1
00:00:04,070 --> 00:00:02,470
nasa's jet propulsion laboratory

2
00:00:06,710 --> 00:00:04,080
presents

3
00:00:08,790 --> 00:00:06,720
the von karman lecture a series of talks

4
00:00:10,709 --> 00:00:08,800
by scientists and engineers who are

5
00:00:14,910 --> 00:00:10,719
exploring our planet

6
00:00:20,890 --> 00:00:14,920
our solar system and all that lies

7
00:00:26,070 --> 00:00:23,830
[Music]

8
00:00:28,230 --> 00:00:26,080
hello everyone and a very pleasant

9
00:00:30,070 --> 00:00:28,240
evening to you wherever you may be

10
00:00:32,069 --> 00:00:30,080
welcome to another remote edition of our

11
00:00:34,310 --> 00:00:32,079
von carmen series i'm brian white from

12
00:00:35,350 --> 00:00:34,320
jpl's office of communications and

13
00:00:37,990 --> 00:00:35,360

education

14
00:00:39,350 --> 00:00:38,000
and tonight we'll be discussing venus

15
00:00:41,830 --> 00:00:39,360
earth's evil twin

16
00:00:42,549 --> 00:00:41,840
or just misunderstood a few quick

17
00:00:44,549 --> 00:00:42,559
reminders

18
00:00:46,549 --> 00:00:44,559
we ask if any technical issue issues

19
00:00:48,150 --> 00:00:46,559
arise we have had calls of

20
00:00:50,709 --> 00:00:48,160
here in southern california of rolling

21
00:00:52,229 --> 00:00:50,719
blackouts we ask that you stick with us

22
00:00:53,750 --> 00:00:52,239
as we get them sorted out

23
00:00:56,069 --> 00:00:53,760
we'll keep going as best as we can and

24
00:00:57,430 --> 00:00:56,079
we also want you to be involved in this

25
00:00:59,510 --> 00:00:57,440
conversation

26
00:01:01,189 --> 00:00:59,520
if you're joining us on youtube or

27
00:01:01,910 --> 00:01:01,199
facebook live you'll notice a chat

28
00:01:05,109 --> 00:01:01,920
window

29
00:01:06,310 --> 00:01:05,119
ahead and refresh that page and it

30
00:01:07,750 --> 00:01:06,320
should be there

31
00:01:09,670 --> 00:01:07,760
ask questions and our hard-working

32
00:01:10,710 --> 00:01:09,680
social media team will bring them into

33
00:01:13,030 --> 00:01:10,720
our conversation

34
00:01:13,910 --> 00:01:13,040
throughout the night and helping us out

35
00:01:16,550 --> 00:01:13,920
this evening

36
00:01:17,109 --> 00:01:16,560
is lindsay mclaurin a public outreach

37
00:01:20,789 --> 00:01:17,119
specialist

38
00:01:22,149 --> 00:01:20,799

hi lindsey hello brian hello everyone

39
00:01:23,510 --> 00:01:22,159
i'm looking forward to fielding your

40
00:01:24,149 --> 00:01:23,520
questions tonight so make sure you use

41
00:01:27,749 --> 00:01:24,159
the chat

42
00:01:29,190 --> 00:01:27,759
and i'm excited to hear sue speak

43
00:01:30,789 --> 00:01:29,200
wonderful thank you lindsay thanks for

44
00:01:32,149 --> 00:01:30,799
joining us on your thursday night

45
00:01:34,069 --> 00:01:32,159
and folks we want to remind you that

46
00:01:35,910 --> 00:01:34,079
this is your space program

47
00:01:37,830 --> 00:01:35,920
there are a ton of nasa resources

48
00:01:39,190 --> 00:01:37,840
available online but one in particular

49
00:01:42,789 --> 00:01:39,200
i'd like to point out tonight

50
00:01:44,789 --> 00:01:42,799
and that's solarsystem.nasa.gov

51
00:01:46,710 --> 00:01:44,799
planets slash venus and that's going to

52
00:01:48,230 --> 00:01:46,720
be image number two

53
00:01:50,230 --> 00:01:48,240
now as you may have guessed you can

54
00:01:50,710 --> 00:01:50,240
explore our whole solar system through

55
00:01:52,149 --> 00:01:50,720
this

56
00:01:53,990 --> 00:01:52,159
website but after our talk if you're

57
00:01:56,789 --> 00:01:54,000
thinking i want to know more about

58
00:01:58,389 --> 00:01:56,799
our twin head there and you'll uncover a

59
