:09:02,280 --> 00:09:03,280

How-- How are we doing that?

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00:09:03,280 --> 00:09:05,950

>> I think that conversation has always been
there at some level.

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00:09:05,950 --> 00:09:10,230

But it's now, I think, well on its way to
increasing rapidly.

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00:09:10,230 --> 00:09:16,390

We now have the capability to really find
landing sights of significance, both for science

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00:09:16,390 --> 00:09:18,670

but certainly human exploration.

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00:09:18,670 --> 00:09:20,250

And we need to probe that.

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00:09:20,250 --> 00:09:23,580

We need to really work more closely together.

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00:09:23,580 --> 00:09:28,150

I think as we get down to the later part of--
latter part of this decade and we're actually

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00:09:28,150 --> 00:09:33,279

using this ISRU that is on Mars 2020.

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00:09:33,279 --> 00:09:38,640

>> Now when you say ISRU that's In-Situ Resource Utilization, fancy word for living off the

165
00:09:38,640 --> 00:09:39,810
land essentially, correct?

166
00:09:39,810 --> 00:09:40,810
>> Correct.

167
00:09:40,810 --> 00:09:46,140
Yeah and it takes in the atmosphere and creates the O₂, separates the carbon from carbon dioxide

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00:09:46,140 --> 00:09:47,650
leaving the oxygen.

169
00:09:47,650 --> 00:09:48,650
>> Okay.

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00:09:48,650 --> 00:09:53,240
>> And so that-- That's an important process and this is really that first demonstration.

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00:09:53,240 --> 00:09:58,920
I think we're going to see more of those experiments as part of the scientific payloads that we

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00:09:58,920 --> 00:10:01,920
do, particularly in the 2020s.

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00:10:01,920 --> 00:10:05,450
So it's a, I think, an exciting era.

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00:10:05,450 --> 00:10:07,680
Mars we should not be afraid of.

175
00:10:07,680 --> 00:10:10,920
It's a fabulous destination for us to explore.

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00:10:10,920 --> 00:10:16,990

It has so many scientific questions that we could answer and it might actually be the

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00:10:16,990 --> 00:10:22,490

first place where we find life beyond the atmosphere of our own earth.

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00:10:22,490 --> 00:10:31,060

And if we can do that that is really a tremendous step forward in understanding life in our

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00:10:31,060 --> 00:10:32,940

own universe and how it is created.

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00:10:32,940 --> 00:10:33,940

>> Sure.

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00:10:33,940 --> 00:10:34,940

And are you ready to go?

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00:10:34,940 --> 00:10:35,940

>> Oh yes.

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00:10:35,940 --> 00:10:36,940

Sign me up.

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00:10:36,940 --> 00:10:38,670

Although my wife might have something to say about it but--

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00:10:38,670 --> 00:10:39,670

>> It's a long trip.

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00:10:39,670 --> 00:10:41,160

>> It is a very long trip.

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00:10:41,160 --> 00:10:42,160

>> Yes.

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00:10:42,160 --> 00:10:45,560

>> And you will not be digging your toes in the sand when you get there.

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00:10:45,560 --> 00:10:50,530

>> [laughs] So well, and you mentioned something about some of the technologies and saying,

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00:10:50,530 --> 00:10:53,780

well we're working on this or that but we're not quite sure.

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00:10:53,780 --> 00:10:58,160

Is there going to be a way that we can be totally sure before we go or do we just go

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00:10:58,160 --> 00:11:00,740

and just, kind of, hope that it's going work?

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00:11:00,740 --> 00:11:02,030

>> It's going to be between those.

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00:11:02,030 --> 00:11:03,030

>> Mm-hmm.

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00:11:03,030 --> 00:11:04,030

>> Everything in life has risk.

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00:11:04,030 --> 00:11:05,030

>> Right.

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00:11:05,030 --> 00:11:06,190

>> Flying to Mars is going to have risk.

