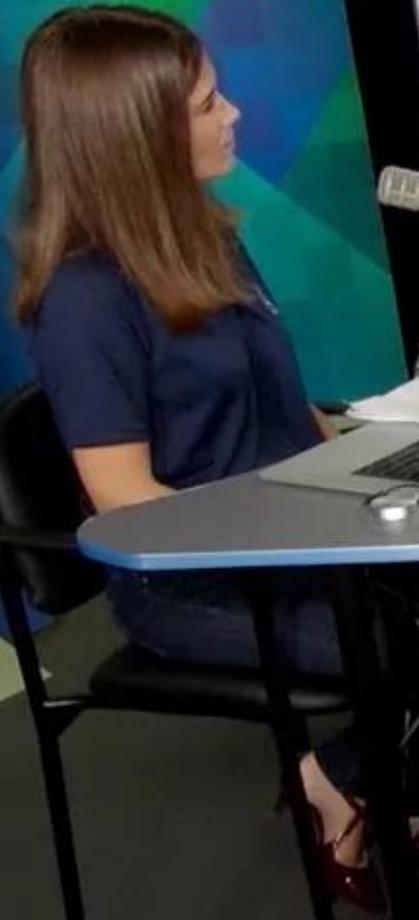




SILICON  
VALLEY  
LIVE



COUNTDOWN TO 2024  
DAYS HOURS MIN SEC  
1564 07:16:07



SILICON  
VALLEY

AMES RESEARCH CENTER

1  
00:00:12,470 --> 00:00:10,070  
hey everybody welcome back to NASA in

2  
00:00:14,660 --> 00:00:12,480  
Silicon Valley live I'm your host Abbey

3  
00:00:16,400 --> 00:00:14,670  
Tabor and if this is your first time

4  
00:00:19,130 --> 00:00:16,410  
joining us NASA and Silicon Valley live

5  
00:00:21,349 --> 00:00:19,140  
is a conversational show out of NASA's

6  
00:00:23,450 --> 00:00:21,359  
Ames Research Center and this is where

7  
00:00:25,910 --> 00:00:23,460  
we talk about all the nerdy NASA news

8  
00:00:30,080 --> 00:00:25,920  
you need to know about so today I have

9  
00:00:33,139 --> 00:00:30,090  
with me my lovely co-host Allison hi hi

10  
00:00:34,400 --> 00:00:33,149  
everyone I am your co-host Allison if

11  
00:00:37,400 --> 00:00:34,410  
you didn't know we are simultaneously

12  
00:00:39,500 --> 00:00:37,410  
live on twitch YouTube Facebook and

13  
00:00:41,450 --> 00:00:39,510

periscope but if you want to participate

14

00:00:43,520 --> 00:00:41,460

in the chat and ask our guests questions

15

00:00:49,220 --> 00:00:43,530

there's only one place you can do that

16

00:00:50,720 --> 00:00:49,230

and that's at WWE TV slash NASA yes and

17

00:00:52,160 --> 00:00:50,730

I am sure you're gonna want to ask

18

00:00:53,889 --> 00:00:52,170

questions because today we are dealing

19

00:00:56,389 --> 00:00:53,899

with one of life's biggest questions

20

00:00:59,299 --> 00:00:56,399

seriously we're gonna talk about are we

21

00:01:01,790 --> 00:00:59,309

alone in the universe yeah this is such

22

00:01:04,340 --> 00:01:01,800

a great topic yes I'm sure everyone will

23

00:01:06,500 --> 00:01:04,350

agree and today we have some really

24

00:01:09,380 --> 00:01:06,510

amazing guests with us to talk about it

25

00:01:11,120 --> 00:01:09,390

yeah hi hi everyone I'm Alfonso Davila

26

00:01:12,920 --> 00:01:11,130

I'm a master biologist here at NASA Ames

27

00:01:16,039 --> 00:01:12,930

and I search for life on other planets

28

00:01:18,200 --> 00:01:16,049

the lid I'm Michael for a long I'm a

29

00:01:19,730 --> 00:01:18,210

roboticist here at ed Ames and I build

30

00:01:21,170 --> 00:01:19,740

intelligent robots to explore other

31

00:01:23,870 --> 00:01:21,180

worlds oh cool

32

00:01:25,399 --> 00:01:23,880

so Abbi before we get into the show how

33

00:01:27,649 --> 00:01:25,409

about we remind our audience about our

34

00:01:29,960 --> 00:01:27,659

cool clock right here yes exactly right

35

00:01:31,819 --> 00:01:29,970

so this right here this beautiful thing

36

00:01:33,770 --> 00:01:31,829

is our moon countdown clock

37

00:01:36,230 --> 00:01:33,780

that's because five years from now in

38

00:01:38,539 --> 00:01:36,240

2024 we are planning to send humans to

39

00:01:40,429 --> 00:01:38,549

the moon that's part of our Artemis

40

00:01:43,730 --> 00:01:40,439

program and this clock is counting down

41

00:01:45,950 --> 00:01:43,740

the days hours minutes and seconds until

42

00:01:49,010 --> 00:01:45,960

we set the next man and the first woman

43

00:01:50,330 --> 00:01:49,020

to walk on the moon's South Pole so we

44

00:01:51,770 --> 00:01:50,340

will talk about that later in the show

45

00:01:55,490 --> 00:01:51,780

but if you want to learn more you can

46

00:01:59,450 --> 00:01:55,500

always go to [www.nasa.gov](http://www.nasa.gov) slash Artemis

47

00:02:03,440 --> 00:01:59,460

alright so let's get right to it is

48

00:02:05,270 --> 00:02:03,450

there life beyond Earth well short

49

00:02:07,340 --> 00:02:05,280

answer we don't know and that's the

50

00:02:09,710 --> 00:02:07,350

reason why we have to search all right

51  
00:02:11,990 --> 00:02:09,720  
but I will say these the more we explore

52  
00:02:12,890 --> 00:02:12,000  
that looks that the odds are looking

53  
00:02:14,149 --> 00:02:12,900  
better in there

54  
00:02:17,149 --> 00:02:14,159  
we might find something out there they

55  
00:02:19,160 --> 00:02:17,159  
are I'm glad you're that yeah well think

56  
00:02:21,319 --> 00:02:19,170  
about it thirty years ago what did we

57  
00:02:22,640 --> 00:02:21,329  
know about other planets in the

58  
00:02:24,229 --> 00:02:22,650  
possibility of life out there we knew

59  
00:02:26,179 --> 00:02:24,239  
there was one planet that is inhabited

60  
00:02:29,179 --> 00:02:26,189  
as the earth mm-hmm there was another

61  
00:02:31,160 --> 00:02:29,189  
planet Mars that maybe yes maybe no we

62  
00:02:33,710 --> 00:02:31,170  
didn't were not really sure and that was

63  
00:02:35,929 --> 00:02:33,720

the extent of it fast forward 30 years

64

00:02:37,550 --> 00:02:35,939

later we know that there are moons out

65

00:02:39,679 --> 00:02:37,560

in the in the outer solar system around

66

00:02:42,710 --> 00:02:39,689

Jupiter and Saturn that have subsurface

67

00:02:44,059 --> 00:02:42,720

oceans of liquid water Wow yeah and we

68

00:02:44,899 --> 00:02:44,069

know that there are millions of planets

69

00:02:46,520 --> 00:02:44,909

around other stars

70

00:02:48,710 --> 00:02:46,530

some of them the right distance from

71

00:02:50,750 --> 00:02:48,720

their Sun that liquid water could be

72

00:02:52,280 --> 00:02:50,760

stable on the surface okay so these look

73

00:02:54,800 --> 00:02:52,290

like very promising places to look and

74

00:02:57,140 --> 00:02:54,810

to look in search of life more and more

75

00:02:58,849 --> 00:02:57,150

opportunities places we might find

76  
00:02:59,300 --> 00:02:58,859  
something the more we learn the better

77  
00:03:01,039 --> 00:02:59,310  
it gets

78  
00:03:03,140 --> 00:03:01,049  
outstanding which brings the question

79  
00:03:05,240 --> 00:03:03,150  
like what is life how do we even define

80  
00:03:07,339 --> 00:03:05,250  
it well it's it's that's a complex well

81  
00:03:09,559 --> 00:03:07,349  
it's a complicated one that fundamental

82  
00:03:11,599 --> 00:03:09,569  
it's chemistry right with beta off made

83  
00:03:14,059 --> 00:03:11,609  
of chemistry molecules interacting

84  
00:03:16,970 --> 00:03:14,069  
reacting at doing things that allow

85  
00:03:18,259 --> 00:03:16,980  
those systems to survive and so when we

86  
00:03:21,069 --> 00:03:18,269  
search for life we're essentially

87  
00:03:23,330 --> 00:03:21,079  
looking for that that type of chemistry

88  
00:03:24,970 --> 00:03:23,340

ideally because it's easier to find

89

00:03:27,379 --> 00:03:24,980

chemistry that is similar to us but

90

00:03:29,000 --> 00:03:27,389

obviously there's chances that whatever

91

00:03:32,300 --> 00:03:29,010

life chemistry is out there it might be

92

00:03:34,550 --> 00:03:32,310

very different what's your perspective

93

00:03:36,259 --> 00:03:34,560

as a roboticist on this Michael well I

94

00:03:37,909 --> 00:03:36,269

mean that's it's it's it's a hard

95

00:03:39,020 --> 00:03:37,919

problem to begin with but especially for

96

00:03:41,030 --> 00:03:39,030

sending robots out they're gonna be

97

00:03:42,199 --> 00:03:41,040

doing exploration for us instead of

98

00:03:44,899 --> 00:03:42,209

having humans looking at all the data

99

00:03:47,300 --> 00:03:44,909

coming back actually trying to quantify

100

00:03:49,339 --> 00:03:47,310

so a computer can say yes this is life

101

00:03:50,479 --> 00:03:49,349

it is a massive challenge in of itself

102

00:03:52,039 --> 00:03:50,489

and I think it's fair to say we don't

103

00:03:53,750 --> 00:03:52,049

really have a good good way to do that

104

00:03:55,580 --> 00:03:53,760

just yet know we know and and if the

105

00:03:56,839 --> 00:03:55,590

question is already difficult imagine

106

00:03:59,420 --> 00:03:56,849

trying to answer the questions with

107

00:04:01,490 --> 00:03:59,430

Roberts with surrogates not with humans

108

00:04:03,319 --> 00:04:01,500

doing the actual experiments you know

109

00:04:05,360 --> 00:04:03,329

that that's the real challenge like you

110

00:04:06,530 --> 00:04:05,370

say you have to teach a machine to do

111

00:04:07,789 --> 00:04:06,540

that you really do have to do these

112

00:04:09,409 --> 00:04:07,799

things that you can sort of

113

00:04:13,280 --> 00:04:09,419

instinctively do but it's hard for you

114

00:04:14,539 --> 00:04:13,290

to write down yeah fascinating well

115

00:04:15,920 --> 00:04:14,549

where would you go to look for life if

116

00:04:18,110 --> 00:04:15,930

you were gonna go out there and really

117

00:04:19,759 --> 00:04:18,120

place your bets on the best place to

118

00:04:21,890 --> 00:04:19,769

look where would you go if I have to

119

00:04:22,830 --> 00:04:21,900

pick one place Mars is still top of my

120

00:04:25,409 --> 00:04:22,840

list

121

00:04:27,960 --> 00:04:25,419

yeah and the reason is because Mars is

122

00:04:31,440 --> 00:04:27,970

close enough to the earth that we can

123

00:04:33,330 --> 00:04:31,450

actually study it repeatedly we've been

124

00:04:34,980 --> 00:04:33,340

sending probes to Mars almost

125

00:04:36,870 --> 00:04:34,990

continuously for the past 20 years and

126

00:04:39,000 --> 00:04:36,880

that's that's a ski that's given as a

127

00:04:41,040 --> 00:04:39,010

very good perspective and idea of how

128

00:04:43,110 --> 00:04:41,050

the planet is today and how it was in

129

00:04:45,600 --> 00:04:43,120

the past good enough that we know now

130

00:04:47,280 --> 00:04:45,610

that Mars in very many different aspects

131

00:04:49,379 --> 00:04:47,290

is very similar to the earth it's very

132

00:04:52,950 --> 00:04:49,389

it's a very familiar place mountains

133

00:04:54,930 --> 00:04:52,960

volcanoes meteorite impacts sediments

134

00:04:56,850 --> 00:04:54,940

rocks that are composed of the same

135

00:05:00,450 --> 00:04:56,860

types of minerals that rocks on earth

136

00:05:01,980 --> 00:05:00,460

and so it looks like at some point the

137

00:05:04,650 --> 00:05:01,990

conditions for life to exist on Mars

138

00:05:06,330 --> 00:05:04,660

might have existed and if that was the

139

00:05:08,790 --> 00:05:06,340

case those forms of life might have been

140

00:05:12,750 --> 00:05:08,800

similar to us similar enough that we

141

00:05:14,850 --> 00:05:12,760

might recognize okay not something

142

00:05:16,170 --> 00:05:14,860

completely alien that wouldn't we

143

00:05:18,510 --> 00:05:16,180

wouldn't be able to recognize even if it

144

00:05:19,800 --> 00:05:18,520

was staring at us in the face okay so

145

00:05:22,500 --> 00:05:19,810

Mars is a good candidate for those

146

00:05:30,390 --> 00:05:22,510

reasons there's some comments about

147

00:05:31,710 --> 00:05:30,400

already Hobbes I hope there is human

148

00:05:34,860 --> 00:05:31,720

life on Mars in my lifetime

149

00:05:36,930 --> 00:05:34,870

so first the robots are gonna go yeah

150

00:05:39,510 --> 00:05:36,940

fun fact there is there is life on Mars

151  
00:05:40,980 --> 00:05:39,520  
that we know of because obviously every

152  
00:05:47,750 --> 00:05:40,990  
every mission that goes to Mars carries

153  
00:05:52,260 --> 00:05:50,580  
technically Michael what do you think

154  
00:05:56,100 --> 00:05:52,270  
the odds are of actually finding life on

155  
00:05:57,570 --> 00:05:56,110  
Mars I mean honestly like we've taken

156  
00:06:00,529 --> 00:05:57,580  
samples now and so probably haven't

157  
00:06:02,969 --> 00:06:00,539  
found definitive proof of life and so

158  
00:06:04,950 --> 00:06:02,979  
the odds don't look great but that's

159  
00:06:06,450 --> 00:06:04,960  
because it's a very big planet and we're

160  
00:06:09,330 --> 00:06:06,460  
sort of sifting through it like grams at

161  
00:06:10,590 --> 00:06:09,340  
a time but then so that's different

162  
00:06:12,719 --> 00:06:10,600  
though than asking what's the

163  
00:06:14,610 --> 00:06:12,729

probability that there is or was life

164

00:06:17,909 --> 00:06:14,620

there to be found yeah that's a good

165

00:06:20,279 --> 00:06:17,919

point and and and that it's important to

166

00:06:22,529 --> 00:06:20,289

recognize that when you look at Mars and

167

00:06:24,600 --> 00:06:22,539

the history of Mars is really a tale of

168

00:06:27,570 --> 00:06:24,610

two different planets really Mars today

169

00:06:30,060 --> 00:06:27,580

is a very extreme environment a lot of

170

00:06:32,550 --> 00:06:30,070

people think that it cannot sustain life

171

00:06:33,960 --> 00:06:32,560

at least not near the surface but the

172

00:06:35,430 --> 00:06:33,970

more we learn them on about Mars it

173

00:06:35,879 --> 00:06:35,440

tells us that way back in the past it

174

00:06:37,679 --> 00:06:35,889

was a very

175

00:06:39,779 --> 00:06:37,689

for an environment where water was

176  
00:06:43,290 --> 00:06:39,789  
flowing on the surface where there were

177  
00:06:45,959 --> 00:06:43,300  
lakes maybe seas even maybe oceans not

178  
00:06:48,809 --> 00:06:45,969  
too dissimilar to lakes and seas and

179  
00:06:50,820 --> 00:06:48,819  
rivers on earth and so conditions in the