00:02:00,469 --> 00:01:58,399
whole mountain of information

60
00:02:02,230 --> 00:02:00,479
from about the planet galleries and

61
00:02:02,870 --> 00:02:02,240
images and videos plus information about

62
00:02:05,190 --> 00:02:02,880
missions

63
00:02:06,709 --> 00:02:05,200

and notable explorers which you can see

64
00:02:09,430 --> 00:02:06,719
down their bottom

65
00:02:09,910 --> 00:02:09,440
include this evening speaker now let's

66
00:02:12,150 --> 00:02:09,920
get

67
00:02:13,190 --> 00:02:12,160
to meet our speaker if we go to image

68
00:02:14,949 --> 00:02:13,200
number three

69
00:02:17,990 --> 00:02:14,959
you're going to see a principal

70
00:02:19,830 --> 00:02:18,000
planetary scientist with jpl since 1992

71
00:02:21,350 --> 00:02:19,840
she has worked on missions to both of

72
00:02:24,390 --> 00:02:21,360
our neighbors mars

73
00:02:25,670 --> 00:02:24,400
and venus please welcome rocky planet

74
00:02:29,430 --> 00:02:25,680
geoscientist

75
00:02:32,869 --> 00:02:29,440
dr sue smerkar hi yes sue

76
00:02:34,390 --> 00:02:32,879
hey hi brian hi everyone thanks for

77
00:02:35,990 --> 00:02:34,400
thanks for having me to talk about my

78
00:02:37,350 --> 00:02:36,000
favorite planet

79
00:02:38,550 --> 00:02:37,360
well thank you for being with us and

80
00:02:40,070 --> 00:02:38,560
talking about your favorite planet and

81
00:02:42,229 --> 00:02:40,080
that's a big question right now

82
00:02:44,470 --> 00:02:42,239
um why are we talking about venus

83
00:02:47,910 --> 00:02:44,480
tonight

84
00:02:50,309 --> 00:02:47,920
venus is like this incredible cosmic

85
00:02:51,990 --> 00:02:50,319
accident you know uh there's all this

86
00:02:55,670 --> 00:02:52,000
primordial stuff floating around

87
00:02:57,589 --> 00:02:55,680
in our solar system and planets form

88
00:02:59,589 --> 00:02:57,599

none of the planets are more similar

89
00:03:00,550 --> 00:02:59,599
than venus in earth no two moons not two

90
00:03:03,110 --> 00:03:00,560
planets

91
00:03:04,630 --> 00:03:03,120
they're it's just this crazy accident

92
00:03:07,990 --> 00:03:04,640
these two bodies ended up

93
00:03:10,710 --> 00:03:08,000
so similar um you know they they're

94
00:03:12,630 --> 00:03:10,720
close to both close to the sun they're

95
00:03:15,350 --> 00:03:12,640
similar in size and composition

96
00:03:15,750 --> 00:03:15,360
and you know on the flip side um there's

97
00:03:19,030 --> 00:03:15,760
the

98
00:03:22,869 --> 00:03:19,040
part uh

99
00:03:25,110 --> 00:03:22,879
you know that sulfuric acid rain uh

100
00:03:26,869 --> 00:03:25,120
the incredible surface temperature you

101
00:03:27,910 --> 00:03:26,879
know it's hard to get about 10 words

102
00:03:29,350 --> 00:03:27,920
into a

103
00:03:31,110 --> 00:03:29,360
description of venus without hearing the

104
00:03:33,030 --> 00:03:31,120
word hell

105
00:03:34,149 --> 00:03:33,040
but we really don't know how long it's

106
00:03:37,190 --> 00:03:34,159
had those uh

107
00:03:38,149 --> 00:03:37,200
surface conditions and um it

108
00:03:41,030 --> 00:03:38,159
actually could have been the first

109
00:03:43,589 --> 00:03:41,040
habitable planet in our solar system

110
00:03:44,949 --> 00:03:43,599
well let's talk about those similarities

111
00:03:45,990 --> 00:03:44,959
and then we'll talk a little bit about

112
00:03:49,030 --> 00:03:46,000
that evil part of

113
00:03:51,030 --> 00:03:49,040

it let's go to image four and you can

114
00:03:53,429 --> 00:03:51,040
talk us through some of these uh

115
00:03:58,070 --> 00:03:53,439
similarities here a little bit

116
00:04:01,350 --> 00:03:58,080
sure so you see um three green

117