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00:11:06,190 --> 00:11:12,880

If we wait until there is no more risk we will be landing on someone else's city on

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00:11:12,880 --> 00:11:18,900

Mars, because the first humans to go to Mars will be taking some risk.

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00:11:18,900 --> 00:11:25,980

So we're doing quite a bit now actually in many different fields, medical, engineering,

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00:11:25,980 --> 00:11:31,010

social sciences to understand what we have to to send people to Mars.

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00:11:31,010 --> 00:11:35,350

>> So Jim you have convinced me that this is a fabulous.

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00:11:35,350 --> 00:11:39,760

You've convinced me it's not really the place to go vacationing at but personally can you

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00:11:39,760 --> 00:11:41,470

tell me why?

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00:11:41,470 --> 00:11:43,890

Why would you say yes I'm ready?

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00:11:43,890 --> 00:11:44,890

Sign me up.

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00:11:44,890 --> 00:11:49,720

>> It's a place that people have never been before and this has been important in the

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00:11:49,720 --> 00:11:54,350

whole history of our species on Earth.

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00:11:54,350 --> 00:11:59,610

When new lands become available we like to

go and see, and we like to go and see with

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00:11:59,610 --> 00:12:00,690

our own eyes.

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00:12:00,690 --> 00:12:02,570

We as a species are curious.

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00:12:02,570 --> 00:12:06,710

We want to know what's there and we want to see with our own eyes and Mars is, sort of,

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00:12:06,710 --> 00:12:11,800

the ultimate expression of that, a place where you could go.

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00:12:11,800 --> 00:12:16,170

>> And isn't it true though, also I know that our trip to the moon, they were the moon boons,

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00:12:16,170 --> 00:12:17,170

right.

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00:12:17,170 --> 00:12:21,480

We have lots of benefits that we-- that actually benefited all of mankind, just getting us

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00:12:21,480 --> 00:12:22,480

to the moon.

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00:12:22,480 --> 00:12:26,630

So do you think that we're going to get the same kind of benefits or even more going to

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00:12:26,630 --> 00:12:27,630

Mars?

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00:12:27,630 --> 00:12:32,550

>> Well as you develop the technologies necessary

to do this kind of exploration.

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00:12:32,550 --> 00:12:34,670

There's all sorts of benefits that come from that.

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00:12:34,670 --> 00:12:40,760

I mean we really, I think, helped herald in the computer age that we have now.

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00:12:40,760 --> 00:12:45,589

You may not recognize it but in the last 50 or 60 years our knowledge of our solar system

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00:12:45,589 --> 00:12:48,620

has just exploded.

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00:12:48,620 --> 00:12:53,530

In the 60s planetary scientists, when they looked at the moon, thought that the craters

226

00:12:53,530 --> 00:12:57,580

were generated from volcanic processes.

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00:12:57,580 --> 00:13:00,560

We now know that those are impact craters.

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00:13:00,560 --> 00:13:05,120

There's hardly any volcanic craters on the moon.

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00:13:05,120 --> 00:13:13,070

And so our whole idea of what our neighborhood is like, our whole idea of living in the solar

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00:13:13,070 --> 00:13:19,310

system, we recognize that the planet is a fragile place to live.

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00:13:19,310 --> 00:13:24,470

And if we are going to survive as a human species, and a number of astronauts have even

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00:13:24,470 --> 00:13:27,150

said this, we must trek out.

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00:13:27,150 --> 00:13:29,610

And I think that's absolutely the right thing to do.

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00:13:29,610 --> 00:13:33,529

>> Can you tell me a little more about we, kind of, touched base some of what we know

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00:13:33,529 --> 00:13:35,200

and what we've discovered on Mars.

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00:13:35,200 --> 00:13:39,450

But talk to me some about the landscape of Mars.

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00:13:39,450 --> 00:13:43,690

>> Well the landscape is tremendous in terms of its variations.

