



1
00:00:00,000 --> 00:00:06,630
(Roar of fire and wind as MSL enters Mars' atmosphere)

2
00:00:06,650 --> 00:00:08,770
Estelle Dodson: When NASA's Mars Science Laboratory,

3
00:00:08,790 --> 00:00:12,270
or MSL, lands on Mars the rover will have many

4
00:00:12,290 --> 00:00:14,150
ambitious science goals.

5
00:00:14,170 --> 00:00:17,370
Named Curiosity, the rover will land in Gale Crater.

6
00:00:17,390 --> 00:00:20,560
This is an ideal spot to study the exposed rock

7
00:00:20,580 --> 00:00:24,710
that offers us tantalizing clues about Mars' past.

8
00:00:24,730 --> 00:00:27,880
One of the ten science instruments that Curiosity carries

9
00:00:27,900 --> 00:00:31,000
is a unique analysis tool called CheMin,

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00:00:31,020 --> 00:00:34,160
short for "Chemistry and Mineralogy."

11
00:00:34,180 --> 00:00:36,870
About the size of a large shoebox, this portable

12
00:00:36,890 --> 00:00:40,640
laboratory will accurately define the mineral composition

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00:00:40,660 --> 00:00:44,920

of samples taken from the Martian soil and rocks.

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00:00:44,940 --> 00:00:46,620

Join us as we meet the team

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00:00:46,640 --> 00:00:48,370

at NASA Ames Research Center

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00:00:48,390 --> 00:00:50,890

who developed the CheMin instrument as well as

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00:00:50,910 --> 00:00:54,460

discover how this technology is proving to be indispensable

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00:00:54,480 --> 00:00:57,280

right here on Earth.

19

00:00:57,300 --> 00:01:15,530

(Music)

(Electronic Sounds of Data)

20

00:01:15,550 --> 00:01:17,310

Estelle: To tell us more about one of the instruments

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00:01:17,330 --> 00:01:19,750

on the Mars Science Laboratory, I'm here with

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00:01:19,770 --> 00:01:21,820

NASA Geologist David Blake.

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00:01:21,840 --> 00:01:24,060

He's the inventor and Principal Investigator

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00:01:24,080 --> 00:01:25,890

on the CheMin instrument.

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00:01:25,910 --> 00:01:27,790

David, can you tell us more about CheMin

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00:01:27,810 --> 00:01:30,060

and what it will be doing on MSL?

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00:01:30,080 --> 00:01:32,520

David Blake: Well, CheMin is an X-ray diffraction instrument

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00:01:32,540 --> 00:01:34,320

and this is the first time we've ever sent

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00:01:34,340 --> 00:01:37,010

an instrument like that into space.

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00:01:37,030 --> 00:01:40,600

X-ray diffraction is the gold standard for how to

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00:01:40,620 --> 00:01:44,070

analyze minerals on the Earth in a large laboratory.

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00:01:44,090 --> 00:01:46,300

So, for the first time ever we will be able to definitively

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00:01:46,320 --> 00:01:49,710

determine what minerals are present in rocks.

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00:01:49,730 --> 00:01:53,080

And by knowing that, we will understand the history

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00:01:53,100 --> 00:01:55,550

of the early Mars environment.

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00:01:55,570 --> 00:01:58,490

Gale Crater is one of the oldest and deepest craters

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00:01:58,510 --> 00:02:00,120

on the surface of Mars.

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00:02:00,140 --> 00:02:02,830

And we believe it has sedimentological records

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00:02:02,850 --> 00:02:05,980

that go back as far as four billion years.

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00:02:06,000 --> 00:02:07,360

Billion with a "B."

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00:02:07,380 --> 00:02:10,620

And the significance of that, is that on the Earth

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00:02:10,640 --> 00:02:13,920

with plate tectonics, we have no sediments that are

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00:02:13,940 --> 00:02:16,730

that old that we can really look at and interpret.

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00:02:16,750 --> 00:02:18,900

This is really the only way to look at a

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00:02:18,920 --> 00:02:22,800

four billion year old sediment and say how it formed

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00:02:22,820 --> 00:02:24,970

and what the conditions were at that time.

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00:02:24,990 --> 00:02:26,660

Estelle: How is this different than Spirit and

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00:02:26,680 --> 00:02:28,890

Opportunity that have come before?

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00:02:28,910 --> 00:02:30,870

David: Well, we're doing something similar to what Spirit

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00:02:30,890 --> 00:02:34,530

and Opportunity has done, but on a much larger scale.