00:04:04,390 --> 00:04:01,360
planets uh venus earth and

118
00:04:08,070 --> 00:04:04,400
an imaginary exoplanet

119
00:04:12,149 --> 00:04:08,080
you know you can see that earth is

120
00:04:13,750 --> 00:04:12,159
just slightly larger than venus and

121
00:04:15,350 --> 00:04:13,760
we know the densities are very similar

122
00:04:16,550 --> 00:04:15,360
which tells us they have a similar bulk

123
00:04:18,229 --> 00:04:16,560
composition

124
00:04:20,069 --> 00:04:18,239
and we've even looked at some of the

125
00:04:20,870 --> 00:04:20,079
atmospheric composition which tells us

126
00:04:23,990 --> 00:04:20,880
that

127
00:04:24,870 --> 00:04:24,000
venus used to have a shallow ocean's

128
00:04:27,670 --> 00:04:24,880
worth of water

129
00:04:29,670 --> 00:04:27,680
at the surface now we don't know when

130
00:04:32,390 --> 00:04:29,680
that surface water was lost

131
00:04:33,270 --> 00:04:32,400
um but we know that it it very likely

132
00:04:34,870 --> 00:04:33,280
started out

133
00:04:36,310 --> 00:04:34,880
uh much more similar to the earth than

134
00:04:37,749 --> 00:04:36,320
it is today

135
00:04:39,430 --> 00:04:37,759
and you know that's that's super

136
00:04:41,350 --> 00:04:39,440
important because uh you know if you're

137
00:04:42,550 --> 00:04:41,360
a space fan you know that uh they've

138
00:04:44,870 --> 00:04:42,560

been finding

139
00:04:45,670 --> 00:04:44,880
um just you know hundreds and hundreds

140
00:04:48,629 --> 00:04:45,680
of

141
00:04:49,749 --> 00:04:48,639
planets around other stars and you know

142
00:04:52,870 --> 00:04:49,759
we're really trying to find

143
00:04:55,590 --> 00:04:52,880
um you know earth 2.0 right the planet

144
00:04:57,030 --> 00:04:55,600
that is so much like our own planet but

145
00:05:00,390 --> 00:04:57,040
around another star

146
00:05:02,469 --> 00:05:00,400
and so to begin to you know predict

147
00:05:04,230 --> 00:05:02,479
which of those those you know more or

148
00:05:06,469 --> 00:05:04,240
less points of light that we

149
00:05:08,390 --> 00:05:06,479
or or points of uh lack of light that

150
00:05:10,070 --> 00:05:08,400
has a transit in front of stars

151
00:05:11,749 --> 00:05:10,080
those those exoplanets which ones are

152
00:05:14,870 --> 00:05:11,759
likely to be like earth

153
00:05:16,950 --> 00:05:14,880
um you know if we if we can't understand

154
00:05:19,270 --> 00:05:16,960
how these two twin planets evolved on

155
00:05:20,870 --> 00:05:19,280
different paths we can't really predict

156
00:05:22,710 --> 00:05:20,880
our exoplanet is going to be like earth

157
00:05:24,469 --> 00:05:22,720
or not

158
00:05:26,710 --> 00:05:24,479
so that twin aspect has not only helped

159
00:05:28,150 --> 00:05:26,720
people for here on earth but also in

160
00:05:31,909 --> 00:05:28,160
discovering

161
00:05:33,350 --> 00:05:31,919
worlds beyond narcissists wonderful um

162
00:05:35,510 --> 00:05:33,360
let's go to image five though let's talk

163
00:05:38,710 --> 00:05:35,520

a little bit about what makes this title

164
00:05:41,110 --> 00:05:38,720
so interesting the evil part of this

165
00:05:41,909 --> 00:05:41,120
right so um you know the surface

166
00:05:44,790 --> 00:05:41,919
temperature

167
00:05:45,990 --> 00:05:44,800
is uh crazy hot you know it's it's one

168
00:05:48,469 --> 00:05:46,000
more planet close to

169
00:05:49,990 --> 00:05:48,479
closer to the sun and that would account

170
00:05:51,189 --> 00:05:50,000
for about you know 100 degrees

171
00:05:53,189 --> 00:05:51,199
fahrenheit

172
00:05:54,310 --> 00:05:53,199
difference in the temperature but in

173
00:05:56,790 --> 00:05:54,320
fact you know it's

