
PROTECTING
OTHER
PLANETS
FROM OUR
GERMS
NASA
GRAVITY ASSIST
Podcast

1
00:00:02,569 --> 00:00:04,003
When we return a sample

2
00:00:04,003 --> 00:00:06,740
from Mars, could we identify

3
00:00:06,740 --> 00:00:09,209
life in that sample?

4
00:00:09,209 --> 00:00:10,543
Can we go there

5
00:00:10,543 --> 00:00:12,545
and sustain ourselves

6
00:00:12,545 --> 00:00:15,415
without harming Mars

7
00:00:15,415 --> 00:00:18,184
if there is something on Mars

8
00:00:18,184 --> 00:00:20,019
that could be harmed?

9
00:00:20,019 --> 00:00:21,321
Hi, I'm Jim Green,

10
00:00:21,321 --> 00:00:22,956
Chief Scientist at NASA

11
00:00:22,956 --> 00:00:25,425
and this is Gravity Assist.

12
00:00:25,425 --> 00:00:26,359
On this season of

13
00:00:26,359 --> 00:00:27,660

Gravity Assist, we're looking

14
00:00:27,660 --> 00:00:29,362
for life beyond Earth.

15
00:00:30,430 --> 00:00:32,465
I'm here with Dr. Lisa Pratt,

16
00:00:32,465 --> 00:00:34,367
and she's NASA's Planetary

17
00:00:34,367 --> 00:00:35,935
Protection Officer.

18
00:00:35,935 --> 00:00:37,737
She plays a critical role

19
00:00:37,737 --> 00:00:40,039
in overseeing and approving

20
00:00:40,039 --> 00:00:42,175
how NASA implements

21
00:00:42,175 --> 00:00:43,543
planetary protection

22
00:00:43,543 --> 00:00:45,111
requirements for all

23
00:00:45,111 --> 00:00:46,646
our planetary missions

24
00:00:46,646 --> 00:00:47,914
both robotic

25
00:00:47,914 --> 00:00:49,983
and human spacecraft.

26
00:00:49,983 --> 00:00:51,151
Welcome, Lisa,

27
00:00:51,151 --> 00:00:52,819
to Gravity Assist.

28
00:00:52,819 --> 00:00:54,387
Hey, thank you, Jim.

29
00:00:54,387 --> 00:00:55,388
You know, you've had

30
00:00:55,388 --> 00:00:56,723
a distinguished career

31
00:00:56,723 --> 00:00:58,625
in biogeochemistry

32
00:00:58,625 --> 00:01:00,960
and astrobiology, and on.

33
00:01:00,960 --> 00:01:02,429
And the Planetary Protection

34
00:01:02,429 --> 00:01:04,097
Officer name, that sounds

35
00:01:04,097 --> 00:01:05,965
really cool.

36
00:01:05,965 --> 00:01:07,300
In fact, I've received letters

37
00:01:07,300 --> 00:01:09,302
from kids all over the world,

38
00:01:09,302 --> 00:01:10,637

and one of them called

39
00:01:10,637 --> 00:01:11,738
your position,

40
00:01:11,738 --> 00:01:13,740
the Guardian of the Galaxy,

41
00:01:13,740 --> 00:01:16,009
so I can't help but think that

42
00:01:16,009 --> 00:01:18,611
every time I talk to you.

43
00:01:18,611 --> 00:01:20,246
But let's start with the basics.

44
00:01:20,246 --> 00:01:22,782
What is planetary protection?

45
00:01:22,782 --> 00:01:24,350
Jim, I wish I could tell you

46
00:01:24,350 --> 00:01:25,552
that I was, in fact,

47
00:01:25,552 --> 00:01:27,120
the Guardian of the Galaxy,

48
00:01:27,120 --> 00:01:29,122
but the reality is

49
00:01:29,122 --> 00:01:30,957
a little more mundane.

50
00:01:30,957 --> 00:01:32,826
Uh, planetary protection

51
00:01:32,826 --> 00:01:36,696
is focused on limiting

52
00:01:36,696 --> 00:01:38,565
biological contamination

53
00:01:38,565 --> 00:01:39,732
of other worlds

54
00:01:39,732 --> 00:01:41,468
with terrestrial organisms,

55
00:01:41,468 --> 00:01:43,336
that's organisms from Earth,

56
00:01:43,336 --> 00:01:45,038
and preventing the return

57
00:01:45,038 --> 00:01:48,274
of harmful potential

58
00:01:48,274 --> 00:01:50,176
extraterrestrial organisms

59
00:01:50,176 --> 00:01:52,479
or just organic materials

60
00:01:52,479 --> 00:01:54,080
when samples are returned

61
00:01:54,080 --> 00:01:55,181
to Earth during

62
00:01:55,181 --> 00:01:56,816
robotic sample return

63
00:01:56,816 --> 00:01:58,852

or in the future

64
00:01:58,852 --> 00:02:00,386
when astronauts come back

65
00:02:00,386 --> 00:02:02,121
to Earth from exploration

66
00:02:02,121 --> 00:02:04,057
missions to other worlds.

67
00:02:04,057 --> 00:02:05,024
We send things

68
00:02:05,024 --> 00:02:06,226
all over the place,

69
00:02:06,226 --> 00:02:08,127
and the next big mission

70
00:02:08,127 --> 00:02:10,296
is, of course, Perseverance.

71
00:02:10,296 --> 00:02:12,632
Uh, and it's going to Mars.

72
00:02:12,632 --> 00:02:14,267
And so when NASA wants to

73
00:02:14,267 --> 00:02:16,603
send a new rover to Mars,

74
00:02:16,603 --> 00:02:18,438
what do you do?

75
00:02:18,438 --> 00:02:20,173
Well, Jim, right from

76
00:02:20,173 --> 00:02:21,908
the very earliest phase

77
00:02:21,908 --> 00:02:23,076
of mission design,

78
00:02:23,076 --> 00:02:24,611
when that-when that light bulb

79
00:02:24,611 --> 00:02:26,646
first comes on with an idea

80
00:02:26,646 --> 00:02:28,781
for a new mission, the Office

81
00:02:28,781 --> 00:02:30,083
of Planetary Protection

82
00:02:30,083 --> 00:02:31,851
provides guidance

83
00:02:31,851 --> 00:02:33,620
to the engineering team

84
00:02:33,620 --> 00:02:36,022
on heat sterilization,

85
00:02:36,022 --> 00:02:38,091
or alternative chemical

86
00:02:38,091 --> 00:02:39,526
cleaning methods, such as

87
00:02:39,526 --> 00:02:41,661
vapor hydrogen peroxide,

88
00:02:41,661 --> 00:02:43,263

because some spacecraft

89
00:02:43,263 --> 00:02:45,265
materials can be cleaned

90
00:02:45,265 --> 00:02:46,432
and others cannot.

91
00:02:46,432 --> 00:02:47,767
And we want to be sure

92
00:02:47,767 --> 00:02:48,801
that we're designing

93
00:02:48,801 --> 00:02:50,970
a spacecraft that will tolerate

94
00:02:50,970 --> 00:02:52,205
the cleaning procedures

95
00:02:52,205 --> 00:02:54,073
necessary to go to

96
00:02:54,073 --> 00:02:55,975
the three places we care about

97
00:02:55,975 --> 00:02:58,044
right now most deeply

98
00:02:58,044 --> 00:02:59,546
in terms of contamination,

99
00:02:59,546 --> 00:03:01,948
and that's Mars, Enceladus,

100
00:03:01,948 --> 00:03:03,416
and Europa.

101
00:03:03,416 --> 00:03:05,184
And when we have a mission

102
00:03:05,184 --> 00:03:06,753
that's being assembled

103
00:03:06,753 --> 00:03:08,721
for one of those locations,

104
00:03:08,721 --> 00:03:09,756
then there's actually

105
00:03:09,756 --> 00:03:11,224
an independent auditor

106
00:03:11,224 --> 00:03:13,426
from our office that travels

107
00:03:13,426 --> 00:03:15,161
to all the facilities

108
00:03:15,161 --> 00:03:17,297
where parts like solar panels

109
00:03:17,297 --> 00:03:18,364
or parachutes are

110
00:03:18,364 --> 00:03:19,966
being manufactured,

111
00:03:19,966 --> 00:03:21,434
and we take samples

112
00:03:21,434 --> 00:03:22,702
to determine the level

113
00:03:22,702 --> 00:03:24,904

of biological cleanliness.