180  
00:06:54,540 --> 00:06:50,830  
past might have been a lot better for

181  
00:06:56,790 --> 00:06:54,550  
life and so it is these dual history of

182  
00:06:58,050 --> 00:06:56,800  
Mars this to a perspective of Mars that

183  
00:07:01,439 --> 00:06:58,060  
we need to consider when we think about

184  
00:07:03,659 --> 00:07:01,449  
life on Mars early life in a in a

185  
00:07:05,189 --> 00:07:03,669  
friendly environment or more recent life

186  
00:07:06,989 --> 00:07:05,199  
in a very an Flynn and friendly

187  
00:07:08,640 --> 00:07:06,999  
environment yeah yeah I see so yes if it

188  
00:07:12,920 --> 00:07:08,650

was more it was a friendlier in the past

189

00:07:15,209 --> 00:07:12,930

and life did emerge maybe we would find

190

00:07:16,740 --> 00:07:15,219

possibilities that we find fossil

191

00:07:18,719 --> 00:07:16,750

evidence of it another present and other

192

00:07:20,519 --> 00:07:18,729

possibilities that when conditions on

193

00:07:22,499 --> 00:07:20,529

the surface became extreme that life

194

00:07:24,149 --> 00:07:22,509

retreated to other places maybe deeper

195

00:07:25,709 --> 00:07:24,159

in the planet under and it's still

196

00:07:27,240 --> 00:07:25,719

trying to survive in those in those

197

00:07:29,909 --> 00:07:27,250

environments yeah that's very exciting

198

00:07:31,829 --> 00:07:29,919

is exciting really bad teeth asks is

199

00:07:33,959 --> 00:07:31,839

there enough sunlight reaching Mars in

200

00:07:36,149 --> 00:07:33,969

order for it to sustain healthy plant

201

00:07:39,809 --> 00:07:36,159

life or will we have to rely on

202

00:07:41,279 --> 00:07:39,819

artificial growing processes but when it

203

00:07:42,480 --> 00:07:41,289

comes to sunlight that that's not a

204

00:07:44,850 --> 00:07:42,490

problem that's not a limiting factor

205

00:07:46,800 --> 00:07:44,860

there are in fact microorganisms on

206

00:07:49,170 --> 00:07:46,810

earth that can survive hundreds of

207

00:07:50,969 --> 00:07:49,180

meters deep in the ocean with very tiny

208

00:07:52,200 --> 00:07:50,979

amounts of light a lot less light and

209

00:07:55,230 --> 00:07:52,210

what reaches Mars

210

00:07:56,550 --> 00:07:55,240

so sunlight not an issue we would need

211

00:07:59,490 --> 00:07:56,560

to worry about things like temperature

212

00:08:01,350 --> 00:07:59,500

and radiation and other and toxic

213

00:08:05,790 --> 00:08:01,360

elements in the ground for those plants

214

00:08:07,740 --> 00:08:05,800

to grow but sunlight yeah one more

215

00:08:10,469 --> 00:08:07,750

question from the from the from the chat

216

00:08:11,879 --> 00:08:10,479

here twitch or ask what is life does it

217

00:08:15,269 --> 00:08:11,889

have to be a nurse does it have to have

218

00:08:17,249 --> 00:08:15,279

a nervous system or a brain or both well

219

00:08:19,079 --> 00:08:17,259

I don't think so some of us don't have a

220

00:08:22,350 --> 00:08:19,089

brain and we can be called

221

00:08:23,939 --> 00:08:22,360

alive most of the history of life on

222

00:08:25,679 --> 00:08:23,949

Earth there were no brains and no

223

00:08:28,050 --> 00:08:25,689

nervous systems it was microbial life

224

00:08:30,749 --> 00:08:28,060

single-celled microorganisms and in fact

225

00:08:31,950 --> 00:08:30,759

if anything the example of life on Earth

226

00:08:33,990 --> 00:08:31,960

is telling us is that being a

227

00:08:35,550 --> 00:08:34,000

single-cell organism with our brain and

228

00:08:36,930 --> 00:08:35,560

the nervous system might be a good thing

229

00:08:38,459 --> 00:08:36,940

because they've been around for billions

230

00:08:41,100 --> 00:08:38,469

of years oh yeah brains and nervous

231

00:08:43,319 --> 00:08:41,110

systems have been around for a lot less

232

00:08:45,210 --> 00:08:43,329

time and so yeah definitely not if not

233

00:08:48,400 --> 00:08:45,220

required

234

00:09:01,480 --> 00:08:52,250

like microbes though right right those

235

00:09:01,490 --> 00:09:10,280

one

236

00:09:15,290 --> 00:09:12,499

actually US vehicles to land on the

237

00:09:18,710 --> 00:09:15,300

surface there and it was about 40 odd

238

00:09:20,900 --> 00:09:18,720

years ago in the 1970s and they were

239

00:09:22,220 --> 00:09:20,910

these largest structures that landed

240

00:09:24,019 --> 00:09:22,230

there and they took pictures of the

241

00:09:25,280 --> 00:09:24,029

surface and they tried to collect soil

242

00:09:35,720 --> 00:09:25,290

samples and did some really interesting

243

00:09:37,699 --> 00:09:35,730

biological experiments there yeah so you

244

00:09:39,110 --> 00:09:37,709

can see the the lander and there's a

245

00:09:41,720 --> 00:09:39,120

human in there to give you a sense of

246

00:09:43,490 --> 00:09:41,730

scale and what he's holding up is the

247

00:09:45,559 --> 00:09:43,500

arm that extended out of the Viking

248

00:09:47,449 --> 00:09:45,569

Lander and scooped up the soil that was

249

00:09:49,730 --> 00:09:47,459

then brought back into the end of the

250

00:09:51,620 --> 00:09:49,740

vehicle to be experimented on oh man hey

251  
00:09:55,009 --> 00:09:51,630  
we have another photo - maybe of the of

252  
00:09:58,430 --> 00:09:55,019  
it on Mars the Viking took the first

253  
00:10:00,819 --> 00:09:58,440  
images on the surface of Mars this one

254  
00:10:05,269 --> 00:10:00,829  
but things like this look how red it is

255  
00:10:07,400 --> 00:10:05,279  
spectacular to see so that's the arm

256  
00:10:08,689 --> 00:10:07,410  
that was collecting soil yes yeah that's

257  
00:10:10,309 --> 00:10:08,699  
grabbing the soil out in the scene there

258  
00:10:12,139 --> 00:10:10,319  
okay and then what did it do with that

259  
00:10:13,850 --> 00:10:12,149  
that was part of an experiment that was

260  
00:10:15,680 --> 00:10:13,860  
part of a very cool experiment the first

261  
00:10:18,559 --> 00:10:15,690  
experiment to search for life on another

262  
00:10:20,090 --> 00:10:18,569  
planet it's no more and no less if I can

263  
00:10:22,519 --> 00:10:20,100

meet a lot of cool stuff it took a lot

264

00:10:24,110 --> 00:10:22,529

of pictures it showed us Mars up close

265

00:10:25,850 --> 00:10:24,120

for the first time but the biological

266

00:10:28,730 --> 00:10:25,860

experiments is what really made the

267

00:10:30,949 --> 00:10:28,740

mission truly exciting and there were

268

00:10:32,840 --> 00:10:30,959

three biological experiments one of them

269

00:10:34,370 --> 00:10:32,850

is particularly interesting it was

270

00:10:36,980 --> 00:10:34,380

called the labeled release experiment

271

00:10:39,439 --> 00:10:36,990

labeled release re-released experiment

272

00:10:41,090 --> 00:10:39,449

that was an experiment that the the idea

273

00:10:43,850 --> 00:10:41,100

for the experiment was that the the arm

274

00:10:46,040 --> 00:10:43,860

with the scoop would collect some with

275

00:10:47,689 --> 00:10:46,050

scoop some dirt from the ground and put

276

00:10:54,879 --> 00:10:47,699

it in a container and then add a

277

00:11:05,600 --> 00:10:57,559

an example of one of the vials that was

278

00:11:07,440 --> 00:11:05,610

made in 1974 1974 June July July 3rd

279

00:11:15,660 --> 00:11:07,450

1974

280

00:11:17,100 --> 00:11:15,670

and this is a vintage chicken soup it's

281

00:11:21,870 --> 00:11:17,110

perfectly clear it's chicken soup for my

282

00:11:23,700 --> 00:11:21,880

groups think about it if you are a

283

00:11:25,080 --> 00:11:23,710

viewer in the cold if you have a cold or

284

00:11:26,670 --> 00:11:25,090

you're cold and you're starving and

285

00:11:29,130 --> 00:11:26,680

you're dehydrated and you're miserable

286

00:11:33,980 --> 00:11:29,140

at home yeah what what's the best thing

287

00:11:36,900 --> 00:11:35,700

microorganisms on Mars if they were

288

00:11:39,810 --> 00:11:36,910

present in the soil they will be

289

00:11:41,580 --> 00:11:39,820

dehydrated no water very cold it's

290

00:11:44,250 --> 00:11:41,590

called very low temperatures mm-hmm and

291

00:11:46,590 --> 00:11:44,260

so to to help them come back alive and

292

00:11:48,660 --> 00:11:46,600

actually be able to detect them we would

293

00:11:51,060 --> 00:11:48,670

add this chicken soup so the microbes

294

00:11:53,280 --> 00:11:51,070

would have something to feed on grow and

295

00:11:56,310 --> 00:11:53,290

then we would be able to measure the

296

00:11:57,300 --> 00:11:56,320

gases that are produced as they eat the

297

00:11:58,590 --> 00:11:57,310

chicken soup so that's what the

298

00:12:00,510 --> 00:11:58,600

experiment did that's what the

299

00:12:02,490 --> 00:12:00,520

experiment did add the chicken soup to

300

00:12:04,290 --> 00:12:02,500

the soil and then sniff the gasses that

301  
00:12:06,060 --> 00:12:04,300  
would come out of the microbes chewing

302  
00:12:08,550 --> 00:12:06,070  
on the molecules like sugars and amino

303  
00:12:09,780 --> 00:12:08,560  
acids all the yummy stuff that microbes

304  
00:12:10,320 --> 00:12:09,790  
like to eat and was added with the

305  
00:12:12,240 --> 00:12:10,330  
chicken soup

306  
00:12:17,400 --> 00:12:12,250  
all right we're looking at traces of

307  
00:12:18,870 --> 00:12:17,410  
them digested so our first evidence of

308  
00:12:24,720 --> 00:12:18,880  
life on another planet could have been

309  
00:12:33,510 --> 00:12:24,730  
Michael poop poop something all wife

310  
00:12:36,780 --> 00:12:33,520  
does yeah it was really interesting and

311  
00:12:38,070 --> 00:12:36,790  
he was very inconclusive so the

312  
00:12:39,840 --> 00:12:38,080  
observation it was a very interesting

313  
00:12:40,920 --> 00:12:39,850

observation one when the chicken soup

314

00:12:43,080 --> 00:12:40,930

was added to the soil there was a

315

00:12:45,090 --> 00:12:43,090

chemical reaction almost immediately and

316

00:12:46,740 --> 00:12:45,100

gases were released and the same types

317

00:12:48,900 --> 00:12:46,750

of gases that you would expect microbes

318

00:12:50,460 --> 00:12:48,910

to produce if they were present that was

319

00:12:52,320 --> 00:12:50,470

interesting and exciting yeah the

320

00:12:55,080 --> 00:12:52,330

problem was that the the rate at which

321

00:12:57,360 --> 00:12:55,090

those gases were released was odd was

322

00:12:58,800 --> 00:12:57,370

way too fast almost instantaneous oh do

323

00:13:00,510 --> 00:12:58,810

you expect that microbes to be present

324

00:13:02,970 --> 00:13:00,520

you should they should take their time

325

00:13:04,410 --> 00:13:02,980

to come out come back apple eyes and eat

326

00:13:06,570 --> 00:13:04,420

their things and then eventually it

327

00:13:07,980 --> 00:13:06,580

releases those gases so that was odd the

328

00:13:10,140 --> 00:13:07,990

other odd thing is that part of the

329

00:13:12,330 --> 00:13:10,150

experiment was to scoop out another

330

00:13:13,710 --> 00:13:12,340

sample of soil and heat it up to very

331

00:13:15,480 --> 00:13:13,720

high temperatures to kill everything

332

00:13:17,610 --> 00:13:15,490

that might have been living there and

333

00:13:19,320 --> 00:13:17,620

then add the chicken soup if the

334

00:13:20,900 --> 00:13:19,330

reaction original reaction was due to

335

00:13:24,170 --> 00:13:20,910

biology we shouldn't see a reaction

336

00:13:25,610 --> 00:13:24,180

in the second case everybody was and

337

00:13:27,020 --> 00:13:25,620

what happened was quite the opposite

338

00:13:29,180 --> 00:13:27,030

they added the chicken soup to the dead

339

00:13:30,740 --> 00:13:29,190

sample and there was a reaction similar

340

00:13:32,300 --> 00:13:30,750

to the first one suggesting that

341

00:13:36,230 --> 00:13:32,310

whatever was causing the reaction was

342

00:13:38,780 --> 00:13:36,240

not a microbe that must've been crazy

343

00:13:40,910 --> 00:13:38,790

you sent your your experiment on a Rover

344

00:13:43,370 --> 00:13:40,920

to Mars and it gets there and it does

345

00:13:52,100 --> 00:13:43,380

its thing and you're not sure and you're

346

00:13:53,300 --> 00:13:52,110

not sure but definitely the the the

347

00:13:59,120 --> 00:13:53,310

experiment was very interesting very

348

00:14:01,190 --> 00:13:59,130

conclusively right so then what well it

349

00:14:02,750 --> 00:14:01,200

was clear from Viking that maybe our

350

00:14:04,610 --> 00:14:02,760

thinking about searching for life at

351

00:14:06,260 --> 00:14:04,620

that time was a bit naive because we

352

00:14:07,430 --> 00:14:06,270

really didn't know much about Mars until

353

00:14:10,820 --> 00:14:07,440

Viking went to Mars

354

00:14:12,290 --> 00:14:10,830

now inside is always 20/20 so with what

355

00:14:14,420 --> 00:14:12,300

we know now we might think it was naive

356

00:14:15,800 --> 00:14:14,430

at the time it was probably a very smart

357

00:14:17,870 --> 00:14:15,810

thing to do well we hadn't been there

358

00:14:20,030 --> 00:14:17,880

yet we hadn't been there yet so but what

359

00:14:22,040 --> 00:14:20,040

what followed up after Viking was a

360

00:14:24,530 --> 00:14:22,050

realization that when next time we