174
00:05:58,629 --> 00:05:56,800
the surface temperature is uh 460

175
00:05:59,749 --> 00:05:58,639
celsius you know about 900 degrees

176
00:06:01,990 --> 00:05:59,759
fahrenheit

177
00:06:02,870 --> 00:06:02,000
so um you know it's the fact that it has

178
00:06:06,469 --> 00:06:02,880
this intense

179
00:06:09,909 --> 00:06:06,479
greenhouse atmosphere you know 97 co2

180
00:06:12,950 --> 00:06:09,919
that makes the surface so hot

181
00:06:15,350 --> 00:06:12,960
um and that incredibly dense atmosphere

182
00:06:16,870 --> 00:06:15,360
is about you know 90 bars almost 100

183
00:06:20,070 --> 00:06:16,880
times more dense

184
00:06:22,629 --> 00:06:20,080
than the earth's atmosphere so it's

185
00:06:24,150 --> 00:06:22,639
um like being half a mile under the

186
00:06:26,309 --> 00:06:24,160
ocean it's so

187
00:06:27,350 --> 00:06:26,319
uh that the atmosphere the air itself is

188
00:06:29,430 --> 00:06:27,360

so dense

189
00:06:31,510 --> 00:06:29,440
so this is the place where the runaway

190
00:06:34,309 --> 00:06:31,520
greenhouse was first discovered

191
00:06:36,230 --> 00:06:34,319
and you know this is where the uh the

192
00:06:39,590 --> 00:06:36,240
evil part comes from yeah the surface

193
00:06:45,350 --> 00:06:43,430
cool um i want to bring up our next

194
00:06:47,990 --> 00:06:45,360
image

195
00:06:49,430 --> 00:06:48,000
because we've talked about venus before

196
00:06:52,230 --> 00:06:49,440
at least in nasa's history

197
00:06:53,029 --> 00:06:52,240
um a big part of that uh we could see

198
00:06:55,029 --> 00:06:53,039
right here

199
00:06:56,870 --> 00:06:55,039
um but you've you've got a relationship

200
00:06:58,230 --> 00:06:56,880
with this mission also this is

201
00:06:59,830 --> 00:06:58,240
mariner 2 and it was the first

202
00:07:01,110 --> 00:06:59,840
successful mission to fly by another

203
00:07:03,990 --> 00:07:01,120
planet

204
00:07:04,550 --> 00:07:04,000
what's your connection with mariner 2

205
00:07:08,150 --> 00:07:04,560
well

206
00:07:08,790 --> 00:07:08,160
uh so mariner 2 was the first spacecraft

207
00:07:11,589 --> 00:07:08,800
that

208
00:07:13,189 --> 00:07:11,599
uh flew by another planet it just so

209
00:07:15,510 --> 00:07:13,199
happens that that was the uh you know

210
00:07:15,990 --> 00:07:15,520
not only the start of the space age but

211
00:07:19,589 --> 00:07:16,000
um

212
00:07:22,790 --> 00:07:20,710
so you've got a you've got a great

213
00:07:23,670 --> 00:07:22,800

connection and also the picture we saw

214
00:07:26,550 --> 00:07:23,680
earlier

215
00:07:28,150 --> 00:07:26,560
you were standing in front of venus

216
00:07:31,909 --> 00:07:28,160
pennsylvania right

217
00:07:33,909 --> 00:07:31,919
right right where my father was born

218
00:07:35,749 --> 00:07:33,919
so you've long been related to this

219
00:07:37,110 --> 00:07:35,759
planet um

220
00:07:38,390 --> 00:07:37,120
something you talked to me about when we

221
00:07:39,670 --> 00:07:38,400
were doing when we were getting ready

222
00:07:41,189 --> 00:07:39,680
for this

223
00:07:42,950 --> 00:07:41,199
there was a great analogy you had with

224
00:07:45,029 --> 00:07:42,960
mars and it kind of connects with

225
00:07:47,189 --> 00:07:45,039
with venus a little bit with these

226
00:07:48,869 --> 00:07:47,199
earlier missions

227
00:07:51,110 --> 00:07:48,879
and why maybe venus doesn't get talked

228
00:07:52,469 --> 00:07:51,120
about as much

229
00:07:54,950 --> 00:07:52,479
yeah i think there are a lot of

230
00:07:56,710 --> 00:07:54,960
parallels between venus exploration and

231
00:07:59,029 --> 00:07:56,720
mars exploration

232