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00:13:43,690 --> 00:13:48,500

Huge shield volcanos, and there are quite a few of them on the surface of Mars that

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00:13:48,500 --> 00:13:50,990

have been built up over time.

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00:13:50,990 --> 00:13:57,610

Or just it would be an enormous amount of effort to be able to scale one, even for humans,

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00:13:57,610 --> 00:14:00,850

and reach the caldera area.

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00:14:00,850 --> 00:14:02,990

The valleys are absolutely enormous.

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00:14:02,990 --> 00:14:06,650

They're tremendously deep and they're very long.

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00:14:06,650 --> 00:14:11,470

Some of the tributaries of Valles Marineris are about the size of our own Grand Canyon,

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00:14:11,470 --> 00:14:16,690

which we all dearly love and are always in awe every time we see them.

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00:14:16,690 --> 00:14:24,700

The other landscapes, in terms of the craters and the variations that are seen, are also

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00:14:24,700 --> 00:14:26,520

quite spectacular.

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00:14:26,520 --> 00:14:32,820

You know where curiosity is sitting is in an ancient river or lake bed.

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00:14:32,820 --> 00:14:34,960

We see the rounded pebbles.

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00:14:34,960 --> 00:14:40,780

We look and we can see regions like that that look familiar to us but yet strangely different.

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00:14:40,780 --> 00:14:43,020

>> And what does rounded pebbles-- What does that mean?

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00:14:43,020 --> 00:14:47,060

>> Well the rounded pebbles, you know, you

start with a rock that's been broken away

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00:14:47,060 --> 00:14:53,610

and it's got sharp edges and as it rolls down the hill and then has moved in water and continually

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00:14:53,610 --> 00:14:58,830

is rounded that's done by an aqueous process.

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00:14:58,830 --> 00:15:04,500

And so then they accumulate well down stream and create a conglomerate and they look just

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00:15:04,500 --> 00:15:08,320

like the ancient river beds that we have here on Earth.

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00:15:08,320 --> 00:15:11,940

We can see those similarities even on Mars.

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00:15:11,940 --> 00:15:17,240

So there'll be some things like that that'll look very familiar, but yet different.

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00:15:17,240 --> 00:15:22,870

We'll understand the commonality and the geological processes.

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00:15:22,870 --> 00:15:25,990

But then there'll be things that will surprise us for sure.

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00:15:25,990 --> 00:15:28,650

>> And so we're talking about the geology part of aspect of Mars.

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00:15:28,650 --> 00:15:31,899

Do we know much about the climate of Mars?

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00:15:31,899 --> 00:15:37,740

>> Well we actually have developed a global climate models right now.

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00:15:37,740 --> 00:15:46,930

We're probably at the state that NOAA, National Oceanic and Atmospheric Administration, that

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00:15:46,930 --> 00:15:54,959

runs the weather systems and weather satellites and predicts our weather and climate.

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00:15:54,959 --> 00:15:57,370

Where they were probably in the 60s.

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00:15:57,370 --> 00:16:03,940

And so we know what the wind patterns are and we have a fair amount of information about

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00:16:03,940 --> 00:16:11,460

levitating dust and transport of dust, because as I mentioned Mars is a very dusty environment.

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00:16:11,460 --> 00:16:17,420

The global wind patterns are actually fairly simple.

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00:16:17,420 --> 00:16:20,300

If clouds were to form they would change rapidly.

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00:16:20,300 --> 00:16:25,180

You'd have variations in temperatures and we can model all that.

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00:16:25,180 --> 00:16:27,990

And that's really pretty exciting.

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00:16:27,990 --> 00:16:33,700

Our knowledge of Mars has grown so extensively that those models will be important when humans

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00:16:33,700 --> 00:16:37,100

arrive and want to know how the weather will change over time.

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00:16:37,100 --> 00:16:38,370

>> Yeah that's very interesting.