361

00:14:26,960 --> 00:14:24,540

search for life we might want to know in

362

00:14:28,820 --> 00:14:26,970

advance a bit more about the planet what

363

00:14:30,350 --> 00:14:28,830

conditions are there and what the

364

00:14:32,180 --> 00:14:30,360

history of the planet was and so a lot

365

00:14:33,520 --> 00:14:32,190

of the follow-up missions tried to

366

00:14:36,890 --> 00:14:33,530

bridge that gap that knowledge gap

367

00:14:39,050 --> 00:14:36,900

understand what happened to Mars over

368

00:14:41,900 --> 00:14:39,060

the course of its history how it became

369

00:14:44,270 --> 00:14:41,910

the extremely dry extremely cold planet

370

00:14:45,830 --> 00:14:44,280

the release today and maybe try to

371

00:14:47,480 --> 00:14:45,840

understand if life was present at some

372

00:14:49,370 --> 00:14:47,490

point whether it could still be there

373

00:14:52,400 --> 00:14:49,380

maybe in other places or maybe the

374

00:14:54,380 --> 00:14:52,410

chances of life surviving throughout

375

00:14:56,450 --> 00:14:54,390

Mars as history were pretty much zero

376

00:14:59,750 --> 00:14:56,460

yeah yeah yeah how'd you go from oceans

377

00:15:02,510 --> 00:14:59,760

to desert desert somehow this life react

378

00:15:04,610 --> 00:15:02,520

to that yeah so we've had a lot of

379

00:15:07,040 --> 00:15:04,620

robotic missions to Mars since then

380

00:15:08,570 --> 00:15:07,050

right Michael what's what have we what

381

00:15:11,360 --> 00:15:08,580

are we done over there well we've sent a

382

00:15:14,600 --> 00:15:11,370

lot of Rovers to the surface now and the

383

00:15:16,940 --> 00:15:14,610

latest one that was curiosity and that's

384

00:15:18,400 --> 00:15:16,950

going and actually collecting samples

385

00:15:20,990 --> 00:15:18,410

and driving around it has a bunch of

386

00:15:23,210 --> 00:15:21,000

instruments it has a drill on board for

387

00:15:27,050 --> 00:15:23,220

collecting samples it has a laser for

388

00:15:30,880 --> 00:15:27,060

zapping rocks so we have video better an

389

00:15:35,410 --> 00:15:33,310

and the thing that personally excites me

390

00:15:38,260 --> 00:15:35,420

is that our curiosity has the ability to

391

00:15:48,790 --> 00:15:38,270

choose what it zaps with its laser which

392

00:15:50,710 --> 00:15:48,800

is which is pretty pretty neat that's

393

00:15:51,900 --> 00:15:50,720

cool and that's very cool for you the

394

00:15:54,280 --> 00:15:51,910

roboticists

395

00:15:56,440 --> 00:15:54,290

teaching they're getting progressively

396

00:15:58,360 --> 00:15:56,450

smarter and progressively more capable

397

00:16:02,620 --> 00:15:58,370

of acting with a little bit less

398

00:16:05,050 --> 00:16:02,630

oversight from us yeah awesome what do

399

00:16:07,540 --> 00:16:05,060

we find out from these Rovers on from

400

00:16:09,630 --> 00:16:07,550

curiosity Rover's many many things but

401  
00:16:13,210 --> 00:16:09,640  
maybe the one that is interesting to the

402  
00:16:14,890 --> 00:16:13,220  
question of life on Mars is it provided

403  
00:16:16,390 --> 00:16:14,900  
the first clear evidence that there were

404  
00:16:17,770 --> 00:16:16,400  
environments on Mars three

405  
00:16:19,680 --> 00:16:17,780  
three-and-a-half billion years ago that

406  
00:16:21,280 --> 00:16:19,690  
could have sustain life as we know it

407  
00:16:23,140 --> 00:16:21,290  
microorganisms on earth would have been

408  
00:16:25,930 --> 00:16:23,150  
happy really in those environments that

409  
00:16:28,060 --> 00:16:25,940  
in that case is a lake environment yeah

410  
00:16:29,890 --> 00:16:28,070  
which had plenty of water it was long

411  
00:16:31,720 --> 00:16:29,900  
lived and the chemistry of that Lake was

412  
00:16:33,220 --> 00:16:31,730  
completely compatible with life as we

413  
00:16:34,780 --> 00:16:33,230

know it was so similar it was very

414

00:16:37,720 --> 00:16:34,790

similar and so the conditions were there

415

00:16:41,260 --> 00:16:37,730

for life to exist in to thrive and

416

00:16:43,240 --> 00:16:41,270

that's that's a major discovery so the

417

00:16:45,130 --> 00:16:43,250

water is kind of the key to all this

418

00:16:47,110 --> 00:16:45,140

water is the key and the progression of

419

00:16:47,680 --> 00:16:47,120

those missions is being precisely follow

420

00:16:50,890 --> 00:16:47,690

the water

421

00:16:52,030 --> 00:16:50,900

important for life and through following

422

00:16:54,700 --> 00:16:52,040

the water we've reached these

423

00:16:55,840 --> 00:16:54,710

environments on the surface that it's

424

00:16:57,790 --> 00:16:55,850

clear that they could have sustained

425

00:16:59,560 --> 00:16:57,800

life in the past yeah how did we first

426

00:17:02,140 --> 00:16:59,570

find water that was one of the robotic

427

00:17:04,030 --> 00:17:02,150

missions wasn't it yeah actually the

428

00:17:05,740 --> 00:17:04,040

Phoenix mission right that's right yeah

429

00:17:07,030 --> 00:17:05,750

it was another stationary Lander like

430

00:17:09,340 --> 00:17:07,040

the Viking that had an arm that could

431

00:17:12,940 --> 00:17:09,350

scoop up soil and collect samples yep

432

00:17:17,800 --> 00:17:12,950

okay as well an image of the Phoenix

433

00:17:19,570 --> 00:17:17,810

lander that scooping yep yep so that can

434

00:17:21,040 --> 00:17:19,580

reach out and collect soil samples yeah

435

00:17:23,080 --> 00:17:21,050

like if like Viking was a lander I

436

00:17:27,130 --> 00:17:23,090

didn't move mm-hmm

437

00:17:29,080 --> 00:17:27,140

we in reality we had an idea that there

438

00:17:32,140 --> 00:17:29,090

might have been there were there's water

439

00:17:35,790 --> 00:17:32,150

on Mars based on orbital data but

440

00:17:37,810 --> 00:17:35,800

Phoenix really truly confirmed those

441

00:17:39,610 --> 00:17:37,820

observed those observations from orbit

442

00:17:42,490 --> 00:17:39,620

and it confirmed it by digging a trench

443

00:17:43,240 --> 00:17:42,500

in the soil and exposing ice water ice

444

00:17:47,110 --> 00:17:43,250

and

445

00:17:49,570 --> 00:17:47,120

at the poles right it was near the North

446

00:17:51,670 --> 00:17:49,580

Pole and based on what we know from

447

00:17:53,530 --> 00:17:51,680

orbit it's as you get closer to the

448

00:17:55,750 --> 00:17:53,540

poles of Mars either the in the North or

449

00:17:57,220 --> 00:17:55,760

the South Pole ground ice becomes more

450

00:17:59,080 --> 00:17:57,230

and more abundant and close to the

451

00:18:02,410 --> 00:17:59,090

surface and in fact the Felix idea was

452

00:18:05,830 --> 00:18:02,420

just a few inches under the cover of dry

453

00:18:07,990 --> 00:18:05,840

soil okay cool okay so water ice it has

454

00:18:11,460 --> 00:18:08,000

found Phoenix and you told me I mean

455

00:18:14,890 --> 00:18:11,470

another big discovery yeah so when

456

00:18:17,700 --> 00:18:14,900

Phoenix analyzed the ice it actually

457

00:18:21,190 --> 00:18:17,710

tasted the ice the first time we taste

458

00:18:22,870 --> 00:18:21,200

taste it tasted salty salty and that was

459

00:18:25,000 --> 00:18:22,880

interesting not very salty but it did

460

00:18:26,680 --> 00:18:25,010

have some salt and the salt turned out

461

00:18:28,240 --> 00:18:26,690

to be another very interesting discovery

462

00:18:31,090 --> 00:18:28,250

from Phoenix I

463

00:18:33,280 --> 00:18:31,100

one of the major salt components in the

464

00:18:35,470 --> 00:18:33,290

soil is called perchlorate it's a

465

00:18:37,810 --> 00:18:35,480

molecule that nobody really cared much

466

00:18:40,120 --> 00:18:37,820

about accepting the rocket fuel industry

467

00:18:42,100 --> 00:18:40,130

because it's actually rocket fuel

468

00:18:43,900 --> 00:18:42,110

but once he was discovered on Mars at

469

00:18:45,580 --> 00:18:43,910

significant abundances everybody became

470

00:18:49,540 --> 00:18:45,590

very interested yeah why is it there

471

00:18:53,770 --> 00:18:49,550

this rocket Mars Cobra team rocket fuel

472

00:18:56,380 --> 00:18:53,780

alright the natural compound it's found

473

00:18:58,480 --> 00:18:56,390

on earth as well in deserts and whatnot

474

00:19:00,130 --> 00:18:58,490

and it's a compound that some some

475

00:19:02,080 --> 00:19:00,140

microbes on earth can actually eat and

476

00:19:03,900 --> 00:19:02,090

there's an energy source yes so that

477

00:19:07,360 --> 00:19:03,910

became a very interesting astrobiology

478

00:19:08,860 --> 00:19:07,370

result an energy source for life sitting

479

00:19:11,320 --> 00:19:08,870

there on the surface very close to water

480

00:19:13,540 --> 00:19:11,330

ice but the other interesting thing

481

00:19:15,610 --> 00:19:13,550

about perchlorate is that it's a very

482

00:19:16,810 --> 00:19:15,620

reactive compound it's not reactive at

483

00:19:18,040 --> 00:19:16,820

room temperature you can have

484

00:19:19,270 --> 00:19:18,050

perchlorate here on the table and it's

485

00:19:21,370 --> 00:19:19,280

not going to happen and nothing's gonna

486

00:19:24,700 --> 00:19:21,380

happen to it over millions of years okay

487

00:19:27,430 --> 00:19:24,710

but if you expose it to radiation as on

488

00:19:29,650 --> 00:19:27,440

Mars the high radiation that we get UV

489

00:19:31,930 --> 00:19:29,660

it decomposes into very reactive

490

00:19:32,470 --> 00:19:31,940

molecules like the Sun breaks it down on

491

00:19:34,140 --> 00:19:32,480

the surface

492

00:19:36,730 --> 00:19:34,150

the radiation breaks it down and makes

493

00:19:39,340 --> 00:19:36,740

reactive compounds just like bleach for

494

00:19:40,840 --> 00:19:39,350

example the stuff at home okay and you

495

00:19:46,090 --> 00:19:40,850

know what happens when you mix bleach

496

00:19:48,160 --> 00:19:46,100

with chicken soup no gas released and

497

00:19:50,990 --> 00:19:48,170

you get very similar gases as they were

498

00:19:54,780 --> 00:19:51,000

released in the Viking experiments

499

00:19:57,090 --> 00:19:54,790

mr. Issa at a similar rate and the

500

00:19:59,970 --> 00:19:57,100

similar abundances as Viking observed so

501  
00:20:02,370 --> 00:19:59,980  
forth years after Viking indirectly

502  
00:20:02,880 --> 00:20:02,380  
without not actually looking for it

503  
00:20:04,830 --> 00:20:02,890  
right

504  
00:20:07,410 --> 00:20:04,840  
Phoenix found the culprit for the vacuum

505  
00:20:09,210 --> 00:20:07,420  
or the most likely culprit the Viking

506  
00:20:11,670 --> 00:20:09,220  
biological experiment results finally an

507  
00:20:12,690 --> 00:20:11,680  
answer yep that's crazy for the people

508  
00:20:14,580 --> 00:20:12,700  
who work on it I hope they were still

509  
00:20:16,110 --> 00:20:14,590  
always closed yeah yeah it was very

510  
00:20:18,960 --> 00:20:16,120  
exciting I'm sure for people who were

511  
00:20:22,680 --> 00:20:18,970  
waiting 40 years to understand what

512  
00:20:24,870 --> 00:20:22,690  
happened exciting okay fascinating we've

513  
00:20:29,010 --> 00:20:24,880

that bunch of questions coming in shall

514

00:20:30,780 --> 00:20:29,020

we turn to a question session we're

515

00:20:32,280 --> 00:20:30,790

gonna ask you a whole bunch as many as

516

00:20:40,140 --> 00:20:32,290

we can in five minutes and we'll look

517

00:20:42,290 --> 00:20:40,150

for rapid responses so master asks is it

518

00:20:45,570 --> 00:20:42,300

possible that we might find fossilized

519

00:20:47,850 --> 00:20:45,580

microbial life that's one of the issues

520

00:20:49,860 --> 00:20:47,860

with microbial life is the data only

521

00:20:52,140 --> 00:20:49,870

behind good fossils not certainly

522

00:20:55,100 --> 00:20:52,150

dinosaur bones that we can excavate and

523

00:20:59,130 --> 00:20:55,110

see and so that's that's a big challenge

524

00:21:00,570 --> 00:20:59,140

how to find evidence of life coming out

525

00:21:02,820 --> 00:21:00,580

of microbes that they're soft-bodied

526  
00:21:04,770 --> 00:21:02,830  
Chinese and unicellular organisms that

527  
00:21:08,360 --> 00:21:04,780  
when they die they decompose and don't

528  
00:21:10,620 --> 00:21:08,370  
leave behind we have some ideas in fact

529  
00:21:12,720 --> 00:21:10,630  
when you look at the fossil record on

530  
00:21:15,480 --> 00:21:12,730  
earth the oldest evidence of life on

531  
00:21:17,850 --> 00:21:15,490  
Earth which is dated 3.5 3.8 billion

532  
00:21:20,760 --> 00:21:17,860  
years ago it's actually structures made

533  
00:21:22,590 --> 00:21:20,770  
by microbes sprog structures made by

534  
00:21:24,000 --> 00:21:22,600  
microbes the microbes are long gone okay

535  
00:21:25,950 --> 00:21:24,010  
they just leave they left the house

536  
00:21:28,380 --> 00:21:25,960  
behind and what we see now is the house

537  
00:21:30,150 --> 00:21:28,390  
okay and so microbes can leave behind

538  
00:21:33,060 --> 00:21:30,160

fossils but it's it's they're hard to

539

00:21:37,350 --> 00:21:33,070

find I mean that is cool I had a

540

00:21:41,070 --> 00:21:37,360

question about what what methods can you

541

00:21:42,390 --> 00:21:41,080

use besides metabolic investigations in

542

00:21:45,240 --> 00:21:42,400

these robotic missions and I think that

543

00:21:47,220 --> 00:21:45,250

that might be there are a number you

544

00:21:48,450 --> 00:21:47,230

could think of well if you go to a place

545

00:21:50,370 --> 00:21:48,460

where you think microbes might actually

546

00:21:52,440 --> 00:21:50,380

be alive and happy you could bring your

547

00:21:54,030 --> 00:21:52,450

microscope uh-huh bring a sample put it

548

00:21:56,490 --> 00:21:54,040

in water look at the microscope and if

549

00:21:59,940 --> 00:21:56,500

not something swims it's like I'm not

550

00:22:01,890 --> 00:21:59,950

waving at you another one could be using

551  
00:22:03,660 --> 00:22:01,900  
instruments that actually analyze

552  
00:22:04,350 --> 00:22:03,670  
chemistry you know a lot of it is

553  
00:22:05,789 --> 00:22:04,360  
organic

554  
00:22:07,740 --> 00:22:05,799  
mystery which is what we think life is

555  
00:22:09,510 --> 00:22:07,750  
gonna be paid off organic compounds and

556  
00:22:12,710 --> 00:22:09,520  
we can search for patterns in that

557  
00:22:15,350 --> 00:22:12,720  
chemistry that are too complex for

558  
00:22:17,430 --> 00:22:15,360  
something non-biological to produce Oh

559  
00:22:19,200 --> 00:22:17,440  
biology makes very complex organic

560  
00:22:21,450 --> 00:22:19,210  
compounds things like DNA and proteins

561  
00:22:23,580 --> 00:22:21,460  
yeah and so if we find something like

562  
00:22:26,250 --> 00:22:23,590  
these would be like finding a skyscraper

563  
00:22:27,810 --> 00:22:26,260

on the moon it's like somebody must have

564

00:22:30,539 --> 00:22:27,820

built it somebody built that yeah yeah

565

00:22:33,210 --> 00:22:30,549

okay that was a question from Jet's 115

566

00:22:35,490 --> 00:22:33,220

that was a good hand eh 87 has one for

567

00:22:38,159 --> 00:22:35,500

you I think Michael what would a rover

568

00:22:40,500 --> 00:22:38,169

mission to the poles be viable or

569

00:22:41,700 --> 00:22:40,510

particularly interesting I think there

570

00:22:43,620 --> 00:22:41,710

definitely be interesting and I think

571

00:22:45,659 --> 00:22:43,630

actually operating in an icy environment

572

00:22:47,669 --> 00:22:45,669

I'm like where the Rovers have been

573

00:22:49,950 --> 00:22:47,679

driving would be a lot more interesting

574

00:22:51,030 --> 00:22:49,960

in her soil a big challenge and also

575

00:22:53,909 --> 00:22:51,040

interesting but then there's also the

576  
00:22:55,409 --> 00:22:53,919  
worry about planetary protection right

577  
00:22:57,570 --> 00:22:55,419  
because if we don't want to breathe

578  
00:22:59,430 --> 00:22:57,580  
bring things there and if there's ice

579  
00:23:01,799 --> 00:22:59,440  
there we could conceivably make water

580  
00:23:03,780 --> 00:23:01,809  
and if we make water and we have

581  
00:23:05,070 --> 00:23:03,790  
microbes on the rover then there's the

582  
00:23:06,750 --> 00:23:05,080  
risk that we could bring our own

583  
00:23:08,789 --> 00:23:06,760  
microbes there and Anna pollute the

584  
00:23:11,700 --> 00:23:08,799  
planet something else to worry about on

585  
00:23:13,919 --> 00:23:11,710  
top of everything else yeah yeah here's

586  
00:23:15,930 --> 00:23:13,929  
a related question from trebla door how

587  
00:23:18,510 --> 00:23:15,940  
long would it take to be certain there

588  
00:23:21,180 --> 00:23:18,520

is no life and so so we wouldn't have to

589

00:23:22,890 --> 00:23:21,190

sterilize everything we send could you

590

00:23:24,360 --> 00:23:22,900

ever be certain you can never be certain

591

00:23:26,640 --> 00:23:24,370

I don't know you could be ever be

592

00:23:28,730 --> 00:23:26,650

certain because we're used to the earth

593

00:23:31,919 --> 00:23:28,740

as a planet where is covered in biology

594

00:23:33,210 --> 00:23:31,929

but when sometimes when you go to some

595

00:23:34,950 --> 00:23:33,220

places on the earth there are extreme

596

00:23:37,110 --> 00:23:34,960

life is not everywhere it's hiding in

597

00:23:38,669 --> 00:23:37,120

very specific places and if you can

598

00:23:40,770 --> 00:23:38,679

imagine a planet that is extreme like

599

00:23:43,140 --> 00:23:40,780

Mars maybe alive is sitting somewhere in

600

00:23:45,810 --> 00:23:43,150

a very tiny place maybe kilometers deep

601  
00:23:48,120 --> 00:23:45,820  
all right how can be sure how can be you

602  
00:23:49,830 --> 00:23:48,130  
be sure of that it's not there so we

603  
00:23:54,299 --> 00:23:49,840  
always need to proceed with caution I

604  
00:23:57,750 --> 00:23:54,309  
think yeah yeah smile bringer asks what

605  
00:24:00,659 --> 00:23:57,760  
about non carbon-based life-forms we

606  
00:24:02,880 --> 00:24:00,669  
usually base life upon life on earth

607  
00:24:05,190 --> 00:24:02,890  
there yeah there are good reasons why we

608  
00:24:06,480 --> 00:24:05,200  
are made the way we are and and there

609  
00:24:09,360 --> 00:24:06,490  
are some of them are reasons that are

610  
00:24:11,070 --> 00:24:09,370  
hard to there's there's only so much you

611  
00:24:13,380 --> 00:24:11,080  
can bend flaws of physics and chemistry

612  
00:24:16,080 --> 00:24:13,390  
to make things work and their ideas

613  
00:24:17,940 --> 00:24:16,090

about non carbon-based life but there

614

00:24:20,010 --> 00:24:17,950

are so far no places in

615

00:24:22,800 --> 00:24:20,020

in the universe that we know of where

616

00:24:25,860 --> 00:24:22,810

non confirm non carbon-based life could

617

00:24:29,390 --> 00:24:25,870

exist there might be there we haven't

618

00:24:32,700 --> 00:24:29,400

found them and so to start searching

619

00:24:33,930 --> 00:24:32,710

it's probably a good idea to search for

620

00:24:35,220 --> 00:24:33,940

first things that you're familiar with

621

00:24:37,170 --> 00:24:35,230

that you can recognize and you know

622

00:24:40,380 --> 00:24:37,180

where to search for rather than search

623

00:24:42,720 --> 00:24:40,390

for things that are so different that we

624

00:24:44,400 --> 00:24:42,730

again might not be able to recognize it

625

00:24:46,320 --> 00:24:44,410

even if it's standing in front of us I

626

00:24:47,790 --> 00:24:46,330

wonder if that's related to this

627

00:24:51,390 --> 00:24:47,800

question so let me throw this out from

628

00:24:53,010 --> 00:24:51,400

death shaft 201 19 why follow water we

629

00:24:54,780 --> 00:24:53,020

don't know for sure that organisms live

630

00:24:55,290 --> 00:24:54,790

only through water right yeah it's a

631

00:24:57,750 --> 00:24:55,300

good point

632

00:25:02,400 --> 00:24:57,760

but he goes back to what we were talking

633

00:25:04,410 --> 00:25:02,410

about Mars had water other places in the

634

00:25:07,050 --> 00:25:04,420

solar system had water we know what life

635

00:25:10,740 --> 00:25:07,060

in water looks like or is made off

636

00:25:13,980 --> 00:25:10,750

thanks to earth biology so why not go

637

00:25:16,020 --> 00:25:13,990

there it's a familiar place right if we

638

00:25:17,280 --> 00:25:16,030

find it there one of the interesting

639

00:25:20,070 --> 00:25:17,290

reasons why we search for life is

640

00:25:21,510 --> 00:25:20,080

because once we find life 2.0 even if

641

00:25:23,460 --> 00:25:21,520

it's water-based and carbon-based but

642

00:25:25,920 --> 00:25:23,470

very different from us then our ideas of

643

00:25:29,000 --> 00:25:25,930

life will change we'll expand and then

644

00:25:31,740 --> 00:25:29,010

maybe we can think more seriously about

645

00:25:33,960 --> 00:25:31,750

life that is completely different yeah

646

00:25:36,540 --> 00:25:33,970

but I think we need life 2.0 before we

647

00:25:38,820 --> 00:25:36,550

can make that yeah big step that's so

648

00:25:40,620 --> 00:25:38,830

exciting I remember maybe a year ago the

649

00:25:42,240 --> 00:25:40,630

three of us had a conversation and you

650

00:25:50,970 --> 00:25:42,250

were telling us that even if you found

651  
00:25:52,860 --> 00:25:50,980  
one dead microbe on Mars that microbes

652  
00:25:58,050 --> 00:25:52,870  
living microbes anybody if we find a

653  
00:26:01,260 --> 00:25:58,060  
living microbe we have to kill it but

654  
00:26:03,660 --> 00:26:01,270  
but but yeah we that even a dead microbe

655  
00:26:06,000 --> 00:26:03,670  
even a fossilized dead micro yeah half

656  
00:26:08,310 --> 00:26:06,010  
decomposed would tell us but

657  
00:26:12,440 --> 00:26:08,320  
revolutionize our idea of life biology

658  
00:26:18,360 --> 00:26:12,450  
and everything so all it takes is one

659  
00:26:21,450 --> 00:26:18,370  
yeah Zola Dare asks how do you program a

660  
00:26:23,760 --> 00:26:21,460  
robot to search for life what sort of

661  
00:26:26,880 --> 00:26:23,770  
decisions do you have to make in order

662  
00:26:28,260 --> 00:26:26,890  
to search the most likely locations well

663  
00:26:30,120 --> 00:26:28,270

the first thing is you have to identify

664

00:26:31,440 --> 00:26:30,130

what the most likely locations are and

665

00:26:33,840 --> 00:26:31,450

the way you do that is actually

666

00:26:35,510 --> 00:26:33,850

people like sponsor and Jose go here go

667

00:26:37,590 --> 00:26:35,520

here this is cool we should look at that

668

00:26:39,390 --> 00:26:37,600

then when it comes to programming the

669

00:26:41,490 --> 00:26:39,400

robot there's there's a lot involved

670

00:26:42,570 --> 00:26:41,500

from just basic things like getting the

671

00:26:44,550 --> 00:26:42,580

robot to physically move in the

672

00:26:45,990 --> 00:26:44,560

environment and then making smarter

673

00:26:48,510 --> 00:26:46,000

decisions and that's really again about

674

00:26:49,800 --> 00:26:48,520

taking sensor data and then trying to

675

00:26:52,470 --> 00:26:49,810

say you know yes this is something

676

00:26:54,150 --> 00:26:52,480

valuable and traditionally we've again

677

00:26:56,340 --> 00:26:54,160

consulted with scientists and try to say

678

00:26:58,470 --> 00:26:56,350

you know well things that look like this

679

00:27:02,030 --> 00:26:58,480

is good things like that look different

680

00:27:10,140 --> 00:27:02,040

we ignore it's a very involved process

681

00:27:11,820 --> 00:27:10,150

takes a village yeah see the scientists

682

00:27:16,680 --> 00:27:11,830

and engineers really working their magic

683

00:27:20,400 --> 00:27:16,690

together well here here's an easy one

684

00:27:28,520 --> 00:27:20,410

from JB dev how do you boil down is it

685

00:27:34,890 --> 00:27:32,250

right now we can't say you know if this

686

00:27:36,990 --> 00:27:34,900

been life and perhaps the best way to do

687

00:27:38,970 --> 00:27:37,000

it is to try and extract the judgment of

688

00:27:40,740 --> 00:27:38,980

the scientists by studying how they

689

00:27:42,720 --> 00:27:40,750

behave and so machine learning

690

00:27:44,730 --> 00:27:42,730

techniques are kind of a promising

691

00:27:46,860 --> 00:27:44,740

approach for that so eventually you know

692

00:27:48,240 --> 00:27:46,870

I'll just sit and watch all the phones

693

00:27:49,350 --> 00:27:48,250

are long enough and I'll write down

694

00:27:51,270 --> 00:27:49,360

everything he does and I'll run it

695

00:27:52,740 --> 00:27:51,280

through a small Python script and then

696

00:28:01,440 --> 00:27:52,750

great yeah I'll ship that out in the

697

00:28:03,570 --> 00:28:01,450

space that's right my job is done and

698

00:28:05,460 --> 00:28:03,580

and and and if you think of the of their

699

00:28:07,680 --> 00:28:05,470

members are easy something waving you do

700

00:28:09,390 --> 00:28:07,690

is and something like a meteorite

701  
00:28:10,740 --> 00:28:09,400  
there's nothing in there easy the

702  
00:28:13,280 --> 00:28:10,750  
problems are they all the gray

703  
00:28:19,020 --> 00:28:13,290  
in-betweens that's the difficult part

704  
00:28:20,520 --> 00:28:19,030  
that's yeah that's also what drives yep

705  
00:28:21,960 --> 00:28:20,530  
yeah and there's something else to say

706  
00:28:23,690 --> 00:28:21,970  
is that it's it's also it's not one

707  
00:28:25,500 --> 00:28:23,700  
thing it's an accumulation of evidence

708  
00:28:27,420 --> 00:28:25,510  
different observations that we

709  
00:28:28,980 --> 00:28:27,430  
eventually collect to build confidence

710  
00:28:33,060 --> 00:28:28,990  
that we've seen something that might be

711  
00:28:35,610 --> 00:28:33,070  
life just looking for one one silver

712  
00:28:37,560 --> 00:28:35,620  
bullet that's gonna science rarely you

713  
00:28:39,510 --> 00:28:37,570

get a silver bullet you get a lot of

714

00:28:41,250 --> 00:28:39,520

smoking guns a lot of smoke and no guns

715

00:28:46,010 --> 00:28:41,260

some guns without smoke but no

716

00:28:50,790 --> 00:28:48,060

yeah I think we have time for a couple

717

00:28:54,120 --> 00:28:50,800

more before we move on to everyone lined

718

00:28:56,070 --> 00:28:54,130

up we got one G Nintendo asks what amino

719

00:28:59,850 --> 00:28:56,080

acids if any have been detected on Mars

720

00:29:01,410 --> 00:28:59,860

not non so far and good isn't that good

721

00:29:04,080 --> 00:29:01,420

a good place to start we found amino

722

00:29:05,850 --> 00:29:04,090

acids in in other planetary bodies small

723

00:29:07,740 --> 00:29:05,860

bodies and asteroids and comets but

724

00:29:09,480 --> 00:29:07,750

sorry those are interesting because they

725

00:29:10,710 --> 00:29:09,490

are building blocks for proteins they're

726

00:29:12,540 --> 00:29:10,720

interesting for two reasons why is

727

00:29:14,010 --> 00:29:12,550

because life on Earth universally uses

728

00:29:15,840 --> 00:29:14,020

them to build proteins which are very

729

00:29:18,810 --> 00:29:15,850

important molecules the other one is

730

00:29:21,330 --> 00:29:18,820

because they are nature provides them

731

00:29:23,010 --> 00:29:21,340

for free amino acids are in presently

732

00:29:25,620 --> 00:29:23,020

meteorites they can form a Berkeley

733

00:29:27,420 --> 00:29:25,630

without the presence of life and so you

734

00:29:29,100 --> 00:29:27,430

would expect them to be available for

735

00:29:30,420 --> 00:29:29,110

life to emerge pretty much in any

736

00:29:32,100 --> 00:29:30,430

environment as far as the environment

737

00:29:33,900 --> 00:29:32,110

they can survive that environment okay

738

00:29:37,440 --> 00:29:33,910

and so they are what we call prebiotic

739

00:29:38,580 --> 00:29:37,450

ly before life available and so it's a

740

00:29:40,230 --> 00:29:38,590

good there's a good place to start

741

00:29:42,420 --> 00:29:40,240

searching for our forever there are

742

00:29:44,330 --> 00:29:42,430

common ingredients or everything else

743

00:29:46,950 --> 00:29:44,340

lines up for life to a marriage

744

00:29:50,820 --> 00:29:46,960

exactly okay all right we haven't found

745

00:29:53,040 --> 00:29:50,830

any on Mars yet all right from MDM PhD

746

00:29:55,380 --> 00:29:53,050

doctor for long what excites you about

747

00:29:58,500 --> 00:29:55,390

the future of robotics and other worlds

748

00:30:00,420 --> 00:29:58,510

what robot would you send to space um

749

00:30:07,320 --> 00:30:00,430

I'm prepared to send any and all robots

750

00:30:08,760 --> 00:30:07,330

to space exactly and so one of the

751

00:30:10,200 --> 00:30:08,770

things that humans like doing when

752

00:30:12,990 --> 00:30:10,210

they're exploring is breathing oxygen

753

00:30:14,790 --> 00:30:13,000

and eating and coming back

754

00:30:16,080 --> 00:30:14,800

whereas robots are less demanding on

755

00:30:18,060 --> 00:30:16,090

that front and so if we're going to

756

00:30:19,350 --> 00:30:18,070

really explore farther away things and

757

00:30:23,670 --> 00:30:19,360

things that are much environment that

758

00:30:27,270 --> 00:30:23,680

are much more hazardous robots are in my

759

00:30:30,060 --> 00:30:27,280

opinion the thing to do yeah yeah so I

760

00:30:33,600 --> 00:30:30,070

think planets the moon still miss

761

00:30:35,220 --> 00:30:33,610

Lafleur in there Mars is Grace Europa is

762

00:30:37,710 --> 00:30:35,230

another possibly exciting relationship

763

00:30:39,660 --> 00:30:37,720

there right yes yeah yeah and that

764

00:30:41,430 --> 00:30:39,670

actually has the potential to have it's

765

00:30:43,500 --> 00:30:41,440

an icy world and may have water on as

766

00:30:52,119 --> 00:30:43,510

well so grad students are authority to

767

00:30:56,529 --> 00:30:54,469

the grad students to make the robots

768

00:31:01,459 --> 00:30:56,539

work that's true that's true

769

00:31:05,419 --> 00:31:01,469

that's a call to these guys new grad

770

00:31:07,700 --> 00:31:05,429

students so there's a comment that will

771

00:31:09,499 --> 00:31:07,710

lead us on to the next topic I want to

772

00:31:11,299 --> 00:31:09,509

talk about I want to hear about some of

773

00:31:13,700 --> 00:31:11,309

the new tools that you guys are

774

00:31:15,049 --> 00:31:13,710

developing and kind of where you want to

775

00:31:16,489 --> 00:31:15,059

look and how that determines how you're

776

00:31:18,619 --> 00:31:16,499

gonna look so this comment was from

777

00:31:21,619 --> 00:31:18,629

holla'd spy five I guess if there is

778

00:31:26,839 --> 00:31:21,629

life on Mars it's deep underground is

779

00:31:28,639 --> 00:31:26,849

that how does that drive yep in

780

00:31:30,259 --> 00:31:28,649

Indonesia if anything we've learned

781

00:31:33,079 --> 00:31:30,269

about Mars is that the surface is

782

00:31:34,759 --> 00:31:33,089

extreme but maybe as you get deeper and

783

00:31:38,029 --> 00:31:34,769

deeper conditions become better and

784

00:31:39,560 --> 00:31:38,039

better and so then there are good

785

00:31:41,089 --> 00:31:39,570

reasons for it as you get closer to the

786

00:31:43,519 --> 00:31:41,099

center of the planet temperatures go up

787

00:31:44,570 --> 00:31:43,529

and we know there's plenty of ice buried

788

00:31:47,239 --> 00:31:44,580

underground so at some point

789

00:31:50,029 --> 00:31:47,249

theoretically that I should melt yes

790

00:31:52,099 --> 00:31:50,039

yeah maybe a habitable environment as

791

00:31:53,119 --> 00:31:52,109

you go deeper also some of the nasty

792

00:31:56,810 --> 00:31:53,129

things you get on the surface you don't

793

00:31:58,159 --> 00:31:56,820

get that like radiation and so it's does

794

00:32:00,139 --> 00:31:58,169

you go deeper you're more protected from

795

00:32:03,459 --> 00:32:00,149

these things so yeah it's good bet if

796

00:32:05,629 --> 00:32:03,469

you go deeper okay also harder yes yes

797

00:32:11,749 --> 00:32:05,639

so is that something you're working on

798

00:32:14,389 --> 00:32:11,759

like how to go deeper we are on their

799

00:32:16,639 --> 00:32:14,399

core to come up with ways to do it you

800

00:32:26,919 --> 00:32:16,649

roll up at Michael's office yes I said

801  
00:32:29,029 --> 00:32:26,929  
ma Michael get me we're actually we're

802  
00:32:32,869 --> 00:32:29,039  
developing a smart drill right now a

803  
00:32:34,789 --> 00:32:32,879  
smart drill yes yeah and and so we want

804  
00:32:37,039 --> 00:32:34,799  
a smart drill because again what does

805  
00:32:38,659 --> 00:32:37,049  
that mean well if the drill that I had

806  
00:32:40,849 --> 00:32:38,669  
deals with the problems it encounters so

807  
00:32:42,560 --> 00:32:40,859  
we don't have to and so all these robots

808  
00:32:43,909 --> 00:32:42,570  
they're far away it takes you know upon

809  
00:32:46,639 --> 00:32:43,919  
Mars it takes about 20 minutes to get

810  
00:32:49,159 --> 00:32:46,649  
signal back right so you can have

811  
00:32:50,329 --> 00:32:49,169  
encountered a problem before we even the

812  
00:32:51,829 --> 00:32:50,339  
drill can it have encountered a problem

813  
00:32:53,869 --> 00:32:51,839

before we even know that it's going on

814

00:32:55,549 --> 00:32:53,879

and it could be too late at that

815

00:32:57,099 --> 00:32:55,559

junction if it just keeps trying to just

816

00:32:59,060 --> 00:32:57,109

just drill as if everything was normal

817

00:33:01,790 --> 00:32:59,070

so the smart roll

818

00:33:05,270 --> 00:33:01,800

tries to recognize problems and then fix

819

00:33:07,370 --> 00:33:05,280

them by well basically by trying to feel

820

00:33:09,650 --> 00:33:07,380

how its how its it's behaving so if

821

00:33:12,020 --> 00:33:09,660

you're drilling at home you know you're

822

00:33:13,310 --> 00:33:12,030

putting a screw into a piece of wood if

823

00:33:15,410 --> 00:33:13,320

something goes wrong you can feel the

824

00:33:16,670 --> 00:33:15,420

drill shakes or it hits a knot and it

825

00:33:19,490 --> 00:33:16,680

just starts skipping or you thread the

826

00:33:21,470 --> 00:33:19,500

screw every sorry you strip the head of

827

00:33:22,730 --> 00:33:21,480

the screw you know you feel that it's

828

00:33:24,260 --> 00:33:22,740

not right

829

00:33:26,180 --> 00:33:24,270

similar we can do similar things with

830

00:33:27,620 --> 00:33:26,190

our drill we can look at vibrations we

831

00:33:29,480 --> 00:33:27,630

can look at how much power it's drawing

832

00:33:31,430 --> 00:33:29,490

to do the drilling we can look at the

833

00:33:33,440 --> 00:33:31,440

temperature how hot it's getting and we

834

00:33:35,660 --> 00:33:33,450

can use that to then try and decide okay

835

00:33:37,610 --> 00:33:35,670

this is a particular kind of fault and

836

00:33:39,050 --> 00:33:37,620

there's several different kinds of

837

00:33:41,420 --> 00:33:39,060

things that can go wrong with drilling

838

00:33:43,370 --> 00:33:41,430

and then we take particular actions to

839

00:33:45,920 --> 00:33:43,380

fix those problems and so it can be

840

00:33:47,990 --> 00:33:45,930

things like there's a rock between the

841

00:33:49,970 --> 00:33:48,000

drill and the hole that it's drilling

842

00:33:52,100 --> 00:33:49,980

and it just sort of binds up or there

843

00:33:54,020 --> 00:33:52,110

can be soil falling in and it can't

844

00:33:57,080 --> 00:33:54,030

clear the hole fast enough so it's it's

845

00:33:59,210 --> 00:33:57,090

not making progress say yes we

846

00:34:01,700 --> 00:33:59,220

instrument the drill put lots of sensors

847

00:34:03,470 --> 00:34:01,710

on it look at what data is coming back

848

00:34:06,620 --> 00:34:03,480

and say okay this is a binding fault

849

00:34:10,040 --> 00:34:06,630

this this is you know this is we've hit

850

00:34:13,040 --> 00:34:10,050

our hard surface we can't penetrate here

851

00:34:14,960 --> 00:34:13,050

take the appropriate action the drill

852

00:34:16,669 --> 00:34:14,970

itself can actually figure that out on

853

00:34:18,740 --> 00:34:16,679

its own oh is that what you're that's

854

00:34:22,159 --> 00:34:18,750

that's the idea teaching it to be a

855

00:34:24,230 --> 00:34:22,169

smarter drill the problem is that Skype

856

00:34:27,830 --> 00:34:24,240

Skype calls between Mars and Earth are

857

00:34:30,620 --> 00:34:27,840

really really bad 20 minutes to get a

858

00:34:32,480 --> 00:34:30,630

hello back and so we cannot rely on on

859

00:34:34,220 --> 00:34:32,490

instruments there exactly and especially

860

00:34:35,990 --> 00:34:34,230

if we're drilling into like icy surfaces

861

00:34:37,490 --> 00:34:36,000

right we could conceivably melt the

862

00:34:39,380 --> 00:34:37,500

walls and again creating water which is

863

00:34:41,930 --> 00:34:39,390

a planetary protection problem but if it

864

00:34:46,880 --> 00:34:41,940

also possibly refreeze and the drill

865

00:34:49,430 --> 00:34:46,890

stuck in definitely a Joule cannot wait

866

00:34:50,030 --> 00:34:49,440

for us to learn about it decide what to

867

00:34:52,100 --> 00:34:50,040

do next

868

00:34:53,510 --> 00:34:52,110

send the information by Danny might be

869

00:34:55,850 --> 00:34:53,520

too late right I can imagine trying to

870

00:34:57,500 --> 00:34:55,860

have a conversation with you and 20

871

00:35:00,020 --> 00:34:57,510

minutes later I get a response back and

872

00:35:05,210 --> 00:35:00,030

I do that hello Abby and if you're

873

00:35:06,680 --> 00:35:05,220

asking for instructions or you might

874

00:35:10,010 --> 00:35:06,690

only get two chances in the day

875

00:35:11,690 --> 00:35:10,020

I'll say something oh that really

876

00:35:17,420 --> 00:35:11,700

underscores the need for some kind of

877

00:35:19,190 --> 00:35:17,430

autonomy here diagnosis on symptoms

878

00:35:21,650 --> 00:35:19,200

right especially so you've said it can

879

00:35:23,420 --> 00:35:21,660

back it back itself out or it can hammer

880

00:35:25,400 --> 00:35:23,430

through a hard yes drill we're

881

00:35:27,290 --> 00:35:25,410

developing is rotary percussive drill

882

00:35:29,059 --> 00:35:27,300

and so that means it can drill in like a

883

00:35:31,099 --> 00:35:29,069

normal drill or it can start hammering

884

00:35:32,059 --> 00:35:31,109

to break up whatever it's drilling

885

00:35:35,650 --> 00:35:32,069

through and make it easier to make

886

00:35:40,430 --> 00:35:38,420

sounds good I'll take what you have sent

887

00:35:41,870 --> 00:35:40,440

drills tomorrow's before though right

888

00:35:43,520 --> 00:35:41,880

can you tell us a little bit about yeah

889

00:35:45,740 --> 00:35:43,530

sir curiosity actually has it has a

890

00:35:49,030 --> 00:35:45,750

drill it's it's similar it's a rotary

891

00:35:52,609 --> 00:35:49,040

percussive mechanism I have here this

892

00:35:54,290 --> 00:35:52,619

this is just a drill that I took from my

893

00:35:55,880 --> 00:35:54,300

machine shop so this is not to scale

894

00:35:58,880 --> 00:35:55,890

it's not an accurate representation of

895

00:36:01,220 --> 00:35:58,890

what MSL has curiosity yeah so

896

00:36:05,120 --> 00:36:01,230

curiosity's drill is a little bit fatter

897

00:36:06,620 --> 00:36:05,130

and it's about gets about a five

898

00:36:08,839 --> 00:36:06,630

centimeter depth so something about this

899

00:36:10,550 --> 00:36:08,849

this length we actually a video of it

900

00:36:13,609 --> 00:36:10,560

drilling yes that we could watch right

901  
00:36:16,130 --> 00:36:13,619  
now on Mars curiosity it's gonna put

902  
00:36:17,569 --> 00:36:16,140  
down its drill the arm with yeah and

903  
00:36:20,359 --> 00:36:17,579  
this whole drilling process takes about

904  
00:36:22,819 --> 00:36:20,369  
25 minutes okay and again it takes 20

905  
00:36:25,730 --> 00:36:22,829  
minutes for the start of the drilling to

906  
00:36:27,170 --> 00:36:25,740  
get back to earth okay it's almost done

907  
00:36:29,630 --> 00:36:27,180  
by the time we'd find out it's begun

908  
00:36:33,559 --> 00:36:29,640  
okay something goes wrong at the start

909  
00:36:36,980 --> 00:36:33,569  
you're way too late yeah so it's on sped

910  
00:36:39,230 --> 00:36:36,990  
up right now right yeah we're seeing

911  
00:36:45,050 --> 00:36:39,240  
yeah right that's a slow process that I

912  
00:36:48,470 --> 00:36:45,060  
see it's not like my meticulous okay so

913  
00:36:50,420 --> 00:36:48,480

it's drilling into Martian rocks we have

914

00:36:52,819 --> 00:36:50,430

photos also of holes that it's drilled

915

00:36:54,470 --> 00:36:52,829

which is kind of fun because it's on

916

00:36:57,440 --> 00:36:54,480

another planet and it looks just like a

917

00:37:00,920 --> 00:36:57,450

drill hole at home can we see the image

918

00:37:03,020 --> 00:37:00,930

of a hole drilled by curiosity yeah so

919

00:37:05,630 --> 00:37:03,030

the big hole is is the drill hole and

920

00:37:06,920 --> 00:37:05,640

then that gray material is the stuff

921

00:37:08,660 --> 00:37:06,930

that was cleared out of the hole as was

922

00:37:10,700 --> 00:37:08,670

making progress and there's that row of

923

00:37:13,040 --> 00:37:10,710

little holes that's where the lasers

924

00:37:14,960 --> 00:37:13,050

acted to sort of vaporize once there and

925

00:37:16,609 --> 00:37:14,970

see what the rock is made of I have a

926

00:37:18,870 --> 00:37:16,619

question why is it gray why is that

927

00:37:22,140 --> 00:37:18,880

powder gray so I'm gonna paint

928

00:37:24,089 --> 00:37:22,150

yeah so summarizes known as the Red

929

00:37:26,999 --> 00:37:24,099

Planet but it's really it's covered in

930

00:37:29,160 --> 00:37:27,009

rust oxidized materials that's why it's

931

00:37:30,930 --> 00:37:29,170

red okay but it's not read all the way

932

00:37:33,299 --> 00:37:30,940

through and that gives you a good idea

933

00:37:35,730 --> 00:37:33,309

of why it's important to go deep is

934

00:37:38,519 --> 00:37:35,740

because it's it's the depth dimension is

935

00:37:41,190 --> 00:37:38,529

another world we would have never

936

00:37:43,019 --> 00:37:41,200

learned that if imagine what we can do

937

00:37:44,849 --> 00:37:43,029

if we go even deeper right we might

938

00:37:46,589 --> 00:37:44,859

learn things well completely unexpected

939

00:37:48,240 --> 00:37:46,599

that wasn't expected so curiosity taught

940

00:37:58,920 --> 00:37:48,250

us that it's it's not really a red

941

00:38:01,109 --> 00:37:58,930

planet and Andy might be ready in other

942

00:38:02,579 --> 00:38:01,119

places yes if anything with learning

943

00:38:04,680 --> 00:38:02,589

about Mars is that it's it's very

944

00:38:06,690 --> 00:38:04,690

different it's not the uniform planet

945

00:38:09,089 --> 00:38:06,700

once we thought it was which is why the

946

00:38:14,099 --> 00:38:09,099

Rover robots are so important we can't

947

00:38:20,519 --> 00:38:14,109

just characterize maybe you land in the

948

00:38:24,990 --> 00:38:20,529

one spot that is great you know 10 feet

949

00:38:26,880 --> 00:38:25,000

over from where life was yes so we've

950

00:38:29,640 --> 00:38:26,890

we've looked at the curiosity drill

951  
00:38:34,079 --> 00:38:29,650  
you've shown us how big that is what are

952  
00:38:39,329 --> 00:38:34,089  
you working on now yes this is the drill

953  
00:38:42,150 --> 00:38:39,339  
that we're working on so what you see

954  
00:38:43,440 --> 00:38:42,160  
here is these ridges here it's that are

955  
00:38:45,960 --> 00:38:43,450  
the flutes and this is what lifts the

956  
00:38:48,029 --> 00:38:45,970  
material out of the hole okay and so we

957  
00:38:49,470 --> 00:38:48,039  
drill this it's about about three feet

958  
00:38:52,499 --> 00:38:49,480  
long and then what we really care about

959  
00:38:53,609 --> 00:38:52,509  
is this last ten centimeter bite here at

960  
00:38:54,900 --> 00:38:53,619  
them at the bottom and that's you'll

961  
00:38:57,569 --> 00:38:54,910  
notice that the flutes are much more

962  
00:38:59,490 --> 00:38:57,579  
tightly spaced yes yes yeah the ridges

963  
00:39:01,650 --> 00:38:59,500

the the ramp right because this is young

964

00:39:05,759 --> 00:39:01,660

it's a ramp it pushes things up and goes

965

00:39:07,470 --> 00:39:05,769

out though the top of the hole so again

966

00:39:09,059 --> 00:39:07,480

they're denser here because we don't

967

00:39:10,920 --> 00:39:09,069

want the material to move by too quickly

968

00:39:13,769 --> 00:39:10,930

once we've hit the depth we care about

969

00:39:17,130 --> 00:39:13,779

and then we pull this out of the hole up

970

00:39:23,370 --> 00:39:17,140

to a sample collection device which then

971

00:39:25,170 --> 00:39:23,380

takes the soil to the instruments and

972

00:39:27,569 --> 00:39:25,180

then we look for things like microbes or

973

00:39:28,890 --> 00:39:27,579

yeah compound or any compounds and

974

00:39:30,500 --> 00:39:28,900

things like these so what is this hole

975

00:39:31,970 --> 00:39:30,510

here I'm looking down a

976

00:39:33,830 --> 00:39:31,980

right there yeah so there's a hole in

977

00:39:35,270 --> 00:39:33,840

the bottom and that's for cables to go

978

00:39:38,060 --> 00:39:35,280

down because again this is a smart drill

979

00:39:39,500 --> 00:39:38,070

and smart means sensors and so we have

980

00:39:41,030 --> 00:39:39,510

the in this drill will have a

981

00:39:42,410 --> 00:39:41,040

temperature sensor to see how hot it's

982

00:39:43,820 --> 00:39:42,420

getting because that tells you like how

983

00:39:45,260 --> 00:39:43,830

hard is it to drill into while you're

984

00:39:49,280 --> 00:39:45,270

drilling through and it also has a

985

00:39:52,670 --> 00:39:49,290

conductivity sensor and that'll help us

986

00:39:54,410 --> 00:39:52,680

detect if we hit water or we're making

987

00:39:57,380 --> 00:39:54,420

liquid water yeah there's liquid water

988

00:39:59,450 --> 00:39:57,390

it's gonna send a signal if it's dry no

989

00:40:02,330 --> 00:39:59,460

signal so why is that data useful what

990

00:40:04,700 --> 00:40:02,340

does that tell you well it tells dam or

991

00:40:06,530 --> 00:40:04,710

he tells the drill how to operate when

992

00:40:08,510 --> 00:40:06,540

to stop when to proceed if it gets very

993

00:40:10,550 --> 00:40:08,520

hard you might want to stop and let it

994

00:40:11,960 --> 00:40:10,560

cool down one reason might be planetary

995

00:40:13,760 --> 00:40:11,970

protection we don't want to create an

996

00:40:15,260 --> 00:40:13,770

environment if we're drilling in things

997

00:40:16,460 --> 00:40:15,270

like ice for example we don't want to

998

00:40:18,100 --> 00:40:16,470

create an environment where microbes

999

00:40:21,860 --> 00:40:18,110

especially microbes we bring with us

1000

00:40:23,690 --> 00:40:21,870

micro planetary protection but we also

1001

00:40:25,700 --> 00:40:23,700

can learn about what what's the

1002

00:40:27,920 --> 00:40:25,710

consistency and this and the strength of

1003

00:40:29,810 --> 00:40:27,930

the materials were drilling into so it's

1004

00:40:31,010 --> 00:40:29,820

information that is good for science but

1005

00:40:35,150 --> 00:40:31,020

it's information is good for the health

1006

00:40:38,420 --> 00:40:35,160

of the drill alright so this you would

1007

00:40:40,580 --> 00:40:38,430

attach on to a rover or a lander yeah

1008

00:40:42,050 --> 00:40:40,590

right okay whatever vehicle is taking

1009

00:40:52,600 --> 00:40:42,060

the drill to the places we want drilling

1010

00:40:54,920 --> 00:40:52,610

and that's something you test right now

1011

00:40:56,420 --> 00:40:54,930

yeah we've got a team of scientists down

1012

00:41:00,710 --> 00:40:56,430

in the Atacama Desert in Chile and

1013

00:41:13,070 --> 00:41:00,720

they're testing a visceral with in an

1014

00:41:15,470 --> 00:41:13,080

actual simulated environment sent back

1015

00:41:18,620 --> 00:41:15,480

to us here yeah names from the atacama

1016

00:41:20,690 --> 00:41:18,630

yes yeah so this is the drill site and

1017

00:41:23,270 --> 00:41:20,700

so a few days ago yeah yeah and that's

1018

00:41:25,640 --> 00:41:23,280

where the scientists are set up in the

1019

00:41:30,080 --> 00:41:25,650

and that's our workhorse robot care x2

1020

00:41:32,870 --> 00:41:30,090

mounted with the tracks for exchange and

1021

00:41:34,550 --> 00:41:32,880

there you can see the drill and the blue

1022

00:41:35,780 --> 00:41:34,560

structure is the arm that we use to

1023

00:41:39,680 --> 00:41:35,790

collect sample on delivery of the

1024

00:41:41,850 --> 00:41:39,690

instruments and it's digging yeah I see

1025

00:41:43,410 --> 00:41:41,860

the drill turning yeah

1026

00:41:46,140 --> 00:41:43,420

that gear right there is where the

1027

00:41:48,570 --> 00:41:46,150

sample comes out of the drill has a when

1028

00:41:49,980 --> 00:41:48,580

it pulls back up and the bucket is the

1029

00:41:51,930 --> 00:41:49,990

copper and here is one of our

1030

00:41:53,610 --> 00:41:51,940

researchers just observing and taking

1031

00:41:57,090 --> 00:41:53,620

notes on the experiment as it trying

1032

00:41:59,430 --> 00:41:57,100

look at that landscape looks a lot like

1033

00:42:01,290 --> 00:41:59,440

the Viking picture we saw a little while

1034

00:42:04,020 --> 00:42:01,300

ago from the surface of Mars this truly

1035

00:42:05,760 --> 00:42:04,030

is Martian Mars on earth yeah yeah so

1036

00:42:07,320 --> 00:42:05,770

cool what is it yeah tell us a little

1037

00:42:08,640 --> 00:42:07,330

bit more was like to be there because

1038

00:42:10,860 --> 00:42:08,650

hey you guys have been there yourselves

1039

00:42:12,300 --> 00:42:10,870

yeah yeah so that's the reason the drill

1040

00:42:13,890 --> 00:42:12,310

is there and the rover and the

1041

00:42:16,680 --> 00:42:13,900

scientists this is part of a project

1042

00:42:21,450 --> 00:42:16,690

called Eretz it's the atacama rover

1043

00:42:24,210 --> 00:42:21,460

astrobiology drilling studies yes and

1044

00:42:28,800 --> 00:42:24,220

and the goal of the rover of the project

1045

00:42:31,290 --> 00:42:28,810

is to to precisely learn Mars science on

1046

00:42:32,880 --> 00:42:31,300

earth so go to the driest place on the

1047

00:42:34,320 --> 00:42:32,890

planet that's the Atacama Desert in

1048

00:42:37,380 --> 00:42:34,330

northern Chile it's the driest place on

1049

00:42:39,270 --> 00:42:37,390

earth it's what we call in in

1050

00:42:42,420 --> 00:42:39,280

astrobiology in planetary sciences and

1051  
00:42:44,340 --> 00:42:42,430  
an analog environment analog analog this

1052  
00:42:46,290 --> 00:42:44,350  
is similar not exactly the same but very

1053  
00:42:49,740 --> 00:42:46,300  
similar two places out there and other

1054  
00:42:52,170 --> 00:42:49,750  
planets and so it allows us to do

1055  
00:42:53,790 --> 00:42:52,180  
science and test engineering without

1056  
00:42:55,350 --> 00:42:53,800  
going to those places before we go to

1057  
00:42:57,330 --> 00:42:55,360  
those places right getting ready to go

1058  
00:42:58,950 --> 00:42:57,340  
when it comes to engineering

1059  
00:43:00,240 --> 00:42:58,960  
make sure that things work properly in

1060  
00:43:02,040 --> 00:43:00,250  
environments that are similar to the

1061  
00:43:03,930 --> 00:43:02,050  
places we want to go when it comes to

1062  
00:43:05,640 --> 00:43:03,940  
science it allows us to understand

1063  
00:43:07,410 --> 00:43:05,650

things like what happens if you have

1064

00:43:09,690 --> 00:43:07,420

chicken soup to soil that is very dry

1065

00:43:12,570 --> 00:43:09,700

then when we go to Mars and do the

1066

00:43:14,880 --> 00:43:12,580

experiment we can kind of predict what

1067

00:43:16,470 --> 00:43:14,890

might happen and so that's what iris is

1068

00:43:17,880 --> 00:43:16,480

doing its preparing NASA to search for

1069

00:43:19,050 --> 00:43:17,890

life on other planets by going to the

1070

00:43:20,760 --> 00:43:19,060

Atacama Desert and testing this

1071

00:43:23,610 --> 00:43:20,770

instrumentation that's so cool I love

1072

00:43:25,530 --> 00:43:23,620

these projects as drying as the other

1073

00:43:27,720 --> 00:43:25,540

comic is we still find life there we

1074

00:43:30,720 --> 00:43:27,730

don't you know this is the earth it's

1075

00:43:33,900 --> 00:43:30,730

hard not to find life and so it's a

1076

00:43:37,280 --> 00:43:33,910

place where we can test how good or bad

1077

00:43:39,570 --> 00:43:37,290

our instruments are it's definitely a

1078

00:43:41,580 --> 00:43:39,580

place where if you don't find anything

1079

00:43:43,410 --> 00:43:41,590

maybe you don't bright you don't have

1080

00:43:45,090 --> 00:43:43,420

the right instrument okay because we

1081

00:43:46,830 --> 00:43:45,100

expect we would expect live on Mars if

1082

00:43:48,660 --> 00:43:46,840

it was present or fossilized life on

1083

00:43:51,060 --> 00:43:48,670

Mars to be a lot less abundant than even

1084

00:43:54,740 --> 00:43:51,070

the Atacama Desert yeah it's a lot a lot

1085

00:44:00,040 --> 00:43:54,750

worse than something of an environment

1086

00:44:10,970 --> 00:44:02,620

you gotta copy the driest place on earth

1087

00:44:12,710 --> 00:44:10,980

where you've been there I haven't it's

1088

00:44:14,599 --> 00:44:12,720

so dry that no plants or animals

1089

00:44:16,220 --> 00:44:14,609

survived the only forms of life that

1090

00:44:17,930 --> 00:44:16,230

survive in the driest parts of their

1091

00:44:19,160 --> 00:44:17,940

camera are microorganisms and they're

1092

00:44:22,760 --> 00:44:19,170

not doing very well for that matter

1093

00:44:24,440 --> 00:44:22,770

mm-hmm and so authentic Mars and

1094

00:44:26,030 --> 00:44:24,450

everything we know about it it tells us

1095

00:44:28,099 --> 00:44:26,040

it's a hundred to a thousand times drier

1096

00:44:30,140 --> 00:44:28,109

than the Atacama so the idea is if you

1097

00:44:32,540 --> 00:44:30,150

can't find it in the Atacama understand

1098

00:44:33,920 --> 00:44:32,550

a chance on Mars yeah you finally got a

1099

00:44:35,839 --> 00:44:33,930

comet you might still not be able to

1100

00:44:37,160 --> 00:44:35,849

find it on Mars because it's so much

1101

00:44:38,510 --> 00:44:37,170

more extreme but the Atacama gives you

1102

00:44:40,130 --> 00:44:38,520

that confidence that if you find it

1103

00:44:41,630 --> 00:44:40,140

there maybe you're in the good truck and

1104

00:44:43,370 --> 00:44:41,640

the right track to find it on Mars

1105

00:44:46,220 --> 00:44:43,380

this is kind of like a test test case

1106

00:44:55,730 --> 00:44:46,230

for Mars yeah yeah I like to call it a

1107

00:44:58,160 --> 00:44:55,740

dry run in the driest desert fascinating

1108

00:45:00,800 --> 00:44:58,170

so yes I did get to go last year to

1109

00:45:03,109 --> 00:45:00,810

cover the story yep and there were lots

1110

00:45:04,790 --> 00:45:03,119

of scientists there last year working in

1111

00:45:06,770 --> 00:45:04,800

the field but this year what's different

1112

00:45:08,599 --> 00:45:06,780

is a whole bunch of you are here yes

1113

00:45:10,880 --> 00:45:08,609

that's right so this is the fourth year

1114

00:45:13,099 --> 00:45:10,890

of the project is the fourth time I

1115

00:45:15,440 --> 00:45:13,109

think that big thing goes to the

1116

00:45:17,800 --> 00:45:15,450

Araucana in the previous years it's been

1117

00:45:20,480 --> 00:45:17,810

a lot of Science in on the ground and

1118

00:45:22,280 --> 00:45:20,490

testing different pieces by themselves

1119

00:45:24,620 --> 00:45:22,290

or integrated into the rover you're

1120

00:45:25,970 --> 00:45:24,630

taking soil samples analyzing it so we

1121

00:45:27,410 --> 00:45:25,980

did a lot of things but this year is

1122

00:45:29,300 --> 00:45:27,420

special because what we're doing this

1123

00:45:32,300 --> 00:45:29,310

year is simulate a Mars mission hmm and

1124

00:45:33,800 --> 00:45:32,310

so we have boots on the ground with the

1125

00:45:35,630 --> 00:45:33,810

rover and the drill and the instruments

1126  
00:45:38,150 --> 00:45:35,640  
and then we have a backroom science team

1127  
00:45:40,430 --> 00:45:38,160  
here at Ames directing the rover what to

1128  
00:45:42,650 --> 00:45:40,440  
do receiving data from the rover and

1129  
00:45:44,510 --> 00:45:42,660  
based on that data giving the next steps

1130  
00:45:46,069 --> 00:45:44,520  
in instructions on what to do next just

1131  
00:45:48,800 --> 00:45:46,079  
the way you would do it on a Mars

1132  
00:45:52,940 --> 00:45:48,810  
mission you would have a team of

1133  
00:45:55,040 --> 00:45:52,950  
scientists back on earth every week we

1134  
00:45:56,420 --> 00:45:55,050  
meet we collected we get the data that

1135  
00:45:58,069 --> 00:45:56,430  
the rover collected the previous day and

1136  
00:46:00,770 --> 00:45:58,079  
the instruments we analyze that data

1137  
00:46:03,140 --> 00:46:00,780  
it's not processed data it's quick looks

1138  
00:46:04,910 --> 00:46:03,150

did we call which tell us yeah you've

1139

00:46:07,650 --> 00:46:04,920

got the sample you got the data it looks

1140

00:46:09,450 --> 00:46:07,660

good move on and based on

1141

00:46:11,130 --> 00:46:09,460

we learned a few snippets we get from

1142

00:46:13,410 --> 00:46:11,140

that from those datasets we decided well

1143

00:46:15,630 --> 00:46:13,420

go there and get that sample or go

1144

00:46:16,980 --> 00:46:15,640

deeper and get another sample hmm it's a

1145

00:46:19,980 --> 00:46:16,990

tactical decision that we need to make

1146

00:46:21,720 --> 00:46:19,990

on the fly you guys you call it dirt to

1147

00:46:23,340 --> 00:46:21,730

data right there's the data that's

1148

00:46:25,620 --> 00:46:23,350

happening on the rover thanks to

1149

00:46:27,810 --> 00:46:25,630

intelligent Rovers that we can tell them

1150

00:46:33,390 --> 00:46:27,820

pick that up and the next thing we know

1151  
00:46:34,620 --> 00:46:33,400  
is the composition thanks Michael I love

1152  
00:46:36,840 --> 00:46:34,630  
that term because it makes it really

1153  
00:46:38,940 --> 00:46:36,850  
clear that the rover is drilling it's

1154  
00:46:40,770 --> 00:46:38,950  
pulling up dirt it's taking the sample

1155  
00:46:42,780 --> 00:46:40,780  
throwing it into the instruments that

1156  
00:46:44,070 --> 00:46:42,790  
carry it with us and then the

1157  
00:46:46,020 --> 00:46:44,080  
instruments are processing the sample

1158  
00:46:49,610 --> 00:46:46,030  
analyzing the sample and sending the

1159  
00:46:57,690 --> 00:46:49,620  
data and humans are not in the loop

1160  
00:46:59,520 --> 00:46:57,700  
airplane man 1997 says that's cool yeah

1161  
00:47:01,980 --> 00:46:59,530  
here's a question also about the drill

1162  
00:47:05,100 --> 00:47:01,990  
MGM PhD asks what material is it made of

1163  
00:47:07,050 --> 00:47:05,110

this is Steve yep

1164

00:47:14,610 --> 00:47:07,060

and it's probably something ideas that

1165

00:47:17,160 --> 00:47:14,620

we would send trap-trap ping VIN asked

1166

00:47:19,620 --> 00:47:17,170

how much analysis can be done directly

1167

00:47:22,410 --> 00:47:19,630

on Mars compared to how much can be done

1168

00:47:23,610 --> 00:47:22,420

by bringing samples back to earth so

1169

00:47:25,020 --> 00:47:23,620

that's a good question there there are

1170

00:47:27,150 --> 00:47:25,030

two different levels of analysis you

1171

00:47:30,000 --> 00:47:27,160

might want to do a preliminary very

1172

00:47:33,450 --> 00:47:30,010

quick analysis to check the health of

1173

00:47:36,540 --> 00:47:33,460

the instruments or two to make sure that

1174

00:47:38,520 --> 00:47:36,550

you got data yes no and that has very

1175

00:47:41,490 --> 00:47:38,530

little science involved but then that

1176

00:47:43,170 --> 00:47:41,500

data gets transferred sent to us and

1177

00:47:46,170 --> 00:47:43,180

then we have all the time in the world

1178

00:47:48,750 --> 00:47:46,180

to look at it carefully and analyze the

1179

00:47:50,760 --> 00:47:48,760

details obviously we might want to make

1180

00:47:54,840 --> 00:47:50,770

decisions quickly for the next steps for

1181

00:47:56,940 --> 00:47:54,850

the mission but all the data gets saved

1182

00:47:58,920 --> 00:47:56,950

in the repository that scientists pretty

1183

00:48:02,550 --> 00:47:58,930

much around the world can access and

1184

00:48:05,250 --> 00:48:02,560

analyze and look and tease out over many

1185

00:48:08,880 --> 00:48:05,260

years so we're still looking at Viking

1186

00:48:11,360 --> 00:48:08,890

data and so you know that's it's that

1187

00:48:13,830 --> 00:48:11,370

science can move it moves a very hectic

1188

00:48:15,600 --> 00:48:13,840

pace at the beginning in the mission but

1189

00:48:17,100 --> 00:48:15,610

then we have all the time in the world

1190

00:48:18,270 --> 00:48:17,110

to actually dig through the data and

1191

00:48:20,010 --> 00:48:18,280

understand what's going on we do have a

1192

00:48:20,610 --> 00:48:20,020

mission where the looking at caching

1193

00:48:25,920 --> 00:48:20,620

samples

1194

00:48:28,350 --> 00:48:25,930

right for ya the next one Mars 2020 that

1195

00:48:30,270 --> 00:48:28,360

sort of follow-on from curiosity and

1196

00:48:32,010 --> 00:48:30,280

it's going to it's going to a lake bed

1197

00:48:33,540 --> 00:48:32,020

it's the venting of the lake yeah all

1198

00:48:35,160 --> 00:48:33,550

work we think was a lake based on what

1199

00:48:37,710 --> 00:48:35,170

we know from orbit yeah and it's going

1200

00:48:39,330 --> 00:48:37,720

to be the first step in campaign for

1201  
00:48:40,320 --> 00:48:39,340  
sample return to bring samples actually

1202  
00:48:44,430 --> 00:48:40,330  
back to earth

1203  
00:48:45,750 --> 00:48:44,440  
very exciting dr. Ryan asks any plans in

1204  
00:48:47,970 --> 00:48:45,760  
the future to take samples from the

1205  
00:48:49,950 --> 00:48:47,980  
areas where we see seasonal brine flow

1206  
00:48:53,220 --> 00:48:49,960  
on cliff faces so that's someone who's

1207  
00:48:56,310 --> 00:48:53,230  
been following the Mars news that's that

1208  
00:48:58,710 --> 00:48:56,320  
salty water was found flowing there are

1209  
00:49:00,540 --> 00:48:58,720  
there are intriguing observations on the

1210  
00:49:02,490 --> 00:49:00,550  
surface of Mars we're not still we're

1211  
00:49:05,760 --> 00:49:02,500  
still trying to figure out what the

1212  
00:49:07,650 --> 00:49:05,770  
cause for these patterns is but there is

1213  
00:49:10,140 --> 00:49:07,660

one possibility there is liquid water or

1214

00:49:12,030 --> 00:49:10,150

salty water and so that that would be

1215

00:49:15,870 --> 00:49:12,040

like it you know for astrobiology that

1216

00:49:20,460 --> 00:49:15,880

would be a beacon go come here and take

1217

00:49:22,800 --> 00:49:20,470

me sample me but the but but it's not

1218

00:49:24,870 --> 00:49:22,810

easy there are many places we would like

1219

00:49:26,310 --> 00:49:24,880

to go and and normally the places we'll

1220

00:49:28,500 --> 00:49:26,320

want to go are the most challenging ones

1221

00:49:30,840 --> 00:49:28,510

they're always on the slope they're

1222

00:49:34,050 --> 00:49:30,850

always a difficult environment so for

1223

00:49:36,540 --> 00:49:34,060

whatever reason it's it's never easy but

1224

00:49:38,040 --> 00:49:36,550

this is definitely one of many places we

1225

00:49:41,040 --> 00:49:38,050

would like to go and collect samples

1226

00:49:44,430 --> 00:49:41,050

mm-hmm okay the challenges of drilling

1227

00:49:48,090 --> 00:49:44,440

offworld makes me think of plans for the

1228

00:49:51,300 --> 00:49:48,100

Artemis program NASA is heading to the

1229

00:49:53,940 --> 00:49:51,310

moon we're 2024 and I think that's gonna

1230

00:49:56,610 --> 00:49:53,950

be part of it isn't it it is yeah and so

1231

00:49:59,070 --> 00:49:56,620

I mean Artemis is the trip back to the

1232

00:50:04,980 --> 00:49:59,080

moon we're sending the first woman and

1233

00:50:06,690 --> 00:50:04,990

then more men to the yeah and so if

1234

00:50:09,180 --> 00:50:06,700

that's setting up to be long-term

1235

00:50:10,740 --> 00:50:09,190

habitation on the on the on the moon and

1236

00:50:14,100 --> 00:50:10,750

one of the things we need to do is try

1237

00:50:16,110 --> 00:50:14,110

and get resources there right so we've

1238

00:50:18,080 --> 00:50:16,120

recently found out that there is water

1239

00:50:21,690 --> 00:50:18,090

on the moon which is kind of surprising

1240

00:50:23,970 --> 00:50:21,700

ice crystals right yeah yeah that's hard

1241

00:50:26,190 --> 00:50:23,980

to extract it's an icy material right

1242

00:50:28,110 --> 00:50:26,200

and again you will want a smart drill to

1243

00:50:29,700 --> 00:50:28,120

try and be mitigating the risks of

1244

00:50:30,720 --> 00:50:29,710

drilling into these icy surfaces so

1245

00:50:33,620 --> 00:50:30,730

stuff like we're doing on air it's

1246

00:50:35,970 --> 00:50:33,630

actually feeds into the to the Artem

1247

00:50:37,710 --> 00:50:35,980

kind of cool that is exciting right

1248

00:50:42,150 --> 00:50:37,720

so it's a multi-purpose drill

1249

00:50:44,490 --> 00:50:42,160

potentially for many locations off world

1250

00:50:45,480 --> 00:50:44,500

yes yeah yes I like that you've got you

1251  
00:50:47,670 --> 00:50:45,490  
know the scientists working with the

1252  
00:50:50,130 --> 00:50:47,680  
engineers for them Mars search for life

1253  
00:50:51,660 --> 00:50:50,140  
and oh it's also gonna be really helpful

1254  
00:50:52,860 --> 00:50:51,670  
when we get to the moon yeah it's an

1255  
00:50:56,070 --> 00:50:52,870  
example of how exploration drives

1256  
00:50:57,690 --> 00:50:56,080  
exploration yeah yeah yeah and we'll

1257  
00:51:00,210 --> 00:50:57,700  
that doesn't stop turning yeah that's

1258  
00:51:03,120 --> 00:51:00,220  
pretty cool so cool these things here's

1259  
00:51:06,020 --> 00:51:03,130  
a question I like from airplane man 1997

1260  
00:51:08,790 --> 00:51:06,030  
what would the drill sound like oh

1261  
00:51:14,270 --> 00:51:08,800  
that's a great question that mr. is a

1262  
00:51:31,740 --> 00:51:29,570  
yeah yeah the drill that's what you've

1263  
00:51:57,360 --> 00:51:31,750

heard there's a high-pitched squeak

1264

00:52:02,180 --> 00:51:57,370

noise but it would listen to it we

1265

00:52:09,330 --> 00:52:05,780

also about the Martian environment

1266

00:52:11,400 --> 00:52:09,340

Lazzaro Martian gravity similar to what

1267

00:52:14,760 --> 00:52:11,410

we have on our planet no no no it's

1268

00:52:16,340 --> 00:52:14,770

about a third yeah does that affect the

1269

00:52:18,540 --> 00:52:16,350

drill and how you have to design it

1270

00:52:21,750 --> 00:52:18,550

that's a good question so when we're

1271

00:52:22,530 --> 00:52:21,760

drilling we apply force yeah and gravity

1272

00:52:24,210 --> 00:52:22,540

helps yeah

1273

00:52:25,440 --> 00:52:24,220

it doesn't actually I would guess effect

1274

00:52:26,820 --> 00:52:25,450

the rate that we could extract material

1275

00:52:28,470 --> 00:52:26,830

from the hole yeah

1276  
00:52:30,810 --> 00:52:28,480  
to compensate for some of the weight

1277  
00:52:34,110 --> 00:52:30,820  
loss yeah that you get on Mars yeah yeah

1278  
00:52:36,210 --> 00:52:34,120  
if you wanna diei for some times we

1279  
00:52:38,310 --> 00:52:36,220  
actually have to add some weight on the

1280  
00:52:41,280 --> 00:52:38,320  
drill so that he can push okay well

1281  
00:52:44,420 --> 00:52:41,290  
downwards we're gonna force enough

1282  
00:52:49,110 --> 00:52:44,430  
doesn't affect yeah all right

1283  
00:52:51,540 --> 00:52:49,120  
more more regal 16 asks as the drill

1284  
00:52:53,820 --> 00:52:51,550  
goes straight down or doesn't have the

1285  
00:52:56,190 --> 00:52:53,830  
ability to change directions or even go

1286  
00:52:58,830 --> 00:52:56,200  
horizontally straight down it's a

1287  
00:53:00,300 --> 00:52:58,840  
straight one one way yes yeah at least

1288  
00:53:02,580 --> 00:53:00,310

in the setup that we're doing in Harrods

1289

00:53:04,950 --> 00:53:02,590

you could conceivably try and do slant

1290

00:53:07,080 --> 00:53:04,960

drilling but that would be a more

1291

00:53:08,610 --> 00:53:07,090

complicated problem again and risky yeah

1292

00:53:10,920 --> 00:53:08,620

because it could like gonna go off to

1293

00:53:12,900 --> 00:53:10,930

one side or something if it you know or

1294

00:53:15,720 --> 00:53:12,910

even Snapp if you force it too much yeah

1295

00:53:16,350 --> 00:53:15,730

yeah it's made to go straight down sorry

1296

00:53:18,810 --> 00:53:16,360

Jen okay

1297

00:53:21,600 --> 00:53:18,820

space TV Internet wants to know if both

1298

00:53:23,160 --> 00:53:21,610

of our guests you guys could be this on

1299

00:53:24,840 --> 00:53:23,170

the surface of Mars tomorrow what would

1300

00:53:28,950 --> 00:53:24,850

be the first thing you would do to

1301

00:53:32,730 --> 00:53:28,960

search for life start digging

1302

00:53:36,960 --> 00:53:32,740

bring some chicken soothe that's a good

1303

00:53:38,550 --> 00:53:36,970

question well I I have the as we

1304

00:53:43,740 --> 00:53:38,560

mentioned earlier the surface of Mars is

1305

00:53:47,310 --> 00:53:43,750

very different whatever you did so if I

1306

00:53:48,600 --> 00:53:47,320

was a bit at some places like near the

1307

00:53:53,580 --> 00:53:48,610

polar caps I would get some of that

1308

00:53:55,530 --> 00:53:53,590

water ice melted cup of tea maybe the

1309

00:53:58,110 --> 00:53:55,540

microscope and see if something swims

1310

00:54:01,590 --> 00:53:58,120

around if I was in the place layer like

1311

00:54:03,480 --> 00:54:01,600

were curiosities ancient rocks that

1312

00:54:03,780 --> 00:54:03,490

formed in the lake bed three billion

1313

00:54:06,120 --> 00:54:03,790

years ago

1314

00:54:08,160 --> 00:54:06,130

I might get some samples and run them

1315

00:54:09,840 --> 00:54:08,170

through very sensitive instruments that

1316

00:54:12,990 --> 00:54:09,850

can analyze the chemistry and search for

1317

00:54:14,820 --> 00:54:13,000

those traces of dead microbes maybe if I

1318

00:54:16,890 --> 00:54:14,830

could bring Michael with me and he could

1319

00:54:18,780 --> 00:54:16,900

drill 2 kilometers I would just wait in

1320

00:54:20,490 --> 00:54:18,790

the surface until we get the sample and

1321

00:54:22,380 --> 00:54:20,500

then and then see what's there if

1322

00:54:24,900 --> 00:54:22,390

something is actually lurking down there

1323

00:54:27,720 --> 00:54:24,910

so depends on where you are yeah yeah

1324

00:54:28,710 --> 00:54:27,730

it's it's a post everything was a very

1325

00:54:30,120 --> 00:54:28,720

environment it still is a very

1326

00:54:32,310 --> 00:54:30,130

environment from a geological

1327

00:54:34,110 --> 00:54:32,320

perspective yeah so it's it's just like

1328

00:54:36,410 --> 00:54:34,120

one place isn't enough if we want to

1329

00:54:42,150 --> 00:54:36,420

increase our odds of finding life yeah

1330

00:54:44,250 --> 00:54:42,160

over yeah but Meister zero-nine asks how

1331

00:54:47,130 --> 00:54:44,260

long would it take from discovering to

1332

00:54:49,860 --> 00:54:47,140

confirming to publishing that life has

1333

00:54:54,510 --> 00:54:49,870

been found scientific process

1334

00:54:58,529 --> 00:54:56,789

I guess it depends what you find please

1335

00:55:07,470 --> 00:54:58,539

find something waving back at you don't

1336

00:55:11,789 --> 00:55:07,480

even publish let everybody enjoy if we

1337

00:55:13,740 --> 00:55:11,799

if we find it's not gonna be probably

1338

00:55:14,579 --> 00:55:13,750

such clear-cut it's not gonna be a

1339

00:55:17,819 --> 00:55:14,589

straight path

1340

00:55:19,650 --> 00:55:17,829

it'd be surprising science how rarely

1341

00:55:22,049 --> 00:55:19,660

works that way that you have a clear

1342

00:55:24,329 --> 00:55:22,059

path from discovery to publication to

1343

00:55:26,549 --> 00:55:24,339

acceptance and especially with things so

1344

00:55:30,029 --> 00:55:26,559

important and and groundbreaking is

1345

00:55:32,750 --> 00:55:30,039

finding life on another planet so it's

1346

00:55:36,539 --> 00:55:32,760

gonna take a while to process the data I

1347

00:55:37,920 --> 00:55:36,549

I wish it was clear cut but if not and

1348

00:55:39,569 --> 00:55:37,930

there will be debates there will be

1349

00:55:41,940 --> 00:55:39,579

meetings and conferences where people

1350

00:55:44,250 --> 00:55:41,950

will go and have a back and forth

1351  
00:55:46,589 --> 00:55:44,260  
eventually papers will be published and

1352  
00:55:48,900 --> 00:55:46,599  
then the scientific method demands that

1353  
00:55:50,779 --> 00:55:48,910  
we don't stop there we try again we

1354  
00:55:54,120 --> 00:55:50,789  
continue and we confirm or disprove

1355  
00:55:57,210 --> 00:55:54,130  
those results and it's that process of

1356  
00:55:59,250 --> 00:55:57,220  
of building on results and testing and

1357  
00:56:02,220 --> 00:55:59,260  
new hypotheses and new experiments but

1358  
00:56:06,029 --> 00:56:02,230  
in the end that provides the evidence

1359  
00:56:10,160 --> 00:56:06,039  
that we need or or not so and so like

1360  
00:56:12,000 --> 00:56:10,170  
with Viking it took about 40 years so

1361  
00:56:14,490 --> 00:56:12,010  
there might be people out there that

1362  
00:56:16,380 --> 00:56:14,500  
were not convinced mm-hmm of the

1363  
00:56:17,640 --> 00:56:16,390

perchlorate explanation okay and it's a

1364

00:56:18,930 --> 00:56:17,650

valid thing in science that you can

1365

00:56:21,690 --> 00:56:18,940

always doubt you should always doubt

1366

00:56:24,450 --> 00:56:21,700

yeah the standing explanation so and

1367

00:56:25,589 --> 00:56:24,460

keep testing and keep testing yeah you

1368

00:56:28,559 --> 00:56:25,599

can't prove things right you can only

1369

00:56:30,900 --> 00:56:28,569

prove them wrong right exactly all right

1370

00:56:33,539 --> 00:56:30,910

good one quick question from digital

1371

00:56:37,109 --> 00:56:33,549

donger will Mars 2020 Rover have any

1372

00:56:40,620 --> 00:56:37,119

instruments for life detection it does

1373

00:56:42,029 --> 00:56:40,630

in a sense because 2020 relies a lot on

1374

00:56:44,190 --> 00:56:42,039

the sound doing a lot of the science

1375

00:56:47,309 --> 00:56:44,200

when the samples come back to earth the

1376

00:56:49,319 --> 00:56:47,319

focus is on smart instruments that can

1377

00:56:52,370 --> 00:56:49,329

identify the right samples to bring back

1378

00:56:55,589 --> 00:56:52,380

ah and so that doesn't require really

1379

00:56:57,029 --> 00:56:55,599

analyzing every element in that walk to

1380

00:56:59,670 --> 00:56:57,039

know exactly where it came from we can

1381

00:57:01,589 --> 00:56:59,680

do that back on earth when the samples

1382

00:57:03,690 --> 00:57:01,599

come back but we do need instruments it

1383

00:57:05,549 --> 00:57:03,700

can tell well you know between those two

1384

00:57:06,970 --> 00:57:05,559

samples they looks this looks like a

1385

00:57:08,500 --> 00:57:06,980

better sample to cache

1386

00:57:10,810 --> 00:57:08,510

and preserve and bring back to earth

1387

00:57:12,040 --> 00:57:10,820

because of its composition it might be

1388

00:57:14,380 --> 00:57:12,050

different and things like this so those

1389

00:57:16,120 --> 00:57:14,390

instruments are selected precisely to do

1390

00:57:21,210 --> 00:57:16,130

that select the best possible samples

1391

00:57:25,420 --> 00:57:21,220

for return meet sleepy underscore Gary

1392

00:57:42,580 --> 00:57:25,430

asks were you inspired by any sci-fi to

1393

00:57:45,160 --> 00:57:42,590

pursue this field No start somewhere

1394

00:57:46,780 --> 00:57:45,170

right with the imagination yes yes but

1395

00:57:50,200 --> 00:57:46,790

endless debates about what's the best

1396

00:57:52,330 --> 00:57:50,210

science movie sci-fi movie md atacama

1397

00:58:08,230 --> 00:57:52,340

michael and i got a lot of time on your

1398

00:58:10,240 --> 00:58:08,240

hands there from mdhd what have we

1399

00:58:12,520 --> 00:58:10,250

learned about Martian dust or dirt that

1400

00:58:13,300 --> 00:58:12,530

would impact robotic tasks is that

1401  
00:58:17,310 --> 00:58:13,310  
something you're learning from the

1402  
00:58:22,120 --> 00:58:19,120  
we're actually having an interesting

1403  
00:58:23,859 --> 00:58:22,130  
problem in Aaron's right now in that

1404  
00:58:25,390 --> 00:58:23,869  
when we're drilling up dirt we have a

1405  
00:58:26,680 --> 00:58:25,400  
camera that's looking at where the dirt

1406  
00:58:28,660 --> 00:58:26,690  
comes out and goes into the scoop and

1407  
00:58:30,970 --> 00:58:28,670  
the dirt is all getting stuck to the

1408  
00:58:33,460 --> 00:58:30,980  
lens of the camera which is a problem

1409  
00:58:36,990 --> 00:58:33,470  
for cameras because they need to be able

1410  
00:58:39,460 --> 00:58:37,000  
see useful yeah so that's that kind of

1411  
00:58:40,870 --> 00:58:39,470  
that mitigation and dust mitigation is a

1412  
00:58:42,340 --> 00:58:40,880  
big thing that's a problem weight is a

1413  
00:58:44,980 --> 00:58:42,350

problem do you remember we have these

1414

00:58:46,420 --> 00:58:44,990

scoop there is collecting cuttings from

1415

00:58:48,160 --> 00:58:46,430

the drill and then brings them to the

1416

00:58:49,690 --> 00:58:48,170

estimate if you have strong winds you're

1417

00:58:51,700 --> 00:58:49,700

canning smart blow out of the school so

1418

00:58:52,840 --> 00:58:51,710

we learned how to position the scoop and

1419

00:58:59,050 --> 00:58:52,850

the rover in a way that it blocks the

1420

00:59:02,320 --> 00:58:59,060

wind and prevent sample loss keep going

1421

00:59:05,140 --> 00:59:02,330

a Reds things before Rovers go to Mars

1422

00:59:06,979 --> 00:59:05,150

and start drilling but that is all the

1423

00:59:10,049 --> 00:59:06,989

time we have for today goes

1424

00:59:12,329 --> 00:59:10,059

but thank you so much to you guys for

1425

00:59:13,709 --> 00:59:12,339

joining us today fascinating and thank

1426

00:59:16,169 --> 00:59:13,719

you to everyone who joined us in the

1427

00:59:18,479 --> 00:59:16,179

chat on twitch join us next time that'll

1428

00:59:21,390 --> 00:59:18,489

be October 24th for our second annual

1429

00:59:23,640 --> 00:59:21,400

NASA themed Halloween costume and

1430

00:59:26,009 --> 00:59:23,650

cosplay contest so that was a lot of fun

1431

00:59:36,160 --> 00:59:26,019

last year join us for that thanks for