ASTROBIOLOGY IN THE FIELD

ICELAND

1
00:00:33,079 --> 00:00:34,079
Iceland.

2
00:00:34,079 --> 00:00:38,339
A harsh Nordic landscape where fire meets
ice.

3
00:00:38,339 --> 00:00:42,879
A country of volcanoes, glaciers, waterfalls,
and expansive tundra.

4
00:00:42,879 --> 00:00:48,149
And for some, the perfect analogue environment
for informing NASA’s search for life on

5
00:00:48,149 --> 00:00:49,149
Mars.

6
00:00:49,149 --> 00:00:55,789
Meet Dr. Amanda Stockton, the principal investigator
of FELDSPAR: the Field Exploration and Life

7
00:00:55,789 --> 00:01:00,059
Detection Sampling for Planetary and Astrobiology
Research.

8
00:01:00,059 --> 00:01:05,210
Dr. Stockton and her team have been traveling
to Iceland to conduct sampling missions in

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00:01:05,210 --> 00:01:10,020
a volcanic environment with striking similarities
to the Red Planet.

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00:01:10,020 --> 00:01:17,080
If you’re thinking about Mars, you’ve
got CRISM and other orbiter instruments that

11
00:01:17,080 --> 00:01:18,909

can look down on the surface.

12
00:01:18,909 --> 00:01:22,970
And when it looks down at the surface you
basically see one pixel, and that pixel is

13
00:01:22,970 --> 00:01:28,570
all the same color; but that pixel can be
a kilometer by a kilometer across.

14
00:01:28,570 --> 00:01:33,380
So we go out to field sites in Iceland where
we've got that kilometer by kilometer and

15
00:01:33,380 --> 00:01:38,440
we go and we see: how many samples do we need
in order to actually represent the whole area,

16
00:01:38,440 --> 00:01:40,780
and how far away do they need to be spaced.

17
00:01:40,780 --> 00:01:45,610
This year, what was really cool, is that we
went out and looked at different colors of

18
00:01:45,610 --> 00:01:46,830
pixels.

19
00:01:46,830 --> 00:01:53,860
We want to go in and see how life varies as
we go across the different colors and that

20
00:01:53,860 --> 00:02:01,489
helps us figure out what pixel do we want
to land in whenever we go looking for signatures

21
00:02:01,489 --> 00:02:03,979
of life.

22

00:02:03,979 --> 00:02:06,640
Traveling to the field site is quite challenging.

23
00:02:06,640 --> 00:02:11,530
The expedition begins in Akureyri, Iceland,
where the team has setup their field laboratory

24
00:02:11,530 --> 00:02:13,130
at the local university.

25
00:02:13,130 --> 00:02:19,170
Dr. Stockton and her team will drive six hours
over sand, rock, and road, completing three

26
00:02:19,170 --> 00:02:21,780
river crossings before they arrive at their
campsite.

27
00:02:21,780 --> 00:02:25,060
Operationally, it’s quite challenging to
get to this field site.

28
00:02:25,060 --> 00:02:27,950
The logistics involved are a little intense.

29
00:02:27,950 --> 00:02:33,650
That involves lots of river crossings, and
dirt roads, and sometimes sandstorms and dust

30
00:02:33,650 --> 00:02:36,480
devils, and all kinds of fun weather.

31
00:02:36,480 --> 00:02:42,060
They’re not nearly as bad as Antarctica,
but it’s challenging for your ordinary tourist,

32
00:02:42,060 --> 00:02:47,250
which makes it particularly wonderful because
we don’t have all of this anthropogenic,

33
00:02:47,250 --> 00:02:50,600
human-caused contamination of the site.

34
00:02:50,600 --> 00:02:55,490
But eventually, we get the samples that give
us the science that we want.

35
00:02:55,490 --> 00:03:05,270
At 4am the following day, the expedition team
rises and heads to the field site.

36
00:03:05,270 --> 00:03:19,250
It is 5am.

37
00:03:19,250 --> 00:03:24,180
Our whole work started because of the NASA
Nordic Astrobiology Summer School.

38
00:03:24,180 --> 00:03:29,280
It was an incredible experience and as part
of that school, some of us got a taste of

39
00:03:29,280 --> 00:03:30,470
field sampling.

40
00:03:30,470 --> 00:03:35,970
Those of us who realized how important this
area was to places like Mars, started thinking,

41
00:03:35,970 --> 00:03:40,120
‘boy, this would be nice if it wasn’t
just part of a school for education, but if

42
00:03:40,120 --> 00:03:44,950
we could actually get some real data to publish
some papers, and since that time now, we have

43
00:03:44,950 --> 00:03:46,720
some new members of our team.