00:08:00,790 --> 00:07:59,039
in the very uh start of the space age

233
00:08:03,830 --> 00:08:00,800
there were a ton of spacecrafts that

234
00:08:05,909 --> 00:08:03,840
explored uh venus um and

235
00:08:07,670 --> 00:08:05,919
with mars uh you know there was also a

236
00:08:10,869 --> 00:08:07,680
lot of interest in mars but

237
00:08:13,029 --> 00:08:10,879
um the first lander on another planetary

238
00:08:15,589 --> 00:08:13,039

surface was a viking lander

239
00:08:16,869 --> 00:08:15,599
and you know people were very excited to

240
00:08:18,629 --> 00:08:16,879
try to test and see

241
00:08:20,070 --> 00:08:18,639
if there could be microbial life in the

242
00:08:22,390 --> 00:08:20,080
soil of mars

243
00:08:23,990 --> 00:08:22,400
so that's what the viking lander was

244
00:08:26,469 --> 00:08:24,000
designed to do

245
00:08:28,390 --> 00:08:26,479
but the answer came back negative and so

246
00:08:31,830 --> 00:08:28,400
people were like meh

247
00:08:35,350 --> 00:08:31,840
mars is dead it's boring forget about it

248
00:08:37,430 --> 00:08:35,360
um and uh you know similarly uh

249
00:08:38,709 --> 00:08:37,440
the last spacecraft that explored the

250
00:08:41,829 --> 00:08:38,719
surface of venus

251
00:08:45,190 --> 00:08:41,839
uh was an orbiter from from nasa

252
00:08:46,790 --> 00:08:45,200
30 years ago and uh from that mission

253
00:08:48,710 --> 00:08:46,800
a lot of people concluded that that

254
00:08:51,750 --> 00:08:48,720
venus was geologically dead

255
00:08:54,710 --> 00:08:51,760
and so also not terribly interesting

256
00:08:56,070 --> 00:08:54,720
um but you know like with with the uh

257
00:08:58,949 --> 00:08:56,080
viking lander

258
00:09:00,790 --> 00:08:58,959
uh in that intervening decades uh you

259
00:09:03,110 --> 00:09:00,800
know that was back in the 70s

260
00:09:04,310 --> 00:09:03,120
um people realized that that test that

261
00:09:06,470 --> 00:09:04,320
they did for life

262
00:09:08,150 --> 00:09:06,480
wasn't the best approach to actually

263
00:09:10,790 --> 00:09:08,160

look for

264
00:09:11,829 --> 00:09:10,800
evidence of past life and so you know of

265
00:09:14,150 --> 00:09:11,839
course now we have this

266
00:09:15,430 --> 00:09:14,160
you know extremely robust mars program

267
00:09:17,190 --> 00:09:15,440
where they're sitting spacecraft or

268
00:09:19,350 --> 00:09:17,200
spacecraft and you know now we have

269
00:09:20,389 --> 00:09:19,360
the perseverance rover on its way to

270
00:09:22,310 --> 00:09:20,399
look for life

271
00:09:23,430 --> 00:09:22,320
because the science of looking for life

272
00:09:25,990 --> 00:09:23,440
has evolved

273
00:09:27,910 --> 00:09:26,000
and similarly for venus uh what we've

274
00:09:28,790 --> 00:09:27,920
learned in the last 30 years has given

275
00:09:31,190 --> 00:09:28,800
us a completely

276
00:09:31,829 --> 00:09:31,200
different perspective on venus you know

277
00:09:33,350 --> 00:09:31,839
we know

278
00:09:35,030 --> 00:09:33,360
we no longer think it's geologically

279
00:09:35,990 --> 00:09:35,040
dead we have good evidence to think it's

280
00:09:37,430 --> 00:09:36,000
active

281
00:09:39,269 --> 00:09:37,440
and you know we've learned a lot of

282
00:09:41,590 --> 00:09:39,279
other things about uh where

283
00:09:43,430 --> 00:09:41,600
interior um where volatiles come from

284
00:09:44,710 --> 00:09:43,440
which is mostly from the interior rather

285
00:09:45,910 --> 00:09:44,720
than from comets so

286
00:09:47,750 --> 00:09:45,920
we have a lot of reason to think there's

287
00:09:50,150 --> 00:09:47,760
still water in the inside and then it's

288
00:09:53,110 --> 00:09:50,160