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00:02:34,550 --> 00:02:38,390

Spirit and Opportunity were kind of like field geologists.

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00:02:38,410 --> 00:02:41,140

They would go out with a hand lens and a hammer

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00:02:41,160 --> 00:02:44,850

and look at rocks, maybe analyze the surface of a rock.

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00:02:44,870 --> 00:02:47,970

But, Mars Science Laboratory goes a step further

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00:02:47,990 --> 00:02:51,290

and we collect those rocks, collect powders, and we have

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00:02:51,310 --> 00:02:55,230

essentially a full up terrestrial laboratory inside the body

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00:02:55,250 --> 00:02:58,880

of Mars Science Laboratory and that's what's going to be different.

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00:02:58,900 --> 00:03:01,320

Estelle: How do you get a laboratory to fit on a

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00:03:01,340 --> 00:03:04,290

rover that's going to go to another planet?

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00:03:04,310 --> 00:03:05,770

David: Okay, well you have to make it small,

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00:03:05,790 --> 00:03:09,100

that's one thing, small and a lot less mass.

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00:03:09,120 --> 00:03:12,790

So, a regular diffractometer in the lab is about like

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00:03:12,810 --> 00:03:15,500
double-wide refrigerator-sized, with lots of

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00:03:15,520 --> 00:03:18,570
complicated motions of the detector, of the sample

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00:03:18,590 --> 00:03:20,200
and of the source.

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00:03:20,220 --> 00:03:24,760
We kind of had a new idea where we actually vibrate the sample

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00:03:24,780 --> 00:03:28,910
with a tuning fork, so that the sample itself does all the motions

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00:03:28,930 --> 00:03:31,520
and the machine doesn't have to.

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00:03:31,540 --> 00:03:33,900
So, we essentially went from a complicated big machine

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00:03:33,920 --> 00:03:36,750
with many moving parts to a small simple machine

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00:03:36,770 --> 00:03:38,930
with no moving parts.

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00:03:38,950 --> 00:03:41,000
Estelle: What's the most exciting thing about CheMin

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00:03:41,020 --> 00:03:43,780
flying on MSL for you?

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00:03:43,800 --> 00:03:45,950
David: So I've been doing diffraction, I've been

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00:03:45,970 --> 00:03:49,360
working in the business for thirty-five years

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00:03:49,380 --> 00:03:53,460
and so having this kind of come to fruition finally

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00:03:53,480 --> 00:03:57,890
is really exciting to me.

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00:03:57,910 --> 00:03:59,540
Estelle: To tell us more about this technology,

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00:03:59,560 --> 00:04:01,130
we're meeting with Philippe Sarrazin,

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00:04:01,150 --> 00:04:03,160
who helped develop the CheMin instrument.

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00:04:03,180 --> 00:04:06,010
He is now the Chief Scientist at InXitu, a division

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00:04:06,030 --> 00:04:09,090
of Olympus that is commercializing the technology.

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00:04:09,110 --> 00:04:11,380
Philippe, what is X-ray diffraction?

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00:04:11,400 --> 00:04:14,930
Is it similar to regular X-ray imaging techniques?

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00:04:14,950 --> 00:04:16,530
Philippe Sarrazin: It's actually quite different.

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00:04:16,550 --> 00:04:18,680
X-ray diffraction is a method for analyzing

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00:04:18,700 --> 00:04:20,480
crystalline materials.

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00:04:20,500 --> 00:04:22,890

Every crystal, every type of crystal has a

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00:04:22,910 --> 00:04:27,220

very unique signature in X-ray diffraction.

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00:04:27,240 --> 00:04:29,030

Crystals are everywhere around us.

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00:04:29,050 --> 00:04:31,810

They're in geological materials, but they're also in

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00:04:31,830 --> 00:04:34,820

man-made materials such as metals, or ceramics

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00:04:34,840 --> 00:04:37,980

or concrete, or even pharmaceutical products.

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00:04:38,000 --> 00:04:42,440

So by using our instruments we can identify

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00:04:42,460 --> 00:04:47,320

the nature of the crystals inside a sample.

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00:04:47,340 --> 00:04:50,680

I can take an example of, you know, two materials

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00:04:50,700 --> 00:04:53,580

that are very much alike, but very much different.

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00:04:53,600 --> 00:04:56,500

Two materials that are made out of 100 percent of carbon:

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00:04:56,520 --> 00:04:59,270

one is graphite and the other one is diamond.

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00:04:59,290 --> 00:05:01,530

X-ray diffraction can tell the difference between

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00:05:01,550 --> 00:05:03,980

diamond and graphite were traditional

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00:05:04,000 --> 00:05:06,340

chemical analyzers would see carbon.

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00:05:06,360 --> 00:05:07,930

Estelle: Tell us how the CheMin instrument evolved

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00:05:07,950 --> 00:05:10,300

into a commercially produced product.

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00:05:10,320 --> 00:05:13,000

Philippe: I used to work with David Blake at NASA

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00:05:13,020 --> 00:05:16,140

and we developed a number of prototypes to

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00:05:16,160 --> 00:05:19,280

demonstrate the capability of the technology.

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00:05:19,300 --> 00:05:21,800

In the process of doing that we had the chance

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00:05:21,820 --> 00:05:24,350

to test our instruments in the field and it was the

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00:05:24,370 --> 00:05:27,710

first time X-ray diffraction was taken out of the lab.

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00:05:27,730 --> 00:05:30,690

Seeing the capability that geologists could use

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00:05:30,710 --> 00:05:35,240

on the site was quite a revelation that there were

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00:05:35,260 --> 00:05:37,010

a number of commercial applications that could

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00:05:37,030 --> 00:05:38,660

be derived from that technology.

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00:05:38,680 --> 00:05:40,900

Estelle: And what types of areas is it being used in?

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00:05:40,920 --> 00:05:43,930

Philippe: So we released our first product in 2007,

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00:05:43,950 --> 00:05:45,670

it's called Terra.

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00:05:45,690 --> 00:05:49,390

And Terra is being used by a number of scientists

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00:05:49,410 --> 00:05:53,750

and engineers in very different fields such as geology obviously,

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00:05:53,770 --> 00:05:59,930

but also the oil industry for oil drilling, in mining

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00:05:59,950 --> 00:06:04,000

or even the pharmaceutical industry or museums.

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00:06:04,020 --> 00:06:06,120

Estelle: How is it being used in a museum?

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00:06:06,140 --> 00:06:07,760

Philippe: The objective was to have an instrument

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00:06:07,780 --> 00:06:11,110

that could analyze surface materials,

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00:06:11,130 --> 00:06:14,760

mostly pigments in works of art such as paintings

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00:06:14,780 --> 00:06:18,520

and frescoes or sculptures and non-destructively.

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00:06:18,540 --> 00:06:21,410

Terra and CheMin are both destructive instruments,

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00:06:21,430 --> 00:06:24,340

you need to sample and grind that sample.

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00:06:24,360 --> 00:06:26,410

Which obviously would be a problem

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00:06:26,430 --> 00:06:29,240

when you are analyzing a very expensive

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00:06:29,260 --> 00:06:32,100

and rare work of art. (Laughs)

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00:06:32,120 --> 00:06:34,120

Estelle: What are some of the more interesting

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00:06:34,140 --> 00:06:36,160

works of art that you've been able to see?

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00:06:36,180 --> 00:06:39,120

Philippe: So that instrument was taken into unique sites,

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00:06:39,140 --> 00:06:43,910

such as King Tut's tomb or the Acropolis in Athens.

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00:06:43,930 --> 00:06:45,270

Estelle: What do you see as the future

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00:06:45,290 --> 00:06:46,900

of the CheMin technology?

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00:06:46,920 --> 00:06:49,340

Philippe: What's unique about what we've created for this

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00:06:49,360 --> 00:06:53,090

Mars project as well as for the commercial spin-off,

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00:06:53,110 --> 00:06:56,050

is that there's nothing in the world, other than

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00:06:56,070 --> 00:06:59,950

what we've developed, that allows doing these analyses

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00:06:59,970 --> 00:07:03,940

in the field and almost instantly you get answers

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00:07:03,960 --> 00:07:05,950

within minutes or tens of minutes.

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00:07:05,970 --> 00:07:10,100

It really opens new horizons for some applications,

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00:07:10,120 --> 00:07:12,520

whether they're scientific or industrial,

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00:07:12,540 --> 00:07:15,370

so there's a lot of potential for the technique

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00:07:15,390 --> 00:07:19,020

that was developed for CheMin.

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00:07:19,040 --> 00:07:20,280

Estelle: Thanks for joining us!

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00:07:20,300 --> 00:07:24,850

And meet us again on our next Destination Innovation.

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00:07:27,950 --> 00:07:30,180

For more information about the CheMin instrument

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00:07:30,200 --> 00:07:36,650

please visit [NASA dot gov slash Ames](http://NASA.gov/Ames).