44
00:03:46,720 --> 00:03:50,980
And we sort of kept it young, early career
people though, which I think is really neat

45
00:03:50,980 --> 00:03:56,830
because it sort of sprung from a grassroots
educational outreach thing that has now become

46
00:03:56,830 --> 00:04:06,930
a real scientific endeavor, and it’s so
fun, I feel so lucky to be a part of this.

47
00:04:06,930 --> 00:04:12,950
Right now we’re trying to get mapping so
we can get a three-dimensional model of the

48
00:04:12,950 --> 00:04:26,990
entire area on this side.

49
00:04:26,990 --> 00:04:33,990
The quadcopter is going to fly up and it will
take pictures in a line; not directly down,

50
00:04:33,990 --> 00:04:36,410
but off at a little bit of an angle.

51
00:04:36,410 --> 00:04:41,841
That offset, plus multiple images, is what
can give us a three-dimensional model of the

52
00:04:41,841 --> 00:04:43,490
entire terrain.

53
00:04:43,490 --> 00:04:48,900
We’ve already got a decent model for the
other side of the volcano, and that’s where

54
00:04:48,900 --> 00:04:51,889

they’re sampling today.

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00:04:51,889 --> 00:04:59,629
We’re Team FELDSPAR, we’re a group of
astrobiologists from Georgia Tech and NASA

56
00:04:59,629 --> 00:05:01,229
and a couple of different institutions.

57
00:05:01,229 --> 00:05:07,830
We’re here at Holuhraun, which is a 2014
eruption site in Iceland.

58
00:05:07,830 --> 00:05:11,370
Because of the geochemistry of the place,
it’s a decent analogue for certain regions

59
00:05:11,370 --> 00:05:12,370
of Mars.

60
00:05:12,370 --> 00:05:17,110
And, more importantly, for our purposes, there’s
almost nothing alive here, even down to the

61
00:05:17,110 --> 00:05:18,550
microbial level.

62
00:05:18,550 --> 00:05:21,621
And it’s actually surprisingly difficult
to find places like that on Earth, because

63
00:05:21,621 --> 00:05:23,110
life is everywhere.

64
00:05:23,110 --> 00:05:26,750
So that makes this a really good place to
test certain ways for looking for very small

65
00:05:26,750 --> 00:05:27,750

amounts of life.

66
00:05:27,750 --> 00:05:33,580
One of the big questions that NASA wants to
answer at Mars is, whether or not it is inhabited.

67
00:05:33,580 --> 00:05:36,479
Whether it had life at one time, or has life
today.

68
00:05:36,479 --> 00:05:40,880
Now, one of the things that we can do here
in Iceland is help to test that theory.

69
00:05:40,880 --> 00:05:45,599
Iceland is one of the most volcanically active
places on Earth, and a lot of the properties

70
00:05:45,599 --> 00:05:50,409
of the basalt and the other volcanic rocks
are really similar to what we see on Mars

71
00:05:50,409 --> 00:05:56,500
and what we’re doing here is trying to see
how life colonizes a fresh lava field.

72
00:05:56,500 --> 00:05:57,639
What moves in first?

73
00:05:57,639 --> 00:05:58,770
What comes after it?

74
00:05:58,770 --> 00:06:00,289
How does that process happen?

75
00:06:00,289 --> 00:06:04,419
And we’re hoping that this can help us find
those places on Mars where we’re most likely

76

00:06:04,419 --> 00:06:05,719
to find life.

77
00:06:05,719 --> 00:06:08,860
Our team has sort of a two-pronged approach
to sampling.

78
00:06:08,860 --> 00:06:13,729
We collect some samples here that we will
then analyze in a field lab, or in a lab back

79
00:06:13,729 --> 00:06:15,630
at one of our respective universities.

80
00:06:15,630 --> 00:06:18,689
But we also try to do some in-situ science,
too.

81
00:06:18,689 --> 00:06:20,810
In-situ means doing it right there, right
now.

82
00:06:20,810 --> 00:06:24,789
Of course, the biology samples are the most
important not to contaminate, so we collect

83
00:06:24,789 --> 00:06:25,789
those first.

84
00:06:25,789 --> 00:06:30,830
Today, we took samples in nested sampling
grids.

85
00:06:30,830 --> 00:06:35,509
One of the key things we want to look at is
how much variation there is point-to-point

86
00:06:35,509 --> 00:06:41,849
at different spatial scales in the types of
signs of life that we might look for on other

87
00:06:41,849 --> 00:06:42,849
worlds.

88
00:06:42,849 --> 00:06:45,889
There are a couple of different biomarkers
that we look for.

89
00:06:45,889 --> 00:06:48,729
Biomarkers are traces of past or present life.

90
00:06:48,729 --> 00:06:54,999
One of the key ones that we look for is ATP,
which is a molecule called Adenosine Triphosphate.

91
00:06:54,999 --> 00:07:00,119
It’s a very convenient store of energy,
molecularly, inside a cell, and so it’s

92
00:07:00,119 --> 00:07:05,779
involved in almost every metabolic reaction
that every cell on Earth does.

93
00:07:05,779 --> 00:07:10,379
Is that correlated in any way with the types
of geochemical measurements that you can make

94
00:07:10,379 --> 00:07:14,639
either on the ground or through remote sensing
before you get there?

95
00:07:14,639 --> 00:07:19,009
Because what it all comes down to is: so you’re
a rover.

96
00:07:19,009 --> 00:07:20,240
You’ve landed.

97
00:07:20,240 --> 00:07:21,240

You look around.

98
00:07:21,240 --> 00:07:22,619
What’s the first test you should run?

99
00:07:22,619 --> 00:07:25,120
If you don’t see anything, should you move?

100
00:07:25,120 --> 00:07:27,509
What’s the second test you should run?

101
00:07:27,509 --> 00:07:32,789
And it’s all down to trying to get the most
science that you can out of a mission to Mars.

102
00:07:32,789 --> 00:07:37,499
Once the biologists have collected the samples
that we’ll be studying to look for life,

103
00:07:37,499 --> 00:07:41,960
then the geologists and the chemists can go
in with our instruments and get the composition.

104
00:07:41,960 --> 00:07:46,770
We will have the team that’s looking at
biological analysis go first, and then we

105
00:07:46,770 --> 00:07:52,039
will come through and use the ASD to look
at the minerology of the rocks that they’re

106
00:07:52,039 --> 00:07:53,039
sampling.

107
00:07:53,039 --> 00:07:57,659
MRO, the Mars Reconnaissance Orbiter uses
instruments to look at the, particularly what

108
00:07:57,659 --> 00:08:00,360

I’m interested in, is the composition of
the surface of Mars.

109
00:08:00,360 --> 00:08:04,979
So, when we look at the composition of Mars,
we use CRISM, which is the Compact Reconnaissance

110
00:08:04,979 --> 00:08:06,770
Imaging Spectrometer for Mars.

111
00:08:06,770 --> 00:08:11,310
It looks in a certain wavelength range, which
is the visible and near-infrared, or VNIR,

112
00:08:11,310 --> 00:08:14,449
to determine the composition of rocks that
we see on the surface.

113
00:08:14,449 --> 00:08:19,319
So, we are using a visible and near-infrared
spectrometer that is handheld, that gives

114
00:08:19,319 --> 00:08:24,639
you similar information as we get from CRISM,
but obviously closer-up, which allows you

115
00:08:24,639 --> 00:08:29,909
to see different absorptions within the visible
and near infrared spectrum to understand the

116
00:08:29,909 --> 00:08:33,229
mineralogy or chemistry or the rock that we’re
looking at.

117
00:08:33,229 --> 00:08:36,529
A lot of the field instruments that we’ve
brought with us, we’ve brought because they’re

118
00:08:36,529 --> 00:08:41,030
very similar to some of the instruments aboard

some of the Mars rovers, for example, Mars

119
00:08:41,030 --> 00:08:42,030
Curiosity.

120
00:08:42,030 --> 00:08:44,770
I’m basically the ‘human rover’.

121
00:08:44,770 --> 00:08:50,070
I have all of the instruments that the rovers
have, not all of them, but the instruments

122
00:08:50,070 --> 00:08:53,260
that I have mimic the instruments that are
on the rovers.

123
00:08:53,260 --> 00:08:57,490
So, we have the ASD, which you’ve already
checked out a little bit.

124
00:08:57,490 --> 00:09:04,620
We also have the XRF, which is an X-Ray Fluorescence
spectrometer, So, we can get compositional

125
00:09:04,620 --> 00:09:06,290
data about the rocks.

126
00:09:06,290 --> 00:09:09,630
The combination of these tools tells us more
about the geology; that’s what this project

127
00:09:09,630 --> 00:09:14,340
is trying to do is link what kind of biology
would you expect based on the geology and

128
00:09:14,340 --> 00:09:24,970
all of the other various environmentally things
that we’re going to try and measure, as

129

00:09:24,970 --> 00:09:26,830
well.

130
00:09:26,830 --> 00:09:31,190
So we now have our samples back in the lab,
and everyone that comes in this room has to

131
00:09:31,190 --> 00:09:38,640
wear a facemask so we do not spray all of
our bugs on the samples when we talk.

132
00:09:38,640 --> 00:09:42,790
And it’s very easy to forget that when you’re
walking around in the lab, so even though

133
00:09:42,790 --> 00:09:46,280
I’m not currently working with the samples,
I still get the facemask.

134
00:09:46,280 --> 00:09:50,610
So we brought our samples back to the lab,
and we laid them all out on the table so that

135
00:09:50,610 --> 00:09:57,860
we could get an overview of the physical characteristics
of the samples and see all of them laid out

136
00:09:57,860 --> 00:09:58,860
together.

137
00:09:58,860 --> 00:10:02,710
The thing that we need to do that’s very
time-sensitive is to look for ATP.

138
00:10:02,710 --> 00:10:06,660
Because the ATP profile of what you get out
of the cells changes very rapidly once they’re

139
00:10:06,660 --> 00:10:08,110
pulled out of the field environment.

140
00:10:08,110 --> 00:10:11,710
So we’ve brought the samples back, they’ve
been stored in the fridge overnight, and we

141
00:10:11,710 --> 00:10:14,660
are now preparing to do extraction.

142
00:10:14,660 --> 00:10:19,680
We take small amounts of those samples, drop
them into small baggies and double-bag those.

143
00:10:19,680 --> 00:10:23,780
That goes over to the Thor station, where
the geologists bang on them with hammers to

144
00:10:23,780 --> 00:10:25,940
break the big chunks up into little chunks.

145
00:10:25,940 --> 00:10:32,010
After that, we’ve got a fine-grained powder
that results from all of this processing.

146
00:10:32,010 --> 00:10:37,610
That goes over to another station where 500
microliters of powder is put into little micro

147
00:10:37,610 --> 00:10:39,570
centrifuge tubes.

148
00:10:39,570 --> 00:10:40,940
And that’s where we’ll end today.

149
00:10:40,940 --> 00:10:42,320
That’s a lot of samples.

150
00:10:42,320 --> 00:10:47,550
Tomorrow, we’ll come back, we’ll add 1
milliliter of buffer to each one of our little

151
00:10:47,550 --> 00:10:50,260
tubes that has our powder in it.

152
00:10:50,260 --> 00:10:56,310
We’ll do a process where we vortex, we shake
up the sample really good, we’ll boil it

153
00:10:56,310 --> 00:11:02,180
so that any cells will break open and release
their ATP; that’s the energy currency of

154
00:11:02,180 --> 00:11:03,180
life.

155
00:11:03,180 --> 00:11:05,170
That’s what we’re looking for with our
assay here.

156
00:11:05,170 --> 00:11:09,480
Once the cells have broken open in the boiling
water, released all of their ATP, we’ll

157
00:11:09,480 --> 00:11:16,640
spin the samples so that the sediment from
our rock drops to the bottom, leaving only

158
00:11:16,640 --> 00:11:18,770
the liquid with the ATP in it at the top.

159
00:11:18,770 --> 00:11:22,020
We’ll take that, add another reagent.

160
00:11:22,020 --> 00:11:25,980
It’s actually luciferase from fireflies!

161
00:11:25,980 --> 00:11:33,600
And it basically has two different forms,
one inert form, and it is able to be converted

162
00:11:33,600 --> 00:11:35,100
to another form that glows.

163
00:11:35,100 --> 00:11:39,800
And very conveniently it takes exactly one
molecule of ATP to do that.

164
00:11:39,800 --> 00:11:44,940
So if you put in a very precisely-measured
amount of this protein, you will see that

165
00:11:44,940 --> 00:11:50,050
it glows, which you can measure, and you can
do some math and figure out how much it glowed

166
00:11:50,050 --> 00:11:54,620
over what period of time and you can figure
out very precisely how much ATP was in your

167
00:11:54,620 --> 00:11:55,620
sample.

168
00:11:55,620 --> 00:11:59,461
So, fireflies use that to light up their bums,
we’re using it to find out how much ATP

169
00:11:59,461 --> 00:12:00,980
is in the sample!

170
00:12:00,980 --> 00:12:06,620
There’s three important things to know about
ATP that makes it useful for understanding

171
00:12:06,620 --> 00:12:08,320
what it means in context.

172
00:12:08,320 --> 00:12:13,310
The first is, there’s no known way of making

it without life.

173
00:12:13,310 --> 00:12:17,240
In other words, if you find it on Earth, you
can be pretty darn sure that something was

174
00:12:17,240 --> 00:12:19,470
alive there that made it.

175
00:12:19,470 --> 00:12:22,440
The second is, it’s universal.

176
00:12:22,440 --> 00:12:26,750
Every form of life that we know of uses it,
but the third thing you have to bear in mind

177
00:12:26,750 --> 00:12:29,060
is: that’s very specific to Earth biochemistry.

178
00:12:29,060 --> 00:12:34,120
Yes, it’s a very good biosignature on earth,
but there’s a lot of debate about whether

179
00:12:34,120 --> 00:12:37,990
or not it would be a useful thing to look
for in other planetary environments.

180
00:12:37,990 --> 00:12:42,310
Ultimately, the goal of this work is to inform
Mars sample return.

181
00:12:42,310 --> 00:12:47,220
Now, some of the techniques that we’re using
here are very Earth-life specific, for example,

182
00:12:47,220 --> 00:12:48,280
the ATP assay.

183
00:12:48,280 --> 00:12:53,830

Now, if I were designing a Mars rover, I might
use some other techniques that are more agnostic

184
00:12:53,830 --> 00:12:57,940
to types of life that, perhaps, have evolved
separately from life here on Earth.

185
00:12:57,940 --> 00:13:00,160
However, it’s a really powerful tool.

186
00:13:00,160 --> 00:13:06,030
By looking at the amount and the distribution
of ATP in our sample sites, we can map that

187
00:13:06,030 --> 00:13:11,190
to the amounts and distributions of life,
and then we can use that to help figure out

188
00:13:11,190 --> 00:13:15,230
what patterns we should be searching for with
other life-detection instruments.

189
00:13:15,230 --> 00:13:20,740
Ideally, we would like to be able to be a
real Mars rover and do everything in the field

190
00:13:20,740 --> 00:13:25,130
right there, but then there’s still some
tests that we need instruments back home in

191
00:13:25,130 --> 00:13:29,360
the states to do.

192
00:13:29,360 --> 00:13:41,190
Now that we’re home, we want to get more
of the physical parameters of the sample,

193
00:13:41,190 --> 00:13:47,760
like the percent moisture content, the relative
grain size distributions of the different

194
00:13:47,760 --> 00:13:49,720
little particulates of the sample.

195
00:13:49,720 --> 00:13:55,810
We also want to get more geochemical data,
and with this we can do X-Ray Diffraction,

196
00:13:55,810 --> 00:14:02,880
which gives us a better understanding of the
connectivity and the elements at the same

197
00:14:02,880 --> 00:14:03,880
time.

198
00:14:03,880 --> 00:14:10,740
XRD stands for X-Ray Diffraction, and it shoots
an x-ray beam at your powder sample, and based

199
00:14:10,740 --> 00:14:16,010
on the angles and the intensities at which
the x-ray beam diffracts, you can tell what

200
00:14:16,010 --> 00:14:18,190
elements are in your sample.

201
00:14:18,190 --> 00:14:24,100
And we can start to firm up the XRF data with
laboratory confirmation of that, and we can

202
00:14:24,100 --> 00:14:30,410
also do RAMAN spectroscopy, which is kind
of the other side of the hand from the IR

203
00:14:30,410 --> 00:14:32,780
reflectance spectroscopy.

204
00:14:32,780 --> 00:14:35,740
We can also get more into the biological analyses.

205
00:14:35,740 --> 00:14:42,680
And this would be similar to a Mars sample
return type of depth of analysis.

206
00:14:42,680 --> 00:14:47,460
These are the sorts of analyses that are very
challenging to do with an in-situ mission.

207
00:14:47,460 --> 00:14:50,650
There are a couple of analyses that we will
do on these samples.

208
00:14:50,650 --> 00:14:57,060
We will extract the DNAs and we will try and
see how much DNA we can find in it, and we

209
00:14:57,060 --> 00:15:03,160
will sequence them to basically look at sequences
where we are able to identify what sort of

210
00:15:03,160 --> 00:15:06,930
microbes are in there, and in what abundances.

211
00:15:06,930 --> 00:15:13,460
One of the ways we get DNA from our samples
is by mixing them with different solutions,

212
00:15:13,460 --> 00:15:17,940
and then, these solutions will let us break
open our cells to get to our DNA.

213
00:15:17,940 --> 00:15:23,040
And then, once we have the DNA in our solution,
we can put it in a machine that will spin

214
00:15:23,040 --> 00:15:27,550
really fast and that will separate our DNA
out so we can get to it.

215
00:15:27,550 --> 00:15:32,190
Now that we have our DNA, because these samples
come from an Icelandic lava field, there’s

216
00:15:32,190 --> 00:15:33,400
not going to be much of it.

217
00:15:33,400 --> 00:15:37,510
We have a technique that will let us act like
a photocopier for DNA; we’re going to be

218
00:15:37,510 --> 00:15:41,490
able to copy our DNA over and over and over,
and get a bunch of it so that we can then

219
00:15:41,490 --> 00:15:45,420
look at it with other instruments that aren’t
as sensitive.

220
00:15:45,420 --> 00:15:50,411
So now that we have a bunch of our DNA, we
have another machine that will read it.

221
00:15:50,411 --> 00:15:55,650
It will literally look through each part of
the DNA and tell us what it is, and then,

222
00:15:55,650 --> 00:16:00,770
we can relate that to microorganisms that
live out in the world.

223
00:16:00,770 --> 00:16:03,520
And we can figure out what exactly is in our
sample.

224
00:16:03,520 --> 00:16:09,780
So now that we know each one of our DNA strands
corresponds to, and we have an idea of what’s

225

00:16:09,780 --> 00:16:16,490
living in our samples, we can then do some
fancy statistics to determine if each of our

226
00:16:16,490 --> 00:16:18,570
samples has different things living in it.

227
00:16:18,570 --> 00:16:22,501
And this will give us an idea if things are
changing as we go from sample site to sample

228
00:16:22,501 --> 00:16:23,501
site.

229
00:16:23,501 --> 00:16:27,960
So, with the ATP that we got in the field,
we know how active they were.

230
00:16:27,960 --> 00:16:31,620
And with the DNA, we know how many there are,
within reason.

231
00:16:31,620 --> 00:16:37,500
And then we can also start to figure out who
they are; who’s in the sample and how the

232
00:16:37,500 --> 00:16:42,000
different communities that we’ve selected
at different places, how they vary and may

233
00:16:42,000 --> 00:16:47,320
interact with each other.

234
00:16:47,320 --> 00:16:53,300
All of these scientists are working together
across space to figure out what the data means

235
00:16:53,300 --> 00:16:56,390
and everybody is an expert in their own area.

236
00:16:56,390 --> 00:17:01,330
What we’re able to do is go in with each
dataset and plot it against another dataset

237
00:17:01,330 --> 00:17:08,169
and try to figure out what are the correlations;
where do we get lines or groupings of different

238
00:17:08,169 --> 00:17:09,679
types of measurements.

239
00:17:09,679 --> 00:17:12,130
And that tells us that’s a good spot to
look for life.

240
00:17:12,130 --> 00:17:19,730
And we can start to get these correlations
and groupings, which help inform future sample

241
00:17:19,730 --> 00:17:25,480
selection, not just for FELDSPAR, but for
other geochemical and planetary science studies.

242
00:17:25,480 --> 00:17:28,720
For example, Mars 2020 and Mars sample return.

243
00:17:28,720 --> 00:17:33,029
They’re planning on caching, collecting
some samples, and then, ultimately, sending

244
00:17:33,029 --> 00:17:35,169
them back here to Earth for analysis.

245
00:17:35,169 --> 00:17:40,249
Now, we hope to collect the right number of
samples because we can only collect a few,

246
00:17:40,249 --> 00:17:43,860
and we’re hoping that we can help inform

that decision.

247
00:17:43,860 --> 00:17:48,170
Even on, you know, a few centimeter scale,
or a meter scale, the types of life, the amount

248
00:17:48,170 --> 00:17:49,980
of life you see are very different.

249
00:17:49,980 --> 00:17:54,990
We’re trying to figure out how we can use
other instruments, some of our field instruments

250
00:17:54,990 --> 00:17:59,059
to say, “OK, you want to collect that one,
not this one, because the chances of finding

251
00:17:59,059 --> 00:18:00,059
life are better.”