geologically active

289
00:09:54,550 --> 00:09:53,120
it's very cool time to go back it's time

290
00:09:55,670 --> 00:09:54,560
to go back

291
00:09:57,110 --> 00:09:55,680
and i'm sure people already have

292
00:09:58,150 --> 00:09:57,120
questions about this so we're going to

293
00:09:59,990 --> 00:09:58,160
bring lindsay back

294
00:10:03,030 --> 00:10:00,000
in here and let's see what people are

295
00:10:05,269 --> 00:10:03,040
asking online

296
00:10:06,230 --> 00:10:05,279
absolutely so rohit on twitter would

297
00:10:08,150 --> 00:10:06,240
like to know

298
00:10:09,990 --> 00:10:08,160
how would a rover be powered on the

299
00:10:11,990 --> 00:10:10,000
surface of venus

300
00:10:13,910 --> 00:10:12,000
oh that's an excellent question yeah

301
00:10:14,310 --> 00:10:13,920
it's very challenging because of those

302
00:10:16,550 --> 00:10:14,320
um

303
00:10:17,350 --> 00:10:16,560
incredibly thick clouds and because it's

304
00:10:19,590 --> 00:10:17,360
super high

305
00:10:21,030 --> 00:10:19,600
surface temperature so a lot of things

306
00:10:23,910 --> 00:10:21,040
that we would normally use

307
00:10:25,110 --> 00:10:23,920
um just don't work so people have really

308
00:10:27,670 --> 00:10:25,120
been investigating that

309
00:10:28,790 --> 00:10:27,680
um and looking at things from you know

310
00:10:31,990 --> 00:10:28,800
very very low

311
00:10:34,389 --> 00:10:32,000
powered solar panels that would uh

312
00:10:35,110 --> 00:10:34,399
give kind of a triple charge and people

313
00:10:37,190 --> 00:10:35,120

even looked at

314
00:10:39,430 --> 00:10:37,200
uh you know wind power like uh flying

315
00:10:42,470 --> 00:10:39,440
flying literally like flying a kite

316
00:10:43,350 --> 00:10:42,480
from the the rover to try to generate

317
00:10:44,870 --> 00:10:43,360
power

318
00:10:46,790 --> 00:10:44,880
um and that there have been ideas to

319
00:10:50,150 --> 00:10:46,800
look at nuclear power

320
00:10:52,550 --> 00:10:50,160
as well but uh there's really

321
00:10:53,590 --> 00:10:52,560
that's very challenging at 900 degrees

322
00:10:56,310 --> 00:10:53,600
so it's

323
00:10:57,190 --> 00:10:56,320
it's tough to operate for a long time on

324
00:10:59,430 --> 00:10:57,200
the surface but

325
00:11:00,230 --> 00:10:59,440
it is being investigated and people are

326
00:11:02,310 --> 00:11:00,240
trying to

327
00:11:03,990 --> 00:11:02,320
move forward and come up with you know

328
00:11:05,990 --> 00:11:04,000
really innovative ways to

329
00:11:08,230 --> 00:11:06,000
make things last for a long time on the

330
00:11:11,430 --> 00:11:08,240
surface

331
00:11:12,310 --> 00:11:11,440
very cool what else we got lindsay yeah

332
00:11:15,190 --> 00:11:12,320
absolutely so

333
00:11:15,829 --> 00:11:15,200
mark on facebook asks is the high

334
00:11:17,750 --> 00:11:15,839
pressure

335
00:11:19,990 --> 00:11:17,760
of the atmosphere due to the extreme

336
00:11:23,509 --> 00:11:20,000
temperatures or is it because there's a

337
00:11:26,470 --> 00:11:23,519
lot of atmosphere pushing down on venus

338
00:11:27,269 --> 00:11:26,480

yeah so it's kind of both you know the

339
00:11:30,389 --> 00:11:27,279
atmosphere

340
00:11:32,630 --> 00:11:30,399
is uh it's not so much uh

341
00:11:33,509 --> 00:11:32,640
you know thicker than our own atmosphere

342
00:11:35,829 --> 00:11:33,519
but it's a lot more

343
00:11:36,870 --> 00:11:35,839
dense and uh the more dense an

344
00:11:38,069 --> 00:11:36,880
atmosphere is

345
00:11:40,310 --> 00:11:38,079
the hotter it's going to be at the

346
00:11:41,910 --> 00:11:40,320
surface so you know just like

347
00:11:43,590 --> 00:11:41,920