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00:16:38,370 --> 00:16:40,570

And so we have seasons?

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00:16:40,570 --> 00:16:42,140

>> Mars does have seasons.

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00:16:42,140 --> 00:16:44,870

Yeah it does.

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00:16:44,870 --> 00:16:50,160

In fact in the polar region we put a spacecraft down on the ground called Phoenix.

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00:16:50,160 --> 00:16:52,399

It wasn't a rover.

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00:16:52,399 --> 00:16:56,740

It was designed to be able to get under the surface and look for the water layer that

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00:16:56,740 --> 00:16:59,279

we thought was pretty close to the surface.

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00:16:59,279 --> 00:17:04,189

And indeed it wasn't very far underneath the soil that we actually found that water layer

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00:17:04,189 --> 00:17:05,750

and tasted it.

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00:17:05,750 --> 00:17:07,230

We knew it was water.

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00:17:07,230 --> 00:17:11,020

99% pure water is what Phoenix saw.

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00:17:11,020 --> 00:17:13,000

But it only lasted three or four months.

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00:17:13,000 --> 00:17:15,509

The snow came, it snowed.

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00:17:15,509 --> 00:17:21,799

There was so much snow at Phoenix that it piled up on its solar panels and broke them

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00:17:21,799 --> 00:17:22,970

off.

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00:17:22,970 --> 00:17:28,309

And so we see from orbit as we've gone over Phoenix now, during the summer time period,

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00:17:28,309 --> 00:17:34,100

where the polar cap is receded, the busted up spacecraft that was underneath the snows

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00:17:34,100 --> 00:17:35,610

that occurred.

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00:17:35,610 --> 00:17:42,619

So we're going to see some familiar things like that, you know, the seasons and the precipitation

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00:17:42,619 --> 00:17:43,730

that does occur.

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00:17:43,730 --> 00:17:44,730

>> Fascinating.

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00:17:44,730 --> 00:17:45,730

Very fascinating.

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00:17:45,730 --> 00:17:46,929

I see why you signed up now.

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00:17:46,929 --> 00:17:47,929

>> Yeah.

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00:17:47,929 --> 00:17:48,929

>> I'm ready to go too.

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00:17:48,929 --> 00:17:49,929

>> Interesting place.

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00:17:49,929 --> 00:17:54,080

And also given our other possibilities in the outer solar system Mars is a picnic [laughs].

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00:17:54,080 --> 00:17:55,080

>> Yeah.

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00:17:55,080 --> 00:18:00,730

>> Mercury goes from roasting hot to freezing cold, far hotter and far colder than Mars

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00:18:00,730 --> 00:18:01,730

can ever be.

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00:18:01,730 --> 00:18:03,789

Venus is hot enough to melt lead.

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00:18:03,789 --> 00:18:09,669

Our own moon goes from plus 200 to minus 100 over the course of its two week day and night

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00:18:09,669 --> 00:18:13,480

cycle, or two weeks of day, two weeks of night.

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00:18:13,480 --> 00:18:19,299

Mars has a day and a night that's like the Earth, about 24 hours to go around, to spin

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00:18:19,299 --> 00:18:20,299

once.

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00:18:20,299 --> 00:18:21,299

It has seasons.

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00:18:21,299 --> 00:18:25,409

It's axial tilt, the way the sun changes its height through summer and winter is the same

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00:18:25,409 --> 00:18:32,140

on Mars as it is on Earth so it really is the garden spot of the inner solar system,

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00:18:32,140 --> 00:18:33,870

except for the Earth of course.

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00:18:33,870 --> 00:18:35,409

>> Garden spot [laughs].

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00:18:35,409 --> 00:18:41,789

So we've heard from a planetary perspective the things that you have hoped to discover

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00:18:41,789 --> 00:18:43,510

and learn further once we get to Mars.

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00:18:43,510 --> 00:18:49,690

Are there any other things that you, as an actual explorer, would hope to learn and find

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00:18:49,690 --> 00:18:50,840

when you get there?

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00:18:50,840 --> 00:18:56,970

>> Well from the exploration standpoint the important thing would be to get there, to

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00:18:56,970 --> 00:19:00,009

survive and thrive there and to come home safely.

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00:19:00,009 --> 00:19:01,009

>> Mm-hmm.

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00:19:01,009 --> 00:19:04,309

>> So that's the purpose of the journey from the exploration standpoint.

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00:19:04,309 --> 00:19:10,600

Now the mission that we take to Mars when the first people go is going to be not just

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00:19:10,600 --> 00:19:13,440

flags and footprints like we did with Apollo.

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00:19:13,440 --> 00:19:18,519

Remember we have put 12 people on the surface of the moon, of whom one was a geologist and

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00:19:18,519 --> 00:19:22,780

that was on the last Apollo flight that ever went.

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00:19:22,780 --> 00:19:27,860

The first crew on Mars is probably going to be half geologists.

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00:19:27,860 --> 00:19:36,780

So the-- That mission and its objectives will be to explore the area geologically, to collect

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00:19:36,780 --> 00:19:41,570

the best samples, to do the best science,
to work with a team of scientists back on

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00:19:41,570 --> 00:19:47,480

Earth, to make sure that they've surveyed
the whole area and found as many interesting

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00:19:47,480 --> 00:19:49,419

things as they can.

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00:19:49,419 --> 00:19:56,379

And even among the section of the crew that's
not geologists, the pilots, the engineers,

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00:19:56,379 --> 00:20:00,450

they're going to have engrained in their mind
that mission success for this flight is to

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00:20:00,450 --> 00:20:01,879

do good geology.

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00:20:01,879 --> 00:20:02,879

>> Sure.

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00:20:02,879 --> 00:20:04,090

>> So they'll have geology training.

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00:20:04,090 --> 00:20:09,010

They'll be-- Once the-- Once the spacecraft
is down, the systems are safe and we're in,

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00:20:09,010 --> 00:20:16,340

sort of, a housekeeping mode those non-geologists
will have had some basic geology training

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00:20:16,340 --> 00:20:19,909

and their job will be to help the geologists
do the best possible science that we can on

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00:20:19,909 --> 00:20:24,100

the surface of this planet and learn as much as we can.

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00:20:24,100 --> 00:20:28,210

So the normal things that we think of when we're just doing an exploration expedition

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00:20:28,210 --> 00:20:32,840

to get out and get back are going to be tightly interwoven with the science goals of this

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00:20:32,840 --> 00:20:34,120

mission.

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00:20:34,120 --> 00:20:38,159

It's going to be a very different thing than Apollo, or maybe similar to the last Apollo

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00:20:38,159 --> 00:20:42,960

flight where we did have a real geologist on the moon.

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00:20:42,960 --> 00:20:45,450

And he was just in heaven because it was such a cool spot.

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00:20:45,450 --> 00:20:47,710

And Mars would be even more interesting.

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00:20:47,710 --> 00:20:57,250

Many more similarities with Earth and much easier for a Earth geologist to recognize

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00:20:57,250 --> 00:21:03,509

things similar to but not identical to things on Earth, whereas the moon is dominated by

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00:21:03,509 --> 00:21:08,200

processes that we barely see on the Earth
and it's tough to, sort of, get a grip on.

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00:21:08,200 --> 00:21:09,200

>> Yeah.

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00:21:09,200 --> 00:21:10,200

>> Mars is going to be closer.

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00:21:10,200 --> 00:21:16,109

>> And with it-- With the geology being such
an important focus in our initial, you know,

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00:21:16,109 --> 00:21:22,450

flights to Mars, have we started learning
or practicing any of the techniques or trying

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00:21:22,450 --> 00:21:27,369

to develop any of the tools in at which we
would actually core and get samples?

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00:21:27,369 --> 00:21:34,509

>> We have been running model planetary exploration
expeditions out in the desert of Arizona.

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00:21:34,509 --> 00:21:37,610

Sometimes with space suits, sometimes with
just space suit mockups.

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00:21:37,610 --> 00:21:43,739

We do mock space expeditions underwater at,
off the coast of Florida where we're working

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00:21:43,739 --> 00:21:48,460

mostly on asteroid techniques because with
being under water you can be weightless.

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00:21:48,460 --> 00:21:51,080

But those techniques work equally well for
Phobos and Deimos.

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00:21:51,080 --> 00:21:53,259

Anything we're doing for asteroids is great for Phobos and Deimos.

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00:21:53,259 --> 00:21:58,470

They may-- Those two moons may actually be asteroids that Mars captured into orbit around

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00:21:58,470 --> 00:21:59,610

itself.

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00:21:59,610 --> 00:22:06,809

So that kind of work is going on but it's at a, sort of, a conceptual level and we won't

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00:22:06,809 --> 00:22:11,350

be able to design the real tools until we get closer to flight.

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00:22:11,350 --> 00:22:17,799

One other thing to bear in mind is that the quality of our analytical equipment, you know,

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00:22:17,799 --> 00:22:22,929

you take a rock and you put it in this machine and it tells you what the rock's made out

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00:22:22,929 --> 00:22:23,929

of, okay.

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00:22:23,929 --> 00:22:25,480

Those are getting better all the time.

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00:22:25,480 --> 00:22:29,119

Something that would have filled this building in the 1960s you can now carry in your hands.

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00:22:29,119 --> 00:22:30,759

>> Yes like our computers [laughs].

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00:22:30,759 --> 00:22:35,091

>> Okay so in 2035 are you going to want this clunky thing that fits in your hand or are

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00:22:35,091 --> 00:22:37,240

you just going to hold your iPhone up to the rock [laughs].

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00:22:37,240 --> 00:22:38,240

>> Sure, yeah.

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00:22:38,240 --> 00:22:39,269

>> It tells you what it's made out of.

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00:22:39,269 --> 00:22:43,539

So in that sense you don't want to design the tools yet.

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00:22:43,539 --> 00:22:44,539

>> Right.

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00:22:44,539 --> 00:22:48,779

>> Because when you get ready to go you want the latest technology, not the very latest

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00:22:48,779 --> 00:22:50,610

because you want something that's proven itself reliable.

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00:22:50,610 --> 00:22:53,600

Because you get the latest thing with bells and whistles, you get off to Mars and it turns

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00:22:53,600 --> 00:22:54,600

out it doesn't work.

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00:22:54,600 --> 00:22:55,600

It's not so good.

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00:22:55,600 --> 00:22:56,600

>> The glitches.

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00:22:56,600 --> 00:23:01,039

>> That actually brings up another point that Jim mentioned, the moon rocks and the sample

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00:23:01,039 --> 00:23:02,289

return.

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00:23:02,289 --> 00:23:08,350

Bringing back the samples from Mars is valuable, not just because you can't take the best equipment

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00:23:08,350 --> 00:23:10,070

to Mars and measure things there.

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00:23:10,070 --> 00:23:15,509

But when you have a sample on the ground you have it for the future.

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00:23:15,509 --> 00:23:21,540

So the moon rocks that we have now that we collected in the late 60s and early 70s are

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00:23:21,540 --> 00:23:22,540

stored.

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00:23:22,540 --> 00:23:23,929

They're safe.

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00:23:23,929 --> 00:23:25,350

We have them.

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00:23:25,350 --> 00:23:30,879

The instruments that we have today that were not even imaginable in the 1960s and early

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00:23:30,879 --> 00:23:33,559

70s; we can take that rock and put that in that machine.

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00:23:33,559 --> 00:23:38,169

100 years from now when we have even better machines, we can take that rock we can put

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00:23:38,169 --> 00:23:39,609

it in that machine.

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00:23:39,609 --> 00:23:46,600

So that's the real, the thing that makes the return sample absolutely treasure is that

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00:23:46,600 --> 00:23:48,120

we have it for the future.

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00:23:48,120 --> 00:23:51,350

You don't just have it for the instruments that you manage to send there, which are going

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00:23:51,350 --> 00:23:52,719

to be old and clunky in 100 years.

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00:23:52,719 --> 00:23:53,719

>> Mm-hmm.

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00:23:53,719 --> 00:23:57,899

>> When we have these amazing things we can barely even dream of today we'll be able to

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00:23:57,899 --> 00:24:02,640

have those samples and analyze them using those amazing new tools as we get them.

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00:24:02,640 --> 00:24:03,640

>> Yeah.

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00:24:03,640 --> 00:24:08,489

And talking about coring, do we know, also going back to the geology is it-- Is the composition

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00:24:08,489 --> 00:24:10,639

of Mars, is it anything like Earth?

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00:24:10,639 --> 00:24:14,480

I mean are we going to get there and think oh my gosh this is much harder and we're not

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00:24:14,480 --> 00:24:15,480

able to do this?

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00:24:15,480 --> 00:24:16,480

How do we know?

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00:24:16,480 --> 00:24:19,320

>> Well you know the rocks will have various densities associated with them.

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00:24:19,320 --> 00:24:23,610

And on the 20/20 we were already developing the drill concept.

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00:24:23,610 --> 00:24:25,409

So we're going to core rocks.

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00:24:25,409 --> 00:24:27,539

We're going to get in several inches.

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00:24:27,539 --> 00:24:30,179

It'll be like a piece of chalk.

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00:24:30,179 --> 00:24:33,129

And then we want to get in the hole and we want to interrogate it.

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00:24:33,129 --> 00:24:36,980

And then we'll zap it with laser and we'll vaporize the rock and then we'll look at the

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00:24:36,980 --> 00:24:40,609

spectrum and then we'll figure out hey that's a sample we want to keep or we want to move

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00:24:40,609 --> 00:24:41,609

on.

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00:24:41,609 --> 00:24:48,200

We'll have very high resolution microscopes, if you will, to look at the mineralogy to

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00:24:48,200 --> 00:24:55,549

see if these rocks have been-- a sediment has come into them because of water has deposited

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00:24:55,549 --> 00:24:56,549

them.

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00:24:56,549 --> 00:24:57,600

In other words are they veiny.

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00:24:57,600 --> 00:24:59,679

You know, what kind of materials there are.

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00:24:59,679 --> 00:25:03,500

So that's the kind of sights that we want to go to.

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00:25:03,500 --> 00:25:12,669

We'll see variations in how hard these rocks are and we want to store those at all levels.

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00:25:12,669 --> 00:25:19,080

As Stan said quite eloquently, these are samples that we'll [Background Music] keep giving

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00:25:19,080 --> 00:25:24,289

science as we bring them back to Earth and then study them because our tools will only

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00:25:24,289 --> 00:25:26,740

get better in terms of analyzing them.

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00:25:26,740 --> 00:25:30,909

>> It's totally fascinating and I think that's about all the time that we have but I really

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00:25:30,909 --> 00:25:33,269

appreciate you guys coming out and talking with us.

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00:25:33,269 --> 00:25:38,919

You can get more information going to the website at www.nasa.gov.

433

00:25:38,919 --> 00:25:43,929

And as always continue and join the conversation on twitter using the hashtag Journey to Mars.

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00:25:43,929 --> 00:25:45,239

I appreciate you guys coming out.

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00:25:45,239 --> 00:25:46,239

Thanks very much.

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00:25:46,239 --> 00:25:47,239

>> Oh my pleasure.

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00:25:47,239 --> 00:25:48,239

>> You're very welcome.