114
00:03:24,904 --> 00:03:27,574
And everyday, I actually review

115
00:03:27,574 --> 00:03:30,209
data on the number of spores

116
00:03:30,209 --> 00:03:32,612
being sampled and detected

117
00:03:32,612 --> 00:03:34,147
on Perseverance

118
00:03:34,147 --> 00:03:36,049
as we get ready for launch.

119
00:03:36,049 --> 00:03:37,951
And we use that to tell us

120
00:03:37,951 --> 00:03:39,452
if we need to do

121
00:03:39,452 --> 00:03:41,287
additional cleaning

122
00:03:41,287 --> 00:03:42,422
or what we call

123
00:03:42,422 --> 00:03:44,223
bio-burden reduction

124
00:03:44,223 --> 00:03:46,192
to get ready for launch.

125
00:03:46,192 --> 00:03:47,327
So Lisa, what is

126
00:03:47,327 --> 00:03:48,528
a spore exactly?

127
00:03:48,528 --> 00:03:49,862
Is it-is it, uh,

128
00:03:49,862 --> 00:03:51,097
biologically made up

129
00:03:51,097 --> 00:03:52,865
of many different things?

130
00:03:52,865 --> 00:03:55,635
A spore is a-is a tiny

131
00:03:55,635 --> 00:03:59,439
microscopic resting cell

132
00:03:59,439 --> 00:04:00,940
that only certain types

133
00:04:00,940 --> 00:04:03,376
of bacteria can make,

134
00:04:03,376 --> 00:04:05,645
and-and they make spores,

135
00:04:05,645 --> 00:04:08,348
a process called sporulation,

136
00:04:08,348 --> 00:04:09,482
um, when the environmental

137
00:04:09,482 --> 00:04:11,484
conditions get-get challenging

138
00:04:11,484 --> 00:04:13,286

and it looks like, uh,

139
00:04:13,286 --> 00:04:14,721
they're gonna have to shut down,

140
00:04:14,721 --> 00:04:15,722
they're not gonna--

141
00:04:15,722 --> 00:04:16,823
they're gonna continue

142
00:04:16,823 --> 00:04:18,524
to be active.

143
00:04:18,524 --> 00:04:20,226
But in the process of making

144
00:04:20,226 --> 00:04:21,995
that-that spore,

145
00:04:21,995 --> 00:04:25,531
that single-cell entity,

146
00:04:25,531 --> 00:04:28,234
they wrap it in layers

147
00:04:28,234 --> 00:04:33,673
of highly resistant biopolymers.

148
00:04:33,673 --> 00:04:35,174
They seal it off,

149
00:04:35,174 --> 00:04:37,343
and thereby they create,

150
00:04:37,343 --> 00:04:39,946
um, the possibility of

151
00:04:39,946 --> 00:04:42,015
that spore later

152
00:04:42,015 --> 00:04:43,616
breaking open

153
00:04:43,616 --> 00:04:45,284
and turning back into

154
00:04:45,284 --> 00:04:46,886
a viable organism

155
00:04:46,886 --> 00:04:49,522
that can replicate and grow,

156
00:04:49,522 --> 00:04:51,257
so the reason going--

157
00:04:51,257 --> 00:04:52,959
and this goes back to Viking.

158
00:04:52,959 --> 00:04:55,728
It's really the-the Viking, um,

159
00:04:55,728 --> 00:04:58,097
planetary protection biologists,

160
00:04:58,097 --> 00:05:00,633
um, that-that thought

161
00:05:00,633 --> 00:05:02,568
this through and said,

162
00:05:02,568 --> 00:05:04,904
"Of all of the entities

163
00:05:04,904 --> 00:05:06,272

known on Earth

164
00:05:06,272 --> 00:05:07,707
that are biological,

165
00:05:07,707 --> 00:05:09,642
the only thing we think

166
00:05:09,642 --> 00:05:12,311
that could get on a spacecraft,

167
00:05:12,311 --> 00:05:14,847
not-not be seen, uh, in

168
00:05:14,847 --> 00:05:18,217
an inspection and stay viable

169
00:05:18,217 --> 00:05:21,554
would be a hardy spore."

170
00:05:21,554 --> 00:05:22,989
So we don't even--

171
00:05:22,989 --> 00:05:24,524
we don't even monitor

172
00:05:24,524 --> 00:05:25,758
all of the spores,

173
00:05:25,758 --> 00:05:27,093
which you would be monitoring

174
00:05:27,093 --> 00:05:28,127
if you were making

175
00:05:28,127 --> 00:05:31,164
medical devices, like implants

176
00:05:31,164 --> 00:05:32,465
and things like that.

177
00:05:32,465 --> 00:05:34,600
For us, we actually,

178
00:05:34,600 --> 00:05:36,169
we-we take a wipe of

179
00:05:36,169 --> 00:05:37,904
a spacecraft surface,

180
00:05:37,904 --> 00:05:40,339
or we take a-a tiny little swab

181
00:05:40,339 --> 00:05:41,374
that looks like

182
00:05:41,374 --> 00:05:43,710
a slightly large Q-tip,

183
00:05:43,710 --> 00:05:47,580
and then we heat shock

184
00:05:47,580 --> 00:05:50,183
that sample to kill

185
00:05:50,183 --> 00:05:52,785
the wimpy organisms,

186
00:05:52,785 --> 00:05:54,454
because we only want to know

187
00:05:54,454 --> 00:05:55,621
how much contamination

188
00:05:55,621 --> 00:05:57,156

is there that could survive

189
00:05:57,156 --> 00:05:59,225
the journey, uh,

190
00:05:59,225 --> 00:06:01,861
launch, travel, you know,

191
00:06:01,861 --> 00:06:03,663
cruise stage and-and the landing

192
00:06:03,663 --> 00:06:04,831
and the exposure

193
00:06:04,831 --> 00:06:06,199
to another planet.

194
00:06:06,199 --> 00:06:09,635
Those are the NASA Standard

195
00:06:09,635 --> 00:06:13,039
Assay, the NSA spores.

196
00:06:13,039 --> 00:06:14,607
There are international

197
00:06:14,607 --> 00:06:15,541
guidelines for

198
00:06:15,541 --> 00:06:17,076
spore cleanliness.

199
00:06:17,076 --> 00:06:18,377
And the total mission

200
00:06:18,377 --> 00:06:19,512
requirement for all

201
00:06:19,512 --> 00:06:21,080
spacecraft elements

202
00:06:21,080 --> 00:06:22,715
impacting Mars

203
00:06:22,715 --> 00:06:25,351
is 500,000 spores

204
00:06:25,351 --> 00:06:27,086
including the rover,

205
00:06:27,086 --> 00:06:28,855
aeroshell, descent stage,

206
00:06:28,855 --> 00:06:30,323
and parachute.

207
00:06:30,323 --> 00:06:32,258
That sounds like a lot,

208
00:06:32,258 --> 00:06:33,259
but the requirement is

209
00:06:33,259 --> 00:06:35,194
less than 300 spores

210
00:06:35,194 --> 00:06:36,429
per square meter

211
00:06:36,429 --> 00:06:38,998
of exposed rover surface.

212
00:06:38,998 --> 00:06:41,567
Spores are tiny, barely visible

213
00:06:41,567 --> 00:06:43,436

with a light microscope,

214
00:06:43,436 --> 00:06:46,072
so 300 spores per square meter

215
00:06:46,072 --> 00:06:49,275
can be scaled up and visualized

216
00:06:49,275 --> 00:06:52,145
as just 28 tennis balls

217
00:06:52,145 --> 00:06:54,747
on an entire football field.

218
00:06:54,747 --> 00:06:57,650
That's thousands of times

219
00:06:57,650 --> 00:06:59,886
less than what our spacecraft

220
00:06:59,886 --> 00:07:01,554
would carry

221
00:07:01,554 --> 00:07:03,089
if we didn't build them

222
00:07:03,089 --> 00:07:04,791
in a clean room facility,

223
00:07:04,791 --> 00:07:06,526
if we didn't constantly

224
00:07:06,526 --> 00:07:08,628
wipe them with

225
00:07:08,628 --> 00:07:11,664
a cleaning fluid specific

226
00:07:11,664 --> 00:07:13,199
to biological cleanliness,

227
00:07:13,199 --> 00:07:17,203
like 70% isopropyl alcohol,

228
00:07:17,203 --> 00:07:18,504
which is what we've all--

229
00:07:18,504 --> 00:07:20,139
we all now read the labels

230
00:07:20,139 --> 00:07:22,775
on our hand sanitizer, uh,

231
00:07:22,775 --> 00:07:24,544
under the current pandemic

232
00:07:24,544 --> 00:07:26,512
to make sure that we're using

233
00:07:26,512 --> 00:07:28,281
at least 70%,

234
00:07:28,281 --> 00:07:30,683
just what we use on spacecraft.

235
00:07:30,683 --> 00:07:31,684
Well, you know, what's

236
00:07:31,684 --> 00:07:33,553
riding with Percy, and I like

237
00:07:33,553 --> 00:07:34,687
that nickname, Percy.

238
00:07:34,687 --> 00:07:35,922

Oh, I do too.

239
00:07:35,922 --> 00:07:37,423
But what's riding with Percy

240
00:07:37,423 --> 00:07:40,593
is the Ingenuity helicopter.

241
00:07:40,593 --> 00:07:42,795
This is really a fabulous idea

242
00:07:42,795 --> 00:07:43,796
to what we call

243
00:07:43,796 --> 00:07:45,498
a technology demonstration,

244
00:07:45,498 --> 00:07:46,833
and we hope it works.

245
00:07:46,833 --> 00:07:48,167
But does that also have

246
00:07:48,167 --> 00:07:49,435
some sort of planetary

247
00:07:49,435 --> 00:07:51,270
protection requirements on it?

248
00:07:51,270 --> 00:07:52,538
Yes, it does.

249
00:07:52,538 --> 00:07:54,006
Uh, it-it's been held

250
00:07:54,006 --> 00:07:56,509
to about the same standards

251
00:07:56,509 --> 00:07:58,010
as that upper deck

252
00:07:58,010 --> 00:07:59,111
of the rover,

253
00:07:59,111 --> 00:08:02,181
but not nearly as, uh, rigorous

254
00:08:02,181 --> 00:08:04,317
as the sterilization

255
00:08:04,317 --> 00:08:06,385
for the sample tubes and drill,

256
00:08:06,385 --> 00:08:07,787
or the wheels.

257
00:08:07,787 --> 00:08:08,788
And that's because it's

258
00:08:08,788 --> 00:08:09,856
a very different

259
00:08:09,856 --> 00:08:11,190
kind of activity.

260
00:08:11,190 --> 00:08:14,060
It-it will not, in any way,

261
00:08:14,060 --> 00:08:15,695
uh, be associated with

262
00:08:15,695 --> 00:08:17,897
the return of samples to earth.

263
00:08:17,897 --> 00:08:19,832

So part of what we're doing

264
00:08:19,832 --> 00:08:22,435
with the-the tubes and the drill

265
00:08:22,435 --> 00:08:23,970
is we're not just worrying

266
00:08:23,970 --> 00:08:26,138
about what we take to Mars,

267
00:08:26,138 --> 00:08:27,874
that's forward contamination.

268
00:08:27,874 --> 00:08:29,475
We're very concerned

269
00:08:29,475 --> 00:08:31,611
about what might come back,

270
00:08:31,611 --> 00:08:32,979
uh, in those samples,

271
00:08:32,979 --> 00:08:34,146
that's backward

272
00:08:34,146 --> 00:08:35,381
planetary protection

273
00:08:35,381 --> 00:08:36,816
and backward planetary

274
00:08:36,816 --> 00:08:39,385
protection ensures

275
00:08:39,385 --> 00:08:41,087
that we do not bring

276
00:08:41,087 --> 00:08:42,955
something harmful

277
00:08:42,955 --> 00:08:44,624
and release it into

278
00:08:44,624 --> 00:08:46,292
the terrestrial environment.

279
00:08:46,292 --> 00:08:47,260
Well, you know, I think

280
00:08:47,260 --> 00:08:50,029
I have, uh, one of these samples

281
00:08:50,029 --> 00:08:51,464
and a sample tube,

282
00:08:51,464 --> 00:08:53,165
uh, right here with me.

283
00:08:53,165 --> 00:08:55,034
Uh, so when I was out at JPL

284
00:08:55,034 --> 00:08:56,202
not too long ago,

285
00:08:56,202 --> 00:08:57,370
and I went into the lab

286
00:08:57,370 --> 00:08:58,738
where they, uh, were testing

287
00:08:58,738 --> 00:09:01,407
the core, I was able to walk out

288
00:09:01,407 --> 00:09:03,342

with one of the cores.

289
00:09:03,342 --> 00:09:04,310
So they had just--

290
00:09:04,310 --> 00:09:05,177
Oh, look at that.

291
00:09:05,177 --> 00:09:06,178
--you know, took this--

292
00:09:06,178 --> 00:09:07,446
Yeah, yeah, they just took

293
00:09:07,446 --> 00:09:09,582
this circular, uh, tube

294
00:09:09,582 --> 00:09:11,384
that has a cutting mechanism,

295
00:09:11,384 --> 00:09:13,486
and it cuts into the rock

296
00:09:13,486 --> 00:09:15,021
and then creates this core.

297
00:09:15,021 --> 00:09:16,722
Then they break it off,

298
00:09:16,722 --> 00:09:18,791
and then that is put into

299
00:09:18,791 --> 00:09:20,626
a sample tube,

300
00:09:20,626 --> 00:09:22,028
and that's what these, um,

301
00:09:22,028 --> 00:09:24,864
uh, the sample tube looks like.

302
00:09:24,864 --> 00:09:26,933
And as you say, these have

303
00:09:26,933 --> 00:09:29,402
to be cleaned really well.

304
00:09:29,402 --> 00:09:30,736
You know, there are places

305
00:09:30,736 --> 00:09:32,838
on Mars I would dearly love

306
00:09:32,838 --> 00:09:34,073
to be able to really

307
00:09:34,073 --> 00:09:35,975
interrogate,

308
00:09:35,975 --> 00:09:37,677
and one of those places

309
00:09:37,677 --> 00:09:39,545
is, uh, what we believe--

310
00:09:39,545 --> 00:09:40,880
uh, we call them

311
00:09:40,880 --> 00:09:42,348
reoccurring slope lineae.

312
00:09:42,348 --> 00:09:44,150
This is, uh, these long lines

313
00:09:44,150 --> 00:09:45,484

of dark material

314
00:09:45,484 --> 00:09:47,119
that appear every summer.

315
00:09:47,119 --> 00:09:49,255
We now know that many of them,

316
00:09:49,255 --> 00:09:51,057
maybe not all, but many of them,

317
00:09:51,057 --> 00:09:52,425
uh, actually could be

318
00:09:52,425 --> 00:09:54,093
briny water.

319
00:09:54,093 --> 00:09:56,295
What would it take for a rover

320
00:09:56,295 --> 00:09:58,464
in planetary protection example

321
00:09:58,464 --> 00:09:59,865
to be able to go over

322
00:09:59,865 --> 00:10:01,434
and look at that,

323
00:10:01,434 --> 00:10:03,502
or potential water streak

324
00:10:03,502 --> 00:10:06,038
coming out of a-of a crater?

325
00:10:06,038 --> 00:10:07,073
Jim, that's-that's

326
00:10:07,073 --> 00:10:08,607
a really good question,

327
00:10:08,607 --> 00:10:10,810
and-and one that I think,

328
00:10:10,810 --> 00:10:12,812
uh, the Perseverance rover

329
00:10:12,812 --> 00:10:15,982
drilling caching assembly

330
00:10:15,982 --> 00:10:17,650
prepares us to do

331
00:10:17,650 --> 00:10:19,285
because we-we have been

332
00:10:19,285 --> 00:10:21,988
successful in sterilizing

333
00:10:21,988 --> 00:10:23,856
at a high temperature

334
00:10:23,856 --> 00:10:25,558
for many, many hours

335
00:10:25,558 --> 00:10:27,193
in a way that would meet

336
00:10:27,193 --> 00:10:28,361
the requirement for

337
00:10:28,361 --> 00:10:29,729
going into a place

338
00:10:29,729 --> 00:10:31,564

where we might encounter

339
00:10:31,564 --> 00:10:33,899
a liquid water environment.

340
00:10:33,899 --> 00:10:35,434
So I actually think

341
00:10:35,434 --> 00:10:36,702
that what we're learning,

342
00:10:36,702 --> 00:10:38,437
uh, from this mission, uh,

343
00:10:38,437 --> 00:10:40,773
to prepare for sample return,

344
00:10:40,773 --> 00:10:41,807
is going to put us

345
00:10:41,807 --> 00:10:43,576
in a-in a-in a good place

346
00:10:43,576 --> 00:10:45,611
to actually design a mission

347
00:10:45,611 --> 00:10:46,712
where we're gonna-we're gonna

348
00:10:46,712 --> 00:10:48,514
reach towards and in-in

349
00:10:48,514 --> 00:10:50,616
some way sample

350
00:10:50,616 --> 00:10:51,684
one of these

351
00:10:51,684 --> 00:10:53,853
recurring slope lineae,

352
00:10:53,853 --> 00:10:55,855
which I usually just call RSLs

353
00:10:55,855 --> 00:10:57,757
because if I don't,

354
00:10:57,757 --> 00:10:59,425
uh, it's a tongue twister.

355
00:10:59,425 --> 00:11:00,693
It is.

356
00:11:00,693 --> 00:11:01,794
And I also think that

357
00:11:01,794 --> 00:11:02,962
what we're learning with

358
00:11:02,962 --> 00:11:05,631
the, uh, rock drilling system

359
00:11:05,631 --> 00:11:07,033
on Perseverance

360
00:11:07,033 --> 00:11:09,602
is how we might, uh, clean,

361
00:11:09,602 --> 00:11:10,936
uh, a drilling system

362
00:11:10,936 --> 00:11:12,438
that would melt drill

363
00:11:12,438 --> 00:11:14,006

into ground ice

364
00:11:14,006 --> 00:11:16,475
or rotary drill, uh,

365
00:11:16,475 --> 00:11:18,544
into-into an ice cap.

366
00:11:18,544 --> 00:11:19,979
So Curiosity landed

367
00:11:19,979 --> 00:11:22,148
in August of 2012,

368
00:11:22,148 --> 00:11:23,149
and so it's been there

369
00:11:23,149 --> 00:11:25,017
many years in that environment.

370
00:11:25,017 --> 00:11:26,719
Do we expect many spores to

371
00:11:26,719 --> 00:11:28,954
have survived on its surfaces?

372
00:11:28,954 --> 00:11:31,190
Jim, even if the-the-the

373
00:11:31,190 --> 00:11:34,026
physical entity is there,

374
00:11:34,026 --> 00:11:35,461
because again, it's made out

375
00:11:35,461 --> 00:11:39,198
of very resilient biopolymers,

376
00:11:39,198 --> 00:11:42,134
it's extremely unlikely that

377
00:11:42,134 --> 00:11:44,103
that spore is viable,

378
00:11:44,103 --> 00:11:45,938
and that's what matters here.

379
00:11:45,938 --> 00:11:47,239
What matters is that

380
00:11:47,239 --> 00:11:49,408
an organism can come back

381
00:11:49,408 --> 00:11:52,111
to life, grow

382
00:11:52,111 --> 00:11:55,047
and replicate and spread.

383
00:11:55,047 --> 00:11:57,216
Uh, and my feeling is,

384
00:11:57,216 --> 00:11:59,652
and-and I-I'd love it

385
00:11:59,652 --> 00:12:01,487
if we had the opportunity

386
00:12:01,487 --> 00:12:03,155
to think this through,

387
00:12:03,155 --> 00:12:04,323
my guess is that

388
00:12:04,323 --> 00:12:05,524

the Curiosity rover

389
00:12:05,524 --> 00:12:07,460
is now clean enough

390
00:12:07,460 --> 00:12:10,629
that if it were to encounter

391
00:12:10,629 --> 00:12:14,800
uh, an RSL, um, or something

392
00:12:14,800 --> 00:12:16,936
interesting to explore,

393
00:12:16,936 --> 00:12:18,804
that it would be clean enough

394
00:12:18,804 --> 00:12:20,473
that we as

395
00:12:20,473 --> 00:12:22,174
an international community,

396
00:12:22,174 --> 00:12:23,209
because we-we-we would

397
00:12:23,209 --> 00:12:24,477
probably discuss this

398
00:12:24,477 --> 00:12:26,045
through COSPAR,

399
00:12:26,045 --> 00:12:27,413
uh, the committee on

400
00:12:27,413 --> 00:12:28,647
space exploration

401
00:12:28,647 --> 00:12:30,983
for which you are NASA's

402
00:12:30,983 --> 00:12:32,084
representative to

403
00:12:32,084 --> 00:12:33,519
the planetary protection panel.

404
00:12:33,519 --> 00:12:34,453
True.

405
00:12:34,453 --> 00:12:36,188
I think we would conclude

406
00:12:36,188 --> 00:12:39,091
that that spacecraft is now

407
00:12:39,091 --> 00:12:42,528
as clean or even cleaner

408
00:12:42,528 --> 00:12:43,729
than what we could

409
00:12:43,729 --> 00:12:45,798
ever accomplish on Earth

410
00:12:45,798 --> 00:12:47,633
and get it to the launch pad

411
00:12:47,633 --> 00:12:49,001
and get it on its way.

412
00:12:49,001 --> 00:12:49,902
Yeah, you know,

413
00:12:49,902 --> 00:12:50,836

for all the research that

414
00:12:50,836 --> 00:12:52,104
we have done, that really

415
00:12:52,104 --> 00:12:53,739
makes sense to me too.

416
00:12:53,739 --> 00:12:55,241
Well, you know, big discussions

417
00:12:55,241 --> 00:12:56,675
are going on at NASA

418
00:12:56,675 --> 00:12:58,611
on how, uh, we're going

419
00:12:58,611 --> 00:13:00,913
to send humans to Mars.

420
00:13:00,913 --> 00:13:02,581
What do we have to do

421
00:13:02,581 --> 00:13:05,417
to protect Mars and-and protect

422
00:13:05,417 --> 00:13:07,052
the humans that are there?

423
00:13:07,052 --> 00:13:08,420
We need to get a lot smarter

424
00:13:08,420 --> 00:13:09,855
than we are right now.

425
00:13:09,855 --> 00:13:10,856
And that's what we're gonna

426
00:13:10,856 --> 00:13:12,791
do with the Moon, you know?

427
00:13:12,791 --> 00:13:14,827
Uh, the Artemis campaign,

428
00:13:14,827 --> 00:13:17,596
the Gateway orbiting facility

429
00:13:17,596 --> 00:13:19,131
and the extended missions down

430
00:13:19,131 --> 00:13:20,900
to the surface of the moon,

431
00:13:20,900 --> 00:13:23,202
that's-that's the proving ground

432
00:13:23,202 --> 00:13:24,470
for Mars, Jim.

433
00:13:24,470 --> 00:13:27,173
If we can study how

434
00:13:27,173 --> 00:13:29,241
the microbes from humans

435
00:13:29,241 --> 00:13:30,643
leak out of the cuffs

436
00:13:30,643 --> 00:13:31,944
of our space suit

437
00:13:31,944 --> 00:13:33,145
or get out of

438
00:13:33,145 --> 00:13:35,147

the-the air handling systems

439
00:13:35,147 --> 00:13:36,649
in our habitats

440
00:13:36,649 --> 00:13:38,684
or trail along behind us

441
00:13:38,684 --> 00:13:40,419
on the wheels of our--

442
00:13:40,419 --> 00:13:41,987
of our vehicles,

443
00:13:41,987 --> 00:13:44,356
then we'll learn how

444
00:13:44,356 --> 00:13:45,758
to prevent that,

445
00:13:45,758 --> 00:13:47,960
or we'll develop, uh,

446
00:13:47,960 --> 00:13:49,161
technologies for

447
00:13:49,161 --> 00:13:51,397
sterilization of material

448
00:13:51,397 --> 00:13:53,065
when we're at Mars

449
00:13:53,065 --> 00:13:54,667
and then we'll be able

450
00:13:54,667 --> 00:13:56,735
to do that exploration

451
00:13:56,735 --> 00:13:58,337
without causing

452
00:13:58,337 --> 00:14:01,307
harmful contamination of Mars.

453
00:14:01,307 --> 00:14:02,808
And I say that, because

454
00:14:02,808 --> 00:14:04,476
we don't know right now.

455
00:14:04,476 --> 00:14:07,346
We-we-we don't have the data

456
00:14:07,346 --> 00:14:09,248
we need to understand

457
00:14:09,248 --> 00:14:10,516
whether or not there's

458
00:14:10,516 --> 00:14:13,085
indigenous Martian life.

459
00:14:13,085 --> 00:14:14,420
We're pretty sure

460
00:14:14,420 --> 00:14:16,455
there's nothing at the surface

461
00:14:16,455 --> 00:14:17,990
because we've been looking.

462
00:14:17,990 --> 00:14:19,391
We've been looking from orbit,

463
00:14:19,391 --> 00:14:20,993

we've been looking from rovers,

464
00:14:20,993 --> 00:14:21,827
we've been looking

465
00:14:21,827 --> 00:14:22,861
from platforms.

466
00:14:22,861 --> 00:14:24,263
We don't see anything

467
00:14:24,263 --> 00:14:25,431
with the characteristics

468
00:14:25,431 --> 00:14:26,632
of life as we know it

469
00:14:26,632 --> 00:14:27,733
on Earth.

470
00:14:27,733 --> 00:14:29,401
But subsurface?

471
00:14:29,401 --> 00:14:32,071
You know, uh, if-if it was

472
00:14:32,071 --> 00:14:33,672
ever there,

473
00:14:33,672 --> 00:14:36,008
and it evolved and adapted,

474
00:14:36,008 --> 00:14:37,710
then I think it's quite possible

475
00:14:37,710 --> 00:14:40,212
it retreated into the subsurface

476
00:14:40,212 --> 00:14:41,947
where we believe there is

477
00:14:41,947 --> 00:14:44,250
to the present day liquid water,

478
00:14:44,250 --> 00:14:46,752
um, below the ice table.

479
00:14:46,752 --> 00:14:48,854
And we certainly do not

480
00:14:48,854 --> 00:14:50,589
want to do something

481
00:14:50,589 --> 00:14:52,258
that would contaminate

482
00:14:52,258 --> 00:14:53,892
or compete, uh, with

483
00:14:53,892 --> 00:14:55,728
a potential Martian life form

484
00:14:55,728 --> 00:14:57,029
before we've had a chance

485
00:14:57,029 --> 00:14:59,164
to study it and understand it.

486
00:14:59,164 --> 00:15:01,767
It would be our first--

487
00:15:01,767 --> 00:15:03,836
you know, our first contact.

488
00:15:03,836 --> 00:15:05,437

And that's-that's--

489
00:15:05,437 --> 00:15:06,438
Yeah, right.

490
00:15:06,438 --> 00:15:08,207
That's-that's a one time only

491
00:15:08,207 --> 00:15:11,010
don't mess it up kind of--

492
00:15:11,010 --> 00:15:12,011
you know, kind of event

493
00:15:12,011 --> 00:15:13,545
and exploration.

494
00:15:13,545 --> 00:15:15,281
It would be, it would be.

495
00:15:15,281 --> 00:15:17,416
Well, you know, I'm gonna spe--

496
00:15:17,416 --> 00:15:18,584
I'm gonna, I guess, speculate,

497
00:15:18,584 --> 00:15:19,952
but I'm gonna think about

498
00:15:19,952 --> 00:15:21,487
a-a potential future,

499
00:15:21,487 --> 00:15:22,888
and that is, let's say

500
00:15:22,888 --> 00:15:24,857
we find life on Mars.

501
00:15:24,857 --> 00:15:26,525
Is it possible that we could--

502
00:15:26,525 --> 00:15:28,027
And it's below the surface,

503
00:15:28,027 --> 00:15:29,128
it's subsurface,

504
00:15:29,128 --> 00:15:30,596
maybe living in the aquifers

505
00:15:30,596 --> 00:15:31,397
where there's water.

506
00:15:31,397 --> 00:15:32,364
Mm-hmm, mm-hmm.

507
00:15:32,364 --> 00:15:33,299
And-and, you know,

508
00:15:33,299 --> 00:15:34,466
there's a lot of possibilities

509
00:15:34,466 --> 00:15:35,401
for that because we have

510
00:15:35,401 --> 00:15:36,435
an enormous amount of life

511
00:15:36,435 --> 00:15:38,103
below our feet too,

512
00:15:38,103 --> 00:15:39,672
uh, in-- on this planet.

513
00:15:39,672 --> 00:15:40,806

Do you think we could get

514
00:15:40,806 --> 00:15:42,041
to the point where humans

515
00:15:42,041 --> 00:15:43,342
and these Martians

516
00:15:43,342 --> 00:15:45,010
could coexist, and-and what

517
00:15:45,010 --> 00:15:48,047
would that look like?

518
00:15:48,047 --> 00:15:49,782
Well, Jim, uh,

519
00:15:49,782 --> 00:15:51,984
like you, uh, I'm sort of

520
00:15:51,984 --> 00:15:53,686
a hopeless optimist about

521
00:15:53,686 --> 00:15:55,254
what scientists and engineers

522
00:15:55,254 --> 00:15:57,189
are capable of doing,

523
00:15:57,189 --> 00:15:59,091
and I think it is possible.

524
00:15:59,091 --> 00:16:00,259
Uh, but I think we need

525
00:16:00,259 --> 00:16:01,927
to understand it,

526
00:16:01,927 --> 00:16:04,063
uh, and-and be aware of

527
00:16:04,063 --> 00:16:06,632
how we would bio barrier,

528
00:16:06,632 --> 00:16:09,435
uh, or very carefully

529
00:16:09,435 --> 00:16:11,303
control our waste,

530
00:16:11,303 --> 00:16:13,105
uh, and our agriculture.

531
00:16:13,105 --> 00:16:14,139
Because if we're gonna--

532
00:16:14,139 --> 00:16:15,007
if we're gonna be up there

533
00:16:15,007 --> 00:16:16,909
for extended periods of time,

534
00:16:16,909 --> 00:16:18,444
uh, we need to--

535
00:16:18,444 --> 00:16:19,478
we-we need to be able to

536
00:16:19,478 --> 00:16:20,813
grow our own food.

537
00:16:20,813 --> 00:16:22,414
And that's a very different

538
00:16:22,414 --> 00:16:24,116

microbiome from just

539
00:16:24,116 --> 00:16:25,784
the, you know, human body,

540
00:16:25,784 --> 00:16:28,120
which we know has a-a signature.

541
00:16:28,120 --> 00:16:29,988
But when we start growing food,

542
00:16:29,988 --> 00:16:31,523
now we've got-- you know,

543
00:16:31,523 --> 00:16:33,525
we've-we've got individual

544
00:16:33,525 --> 00:16:35,394
organisms that live in

545
00:16:35,394 --> 00:16:37,696
and on the roots of plants.

546
00:16:37,696 --> 00:16:39,431
Uh, mycorrhizal fungi

547
00:16:39,431 --> 00:16:40,599
that have, you know,

548
00:16:40,599 --> 00:16:42,134
a distinct characteristic,

549
00:16:42,134 --> 00:16:44,069
and-and-and bacteria as well.

550
00:16:44,069 --> 00:16:45,571
So we need to be

551
00:16:45,571 --> 00:16:47,973
very, very careful initially

552
00:16:47,973 --> 00:16:49,408
so we don't do something

553
00:16:49,408 --> 00:16:51,810
inadvertent and irreversible.

554
00:16:51,810 --> 00:16:53,078
And then I think there is

555
00:16:53,078 --> 00:16:54,980
a-- there is a possibility

556
00:16:54,980 --> 00:16:56,348
in the future that we can

557
00:16:56,348 --> 00:16:58,283
be there and we can study.

558
00:16:58,283 --> 00:17:00,185
Uh, frankly, you know,

559
00:17:00,185 --> 00:17:01,453
we're going to have to learn

560
00:17:01,453 --> 00:17:02,621
if there is something in--

561
00:17:02,621 --> 00:17:03,822
in the subsurface,

562
00:17:03,822 --> 00:17:04,957
how to not have it

563
00:17:04,957 --> 00:17:07,159

get inside our habitats,

564
00:17:07,159 --> 00:17:09,862
uh, and in some way present

565
00:17:09,862 --> 00:17:11,096
uh, present harmful

566
00:17:11,096 --> 00:17:12,164
contamination to us.

567
00:17:12,164 --> 00:17:13,365
It's very complicated.

568
00:17:13,365 --> 00:17:14,266
Right, it is.

569
00:17:14,266 --> 00:17:15,467
Very complicated relationship

570
00:17:15,467 --> 00:17:17,035
that will have to develop.

571
00:17:17,035 --> 00:17:18,437
But again, in the same way,

572
00:17:18,437 --> 00:17:19,671
if the moon is

573
00:17:19,671 --> 00:17:21,707
the proving ground for Mars,

574
00:17:21,707 --> 00:17:22,975
I think Mars is

575
00:17:22,975 --> 00:17:24,743
the proving ground for

576
00:17:24,743 --> 00:17:26,345
the extraordinary icy worlds

577
00:17:26,345 --> 00:17:28,947
that are out there, uh, around-

578
00:17:28,947 --> 00:17:30,449
around Saturn and Jupiter.

579
00:17:30,449 --> 00:17:31,817
Let's-let's make sure

580
00:17:31,817 --> 00:17:33,152
we know what we're doing

581
00:17:33,152 --> 00:17:35,821
in a very dry, hostile,

582
00:17:35,821 --> 00:17:37,856
cold terrestrial planet

583
00:17:37,856 --> 00:17:40,492
before we go to an icy moon.

584
00:17:40,492 --> 00:17:41,627
I'm going to guess

585
00:17:41,627 --> 00:17:42,761
that you believe there's

586
00:17:42,761 --> 00:17:43,762
life beyond Earth.

587
00:17:43,762 --> 00:17:45,798
[laughter]

588
00:17:45,798 --> 00:17:46,899

Jim, I would be

589
00:17:46,899 --> 00:17:49,501
absolutely flabbergasted

590
00:17:49,501 --> 00:17:52,304
if there was not life

591
00:17:52,304 --> 00:17:53,372
elsewhere in our solar system.

592
00:17:53,372 --> 00:17:54,440
Right.

593
00:17:54,440 --> 00:17:56,208
Because I-I think, um,

594
00:17:56,208 --> 00:17:58,210
evolutionary biology,

595
00:17:58,210 --> 00:18:00,612
uh, has really, uh, really

596
00:18:00,612 --> 00:18:02,147
changed over just

597
00:18:02,147 --> 00:18:03,615
the past two decades.

598
00:18:03,615 --> 00:18:05,417
And once we began to realize

599
00:18:05,417 --> 00:18:07,085
that there is essentially

600
00:18:07,085 --> 00:18:09,321
no place on Earth that

601
00:18:09,321 --> 00:18:11,490
doesn't have, uh, living--

602
00:18:11,490 --> 00:18:13,492
uh, living organisms,

603
00:18:13,492 --> 00:18:14,893
it makes it very hard for me

604
00:18:14,893 --> 00:18:16,495
to think, uh, that life

605
00:18:16,495 --> 00:18:19,565
only, uh, got started here.

606
00:18:19,565 --> 00:18:21,033
The very fact that we don't

607
00:18:21,033 --> 00:18:22,601
know what the origin of life

608
00:18:22,601 --> 00:18:23,635
is on Earth,

609
00:18:23,635 --> 00:18:25,070
we don't have a geologic record

610
00:18:25,070 --> 00:18:26,305
that gets us back in time

611
00:18:26,305 --> 00:18:27,973
far enough with

612
00:18:27,973 --> 00:18:29,274
unaltered materials

613
00:18:29,274 --> 00:18:30,642

to know what the origin

614
00:18:30,642 --> 00:18:31,944
looked like on Earth,

615
00:18:31,944 --> 00:18:33,378
also makes me wonder

616
00:18:33,378 --> 00:18:36,582
if the origin was someplace else

617
00:18:36,582 --> 00:18:38,383
and something arrived

618
00:18:38,383 --> 00:18:41,520
on Earth, uh, ready to go--

619
00:18:41,520 --> 00:18:42,454
Okay.

620
00:18:42,454 --> 00:18:43,822
...or partially formed, or--

621
00:18:43,822 --> 00:18:46,024
uh, and-and any of those ideas,

622
00:18:46,024 --> 00:18:49,361
uh, makes me keep my mind open

623
00:18:49,361 --> 00:18:51,163
about life elsewhere

624
00:18:51,163 --> 00:18:53,131
in our solar system.

625
00:18:53,131 --> 00:18:55,367
If it's there, any place else

626
00:18:55,367 --> 00:18:56,635
in our solar system,

627
00:18:56,635 --> 00:18:58,036
then I think we will have to

628
00:18:58,036 --> 00:18:59,771
conclude that on the spectrum

629
00:18:59,771 --> 00:19:02,574
from-from rare to common,

630
00:19:02,574 --> 00:19:04,510
that it's going to be common.

631
00:19:04,510 --> 00:19:06,678
If we don't find

632
00:19:06,678 --> 00:19:09,681
any vestige, um, of a life form,

633
00:19:09,681 --> 00:19:10,582
any place else

634
00:19:10,582 --> 00:19:11,884
in our solar system,

635
00:19:11,884 --> 00:19:13,118
uh, that's gonna--

636
00:19:13,118 --> 00:19:13,986
you know, that's gonna

637
00:19:13,986 --> 00:19:17,089
push us towards rare.

638
00:19:17,089 --> 00:19:18,023

Well, you know, when you

639
00:19:18,023 --> 00:19:19,391
look out into the solar system,

640
00:19:19,391 --> 00:19:20,792
where do you think

641
00:19:20,792 --> 00:19:22,961
we will find it first?

642
00:19:22,961 --> 00:19:24,129
I'm still cautiously

643
00:19:24,129 --> 00:19:25,631
optimistic about Mars,

644
00:19:25,631 --> 00:19:27,266
because of the methane mystery.

645
00:19:27,266 --> 00:19:28,367
Mm-hmm, mm-hmm.

646
00:19:28,367 --> 00:19:29,501
We see these-these-these

647
00:19:29,501 --> 00:19:32,004
pulses of elevated methane

648
00:19:32,004 --> 00:19:33,338
in the atmosphere.

649
00:19:33,338 --> 00:19:34,606
Um, and not only do we have

650
00:19:34,606 --> 00:19:36,208
no explanation for where

651
00:19:36,208 --> 00:19:37,442
that methane comes from,

652
00:19:37,442 --> 00:19:38,744
we don't have an explanation

653
00:19:38,744 --> 00:19:39,978
for how that methane

654
00:19:39,978 --> 00:19:42,014
is removed from the atmosphere.

655
00:19:42,014 --> 00:19:43,615
We have a-a great mystery

656
00:19:43,615 --> 00:19:45,017
on Mars right now.

657
00:19:45,017 --> 00:19:46,118
Um, and that's why--

658
00:19:46,118 --> 00:19:46,919
Right, we do.

659
00:19:46,919 --> 00:19:47,686
--as the Planetary

660
00:19:47,686 --> 00:19:48,520
Protection Officer,

661
00:19:48,520 --> 00:19:49,421
I want to see us continue

662
00:19:49,421 --> 00:19:51,256
to explore with

663
00:19:51,256 --> 00:19:54,793

a very, very careful, uh, eye

664
00:19:54,793 --> 00:19:57,029
on forward contamination.

665
00:19:57,029 --> 00:19:58,163
That gets back to your question

666
00:19:58,163 --> 00:19:59,731
about, can we go there,

667
00:19:59,731 --> 00:20:01,700
uh, and sustain ourselves

668
00:20:01,700 --> 00:20:04,703
without harming Mars

669
00:20:04,703 --> 00:20:08,073
if there is something on Mars

670
00:20:08,073 --> 00:20:09,841
that could be harmed?

671
00:20:09,841 --> 00:20:12,177
Ultimately, I think

672
00:20:12,177 --> 00:20:14,279
it's a better bet

673
00:20:14,279 --> 00:20:16,048
to look in the oceans

674
00:20:16,048 --> 00:20:17,883
beneath the-the ice covers

675
00:20:17,883 --> 00:20:20,085
in places like, uh,

676
00:20:20,085 --> 00:20:22,754
Europa and Enceladus.

677
00:20:22,754 --> 00:20:24,256
So let's say we brought

678
00:20:24,256 --> 00:20:26,158
the samples back, uh,

679
00:20:26,158 --> 00:20:27,793
from Percy, and now we--

680
00:20:27,793 --> 00:20:28,860
now we've started to

681
00:20:28,860 --> 00:20:30,329
interrogate them.

682
00:20:30,329 --> 00:20:31,897
Do you think we know enough

683
00:20:31,897 --> 00:20:33,398
to be able to say

684
00:20:33,398 --> 00:20:35,067
these samples, we can

685
00:20:35,067 --> 00:20:36,835
delineate things that, uh,

686
00:20:36,835 --> 00:20:38,136
we brought that actually

687
00:20:38,136 --> 00:20:39,137
have come back

688
00:20:39,137 --> 00:20:40,172

from those things that

689
00:20:40,172 --> 00:20:42,274
are indigenous to Mars?

690
00:20:42,274 --> 00:20:43,208
Jim, that would--

691
00:20:43,208 --> 00:20:44,943
that would be a false positive.

692
00:20:44,943 --> 00:20:47,045
It-it would mean, uh, could we

693
00:20:47,045 --> 00:20:49,081
or do we need to worry about,

694
00:20:49,081 --> 00:20:51,917
uh, being confused

695
00:20:51,917 --> 00:20:53,619
and misidentifying something

696
00:20:53,619 --> 00:20:55,120
that made a round trip,

697
00:20:55,120 --> 00:20:56,288
uh, with something that came

698
00:20:56,288 --> 00:20:57,556
from Mars itself?

699
00:20:57,556 --> 00:20:59,658
I-I frankly--

700
00:20:59,658 --> 00:21:00,692
um, and we've spent a lot

701
00:21:00,692 --> 00:21:01,994
of time discussing this

702
00:21:01,994 --> 00:21:04,029
with outside experts, uh,

703
00:21:04,029 --> 00:21:06,131
I have very little, uh, worry

704
00:21:06,131 --> 00:21:07,733
about a false positive.

705
00:21:07,733 --> 00:21:10,268
And-and the reason for that

706
00:21:10,268 --> 00:21:13,905
is that we are archiving

707
00:21:13,905 --> 00:21:16,475
samples from the spacecraft,

708
00:21:16,475 --> 00:21:18,143
from the facility,

709
00:21:18,143 --> 00:21:19,911
from the launch pad,

710
00:21:19,911 --> 00:21:21,380
and we are storing

711
00:21:21,380 --> 00:21:23,248
and saving those samples

712
00:21:23,248 --> 00:21:24,950
for future study,

713
00:21:24,950 --> 00:21:26,318

uh, so that we know,

714
00:21:26,318 --> 00:21:28,086
uh, a great deal

715
00:21:28,086 --> 00:21:29,354
about everything that

716
00:21:29,354 --> 00:21:30,622
could have potentially

717
00:21:30,622 --> 00:21:32,658
gotten on that spacecraft

718
00:21:32,658 --> 00:21:34,226
and flown with us.

719
00:21:34,226 --> 00:21:35,527
Wow, that sounds great.

720
00:21:35,527 --> 00:21:36,828
Well, you know, Lisa,

721
00:21:36,828 --> 00:21:39,431
I always like to ask my guests

722
00:21:39,431 --> 00:21:41,633
to tell me what was that event

723
00:21:41,633 --> 00:21:43,268
or person, place or thing

724
00:21:43,268 --> 00:21:44,569
that happened to 'em

725
00:21:44,569 --> 00:21:46,471
that got 'em so excited

726
00:21:46,471 --> 00:21:48,140
about being the scientist

727
00:21:48,140 --> 00:21:49,675
they are today,

728
00:21:49,675 --> 00:21:50,842
and I call that

729
00:21:50,842 --> 00:21:52,477
a gravity assist.

730
00:21:52,477 --> 00:21:54,179
So Lisa, what was

731
00:21:54,179 --> 00:21:56,281
your gravity assist?

732
00:21:56,281 --> 00:21:57,249
You know, Jim, it's hard

733
00:21:57,249 --> 00:21:58,450
for me to point

734
00:21:58,450 --> 00:22:00,485
to, um, a single event

735
00:22:00,485 --> 00:22:02,521
because I-I think you're aware

736
00:22:02,521 --> 00:22:03,789
uh, that I--

737
00:22:03,789 --> 00:22:05,724
uh, I had quite a number of,

738
00:22:05,724 --> 00:22:07,225

uh, not false starts,

739
00:22:07,225 --> 00:22:08,827
but moved-- you know, moved down

740
00:22:08,827 --> 00:22:10,696
one path with my education.

741
00:22:10,696 --> 00:22:12,831
And then said, "This really

742
00:22:12,831 --> 00:22:14,032
doesn't interest me that much."

743
00:22:14,032 --> 00:22:15,434
I-I went off to college

744
00:22:15,434 --> 00:22:17,069
as a Spanish major.

745
00:22:17,069 --> 00:22:18,270
Wow.

746
00:22:18,270 --> 00:22:20,939
And even though I had taken

747
00:22:20,939 --> 00:22:22,240
a lot of math and science

748
00:22:22,240 --> 00:22:23,475
in high school,

749
00:22:23,475 --> 00:22:24,743
uh, and knew that--

750
00:22:24,743 --> 00:22:25,610
knew that that was something

751
00:22:25,610 --> 00:22:27,612
I was good at, I just--

752
00:22:27,612 --> 00:22:29,281
I didn't see any role models,

753
00:22:29,281 --> 00:22:31,083
I didn't see any way that

754
00:22:31,083 --> 00:22:32,084
that was going to work out.

755
00:22:32,084 --> 00:22:33,018
Wow.

756
00:22:33,018 --> 00:22:35,320
Uh, and then, uh,

757
00:22:35,320 --> 00:22:36,722
I realized that I really

758
00:22:36,722 --> 00:22:38,690
still fundamentally loved,

759
00:22:38,690 --> 00:22:41,560
uh, biology in particular.

760
00:22:41,560 --> 00:22:43,361
Uh, so I started taking

761
00:22:43,361 --> 00:22:45,263
biology classes,

762
00:22:45,263 --> 00:22:48,166
and then I decided I-I didn't

763
00:22:48,166 --> 00:22:50,635

want to be killing frogs

764
00:22:50,635 --> 00:22:52,571
in-in biology labs.

765
00:22:52,571 --> 00:22:53,505
This was at a time

766
00:22:53,505 --> 00:22:54,473
when we were still working

767
00:22:54,473 --> 00:22:55,674
with live-live animals

768
00:22:55,674 --> 00:22:56,641
in undergraduate labs.

769
00:22:56,641 --> 00:22:57,509
Right.

770
00:22:57,509 --> 00:22:58,410
And, uh, had

771
00:22:58,410 --> 00:23:00,045
a-an inspirational moment

772
00:23:00,045 --> 00:23:02,781
when I decided I'm a botanist.

773
00:23:02,781 --> 00:23:04,249
Uh, you know, plants-plants

774
00:23:04,249 --> 00:23:05,917
don't-don't bleed.

775
00:23:05,917 --> 00:23:08,220
So I actually transferred to

776
00:23:08,220 --> 00:23:09,821
the University of North Carolina

777
00:23:09,821 --> 00:23:11,590
as a botany major.

778
00:23:11,590 --> 00:23:13,091
And then if there was

779
00:23:13,091 --> 00:23:14,659
a sort of, uh, pivotal

780
00:23:14,659 --> 00:23:16,194
gravity assist for me,

781
00:23:16,194 --> 00:23:17,929
it was in my-my senior year

782
00:23:17,929 --> 00:23:18,864
when I took

783
00:23:18,864 --> 00:23:20,298
my first geology course.

784
00:23:20,298 --> 00:23:22,400
And the instructor, uh,

785
00:23:22,400 --> 00:23:25,003
John Dennison at Chapel Hill,

786
00:23:25,003 --> 00:23:27,439
uh, had a way of talking about,

787
00:23:27,439 --> 00:23:30,609
uh, time travel, uh, through

788
00:23:30,609 --> 00:23:32,310

study of the geologic record,

789
00:23:32,310 --> 00:23:34,112
through stratigraphy,

790
00:23:34,112 --> 00:23:38,416
that was so awe inspiring,

791
00:23:38,416 --> 00:23:42,154
uh, that I knew that I was,

792
00:23:42,154 --> 00:23:43,855
uh, even more passionate

793
00:23:43,855 --> 00:23:45,023
and more interested

794
00:23:45,023 --> 00:23:47,626
in, uh, the history, um,

795
00:23:47,626 --> 00:23:49,060
of life on Earth

796
00:23:49,060 --> 00:23:49,928
and the evolution of

797
00:23:49,928 --> 00:23:51,062
life on earth, uh,

798
00:23:51,062 --> 00:23:53,064
through the study of ancient--

799
00:23:53,064 --> 00:23:54,766
uh, the ancient rock record.

800
00:23:54,766 --> 00:23:56,034
I was more interested in that

801
00:23:56,034 --> 00:23:57,169
than living plants.

802
00:23:57,169 --> 00:23:58,570
And so that's my--

803
00:23:58,570 --> 00:24:00,138
Uh, I guess that's-that's my--

804
00:24:00,138 --> 00:24:01,473
that's my gravity assist.

805
00:24:01,473 --> 00:24:03,141
And it's-- it-it's what

806
00:24:03,141 --> 00:24:05,744
serendipitously, uh, gave me

807
00:24:05,744 --> 00:24:08,446
a dual-- dual degrees in

808
00:24:08,446 --> 00:24:10,081
life sciences and earth sciences

809
00:24:10,081 --> 00:24:12,751
that actually positioned me,

810
00:24:12,751 --> 00:24:15,353
uh, ultimately to, uh,

811
00:24:15,353 --> 00:24:17,856
be competitive, uh, for

812
00:24:17,856 --> 00:24:19,791
the Planetary Protection Officer

813
00:24:19,791 --> 00:24:22,127

position when it was, uh,

814
00:24:22,127 --> 00:24:24,329
uh, advertised and opened,

815
00:24:24,329 --> 00:24:25,831
uh, three years ago.

816
00:24:25,831 --> 00:24:27,098
I was just so delighted

817
00:24:27,098 --> 00:24:28,600
that you applied.

818
00:24:28,600 --> 00:24:31,236
What made you decide to do that?

819
00:24:31,236 --> 00:24:33,038
Uh, this is, uh--

820
00:24:33,038 --> 00:24:34,940
this is-this is kind of

821
00:24:34,940 --> 00:24:36,575
a strange and wonderful story

822
00:24:36,575 --> 00:24:38,410
about role reversal,

823
00:24:38,410 --> 00:24:40,679
so, um, a number of people,

824
00:24:40,679 --> 00:24:42,948
both inside and outside NASA,

825
00:24:42,948 --> 00:24:45,050
had, uh, had let me know

826
00:24:45,050 --> 00:24:47,452
that-that the position was open.

827
00:24:47,452 --> 00:24:48,753
And I kept saying, "No.

828
00:24:48,753 --> 00:24:51,456
"You know, maybe 10 years ago,

829
00:24:51,456 --> 00:24:53,525
"it's too late in my career."

830
00:24:53,525 --> 00:24:56,494
Um, and I made the mistake--

831
00:24:56,494 --> 00:24:57,562
Well, maybe it was a mistake,

832
00:24:57,562 --> 00:24:58,463
maybe it's the best thing

833
00:24:58,463 --> 00:24:59,264
that could have happened.

834
00:24:59,264 --> 00:25:00,432
I was talking to my daughter

835
00:25:00,432 --> 00:25:01,366
about it.

836
00:25:01,366 --> 00:25:02,968
Uh, she's, uh,

837
00:25:02,968 --> 00:25:05,103
an engineering graduate student,

838
00:25:05,103 --> 00:25:06,705

uh, at Stanford,

839
00:25:06,705 --> 00:25:09,608
and-and I-I-I said, "You know,

840
00:25:09,608 --> 00:25:11,109
this position is open,"

841
00:25:11,109 --> 00:25:14,312
and that began weeks

842
00:25:14,312 --> 00:25:17,082
of relentless, uh, work

843
00:25:17,082 --> 00:25:18,383
on her part to--

844
00:25:18,383 --> 00:25:19,317
Wow.

845
00:25:19,317 --> 00:25:20,151
--talk me into applying.

846
00:25:20,151 --> 00:25:22,654
I kept saying, "No, it's just--

847
00:25:22,654 --> 00:25:24,522
it's just too late."

848
00:25:24,522 --> 00:25:26,324
And then finally, uh,

849
00:25:26,324 --> 00:25:28,693
one time, uh, on a phone call,

850
00:25:28,693 --> 00:25:29,861
and this was--

851
00:25:29,861 --> 00:25:31,930
Jim, this was three days

852
00:25:31,930 --> 00:25:33,498
before the position

853
00:25:33,498 --> 00:25:34,566
was going to close

854
00:25:34,566 --> 00:25:36,201
for applications,

855
00:25:36,201 --> 00:25:37,469
she said to me,

856
00:25:37,469 --> 00:25:40,872
"So Mom, following

857
00:25:40,872 --> 00:25:43,642
your passion and-and reaching

858
00:25:43,642 --> 00:25:45,210
for your dream job

859
00:25:45,210 --> 00:25:46,845
is advice you can dish out

860
00:25:46,845 --> 00:25:48,947
but you can't take it yourself?"

861
00:25:48,947 --> 00:25:50,348
[laughter]

862
00:25:50,348 --> 00:25:53,885
And I was-I was so shocked

863
00:25:53,885 --> 00:25:55,987

that, uh, this 25 year old

864
00:25:55,987 --> 00:25:58,123
threw-threw back at me

865
00:25:58,123 --> 00:25:59,891
what I throw at her

866
00:25:59,891 --> 00:26:02,761
that I actually said,

867
00:26:02,761 --> 00:26:05,630
"You know what, I'm gonna apply.

868
00:26:05,630 --> 00:26:07,399
I-I'll never be selected,

869
00:26:07,399 --> 00:26:09,567
but I'm going to apply,

870
00:26:09,567 --> 00:26:11,169
and for the rest of your life,

871
00:26:11,169 --> 00:26:12,537
you're going to say to me,

872
00:26:12,537 --> 00:26:14,139
'I'm so proud of you

873
00:26:14,139 --> 00:26:15,840
for applying.'"

874
00:26:15,840 --> 00:26:17,309
And then, you know,

875
00:26:17,309 --> 00:26:18,743
the unexpected happened,

876
00:26:18,743 --> 00:26:20,845
and I have had

877
00:26:20,845 --> 00:26:23,315
the most wonderful 2.5 years,

878
00:26:23,315 --> 00:26:26,318
uh, to date, um, of-of being

879
00:26:26,318 --> 00:26:28,420
the Planetary Protection Officer

880
00:26:28,420 --> 00:26:30,455
and helping, uh, helping NASA

881
00:26:30,455 --> 00:26:33,591
find ways to not contaminate,

882
00:26:33,591 --> 00:26:36,027
uh, forward or backward.

883
00:26:36,027 --> 00:26:37,529
Uh, it-it's a gift that--

884
00:26:37,529 --> 00:26:38,463
uh, it's a gift that

885
00:26:38,463 --> 00:26:39,864
Isabelle gave me.

886
00:26:39,864 --> 00:26:40,699
Well, I gotta tell you,

887
00:26:40,699 --> 00:26:42,367
I'm so proud of you

888
00:26:42,367 --> 00:26:43,501

for applying

889
00:26:43,501 --> 00:26:45,303
because, uh, uh, I have

890
00:26:45,303 --> 00:26:46,571
enjoyed working with you

891
00:26:46,571 --> 00:26:47,839
over the last several years.

892
00:26:47,839 --> 00:26:49,607
It's just been a wonderful

893
00:26:49,607 --> 00:26:51,276
experience for me too.

894
00:26:51,276 --> 00:26:52,610
Well, thanks so much

895
00:26:52,610 --> 00:26:54,045
for tagging up with me today

896
00:26:54,045 --> 00:26:55,847
to discuss, uh, what

897
00:26:55,847 --> 00:26:57,449
a Planetary Protection Officer

898
00:26:57,449 --> 00:26:59,918
does and how they do it.

899
00:26:59,918 --> 00:27:01,219
I've really enjoyed

900
00:27:01,219 --> 00:27:02,587
our discussion today.

901
00:27:02,587 --> 00:27:03,922
Hey, Jim, I'm just, uh--

902
00:27:03,922 --> 00:27:05,357
I'm just delighted, uh,

903
00:27:05,357 --> 00:27:06,358
that you asked

904
00:27:06,358 --> 00:27:07,292
and we had a chance.

905
00:27:07,292 --> 00:27:08,893
You caught me off guard with

906
00:27:08,893 --> 00:27:10,428
a couple of these questions,

907
00:27:10,428 --> 00:27:12,797
but, uh, the speculation was

908
00:27:12,797 --> 00:27:13,865
lots of fun,

909
00:27:13,865 --> 00:27:16,568
and, uh, go Perseverance.

910
00:27:16,568 --> 00:27:19,104
Go Perseverance.

911
00:27:19,104 --> 00:27:20,405
Join me next time as we

912
00:27:20,405 --> 00:27:22,073
continue our journey to look

913
00:27:22,073 --> 00:27:23,808

for a life beyond Earth.