you know we just had a death valley be

348
00:11:46,470 --> 00:11:43,600
130 degrees

349
00:11:47,430 --> 00:11:46,480
uh and one of the reasons is the one of

350
00:11:51,750 --> 00:11:47,440
the hottest places

351
00:11:55,030 --> 00:11:51,760
of the planet is because it's so low

352
00:11:56,870 --> 00:11:55,040
so the higher pressure increases

353
00:12:04,389 --> 00:11:56,880
the the temperature as well so it's kind

354
00:12:09,750 --> 00:12:06,629
cool lindsay i think we got time for one

355
00:12:12,150 --> 00:12:09,760
more question before we move on

356
00:12:16,470 --> 00:12:12,160
a mall on facebook asks what is the

357
00:12:19,670 --> 00:12:16,480
reason behind the acid rain on venus

358
00:12:23,030 --> 00:12:19,680
um well the clouds and venus are

359
00:12:25,350 --> 00:12:23,040
largely sulfuric acid and

360
00:12:26,949 --> 00:12:25,360
you know the sulfur in the atmosphere we

361
00:12:29,990 --> 00:12:26,959
think uh comes from

362
00:12:32,230 --> 00:12:30,000
uh volcanoes so uh that's

363
00:12:33,829 --> 00:12:32,240

one of the key components of the

364
00:12:36,230 --> 00:12:33,839
atmospheric composition

365
00:12:37,269 --> 00:12:36,240
and uh at that pressure and temperature

366
00:12:39,430 --> 00:12:37,279
that you get

367
00:12:41,110 --> 00:12:39,440
uh on venus that's the uh one of the

368
00:12:44,230 --> 00:12:41,120
dominant parts of the cloud

369
00:12:47,750 --> 00:12:44,240
composition there is some water as well

370
00:12:49,829 --> 00:12:47,760
and you know the the the temperature the

371
00:12:50,949 --> 00:12:49,839
volcanic outgassing everything is just

372
00:12:55,030 --> 00:12:50,959
right to

373
00:12:58,389 --> 00:12:56,790
it does actually go to the surface

374
00:13:00,069 --> 00:12:58,399
because the surface is so hot it does it

375
00:13:01,910 --> 00:13:00,079
just kind of falls but it evaporates

376
00:13:04,710 --> 00:13:01,920
before it hits the ground

377
00:13:06,069 --> 00:13:04,720
sorry well no that's that's that's

378
00:13:09,910 --> 00:13:06,079
interesting and that's actually

379
00:13:10,710 --> 00:13:09,920
a good segue um because if venus is like

380
00:13:12,550 --> 00:13:10,720
earth

381
00:13:13,910 --> 00:13:12,560
what are these smaller similarities that

382
00:13:15,190 --> 00:13:13,920
you would want to study and a lot of

383
00:13:16,389 --> 00:13:15,200
good questions we've talked about rain

384
00:13:18,310 --> 00:13:16,399
doesn't but

385
00:13:20,150 --> 00:13:18,320
what are these connections and things

386
00:13:23,190 --> 00:13:20,160
that we actually can

387
00:13:26,949 --> 00:13:23,200
look at and learn about yeah so

388
00:13:29,430 --> 00:13:26,959

um you know the surface is you know

389
00:13:30,069 --> 00:13:29,440
very interesting of course um but it's

390
00:13:32,389 --> 00:13:30,079
it's only

391
00:13:33,990 --> 00:13:32,399
uh perhaps relatively recently that it's

392
00:13:37,110 --> 00:13:34,000
got it it's attained this

393
00:13:39,030 --> 00:13:37,120
uh you know super intense greenhouse and

394
00:13:42,150 --> 00:13:39,040
uh it's superficial right

395
00:13:43,509 --> 00:13:42,160
atmospheres uh can change but the the

396
00:13:45,910 --> 00:13:43,519
surface of the planet

397
00:13:47,430 --> 00:13:45,920
is where we really get to the you know

398
00:13:49,189 --> 00:13:47,440
incredible um

399
00:13:50,710 --> 00:13:49,199
analogies with things going on on the

400
00:13:52,790 --> 00:13:50,720
earth

401
00:13:54,310 --> 00:13:52,800
you know like i said it's similar bulk

402
00:13:55,910 --> 00:13:54,320
composition similar size

403
00:13:59,110 --> 00:13:55,920
and so that really means it has a

404
00:14:02,069 --> 00:13:59,120
similar engine if you will to drive

405
00:14:02,870 --> 00:14:02,079
activity on the planet and in the

406
00:14:06,310 --> 00:14:02,880
interior and

407
00:14:09,670 --> 00:14:06,320
and in the atmosphere so um you know on

408
00:14:10,870 --> 00:14:09,680
on earth and any rocky body you have a

409
00:14:13,110 --> 00:14:10,880
ton of heat it's like

410
00:14:14,310 --> 00:14:13,120
it's like i said an engine um there's

411
00:14:17,350 --> 00:14:14,320
radiator heat

412
00:14:20,389 --> 00:14:17,360
there's heat from cooling and on earth

413
00:14:22,230 --> 00:14:20,399

the system of plate tectonics is what

414
00:14:23,030 --> 00:14:22,240
happens at the surface to let that heat

415
00:14:24,790 --> 00:14:23,040
come out

416
00:14:26,230 --> 00:14:24,800
you know uh on continents we have all

417
00:14:28,470 --> 00:14:26,240
these plate boundaries you know

418
00:14:31,110 --> 00:14:28,480
mountains collide where plates collide

419
00:14:32,550 --> 00:14:31,120
uh san andreas slips past each other

420
00:14:35,350 --> 00:14:32,560
very close to here

421
00:14:36,949 --> 00:14:35,360
um and uh then there are plates that uh

422
00:14:39,750 --> 00:14:36,959
sink into the mantle you know they

423
00:14:40,310 --> 00:14:39,760
one plate subducts underneath the other

424
00:14:42,790 --> 00:14:40,320
um

425
00:14:44,629 --> 00:14:42,800
and this system of plate tectonics is

426
00:14:46,870 --> 00:14:44,639
you know just

427
00:14:48,150 --> 00:14:46,880
the the primary force that shapes the

428
00:14:50,470 --> 00:14:48,160
surface of our planet

429
00:14:52,710 --> 00:14:50,480
it's had a huge impact on the overall

430
00:14:55,030 --> 00:14:52,720
climate evolution and and maybe even the

431
00:14:56,870 --> 00:14:55,040
habitability of earth

432
00:14:58,550 --> 00:14:56,880
and you know before we had this the

433
00:14:58,949 --> 00:14:58,560
spacecraft magellan everyone thought

434
00:15:00,949 --> 00:14:58,959
that

435
00:15:02,310 --> 00:15:00,959
venus would have played tectonics but it

436
00:15:03,430 --> 00:15:02,320
turns out it doesn't seem to have plate

437
00:15:06,629 --> 00:15:03,440
tectonics

438
00:15:10,710 --> 00:15:06,639

although it seems to have the conditions

439
00:15:12,310 --> 00:15:10,720
which we think lead to plate tectonics

440
00:15:13,990 --> 00:15:12,320
so in particular we think it we think it

441
00:15:15,509 --> 00:15:14,000
has this process subduction

442
00:15:17,750 --> 00:15:15,519
and it and it's super interesting

443
00:15:19,670 --> 00:15:17,760
because that early

444
00:15:21,350 --> 00:15:19,680
early in earth's evolution this whole

445
00:15:23,030 --> 00:15:21,360
system got set up and

446
00:15:25,030 --> 00:15:23,040
uh you know billions of years ago on

447
00:15:27,269 --> 00:15:25,040
earth the lithosphere was hotter that

448
00:15:30,949 --> 00:15:27,279
outer part was hotter

449
00:15:33,350 --> 00:15:30,959
and that makes it potentially easier to

450
00:15:35,269 --> 00:15:33,360
start this whole process

451
00:15:36,710 --> 00:15:35,279
we think that's maybe going on on venus

452
00:15:40,550 --> 00:15:36,720
today

453
00:15:42,150 --> 00:15:40,560
but you know we have so many questions

454
00:15:42,949 --> 00:15:42,160
about how it actually begins for the

455
00:15:47,110 --> 00:15:42,959
earth

456
00:15:47,910 --> 00:15:47,120
happened billions of years ago and we

457
00:15:51,269 --> 00:15:47,920
have very little

458
00:15:53,509 --> 00:15:51,279
evidence you know concrete

459
00:15:55,350 --> 00:15:53,519
rocks data from that time period so

460
00:15:56,790 --> 00:15:55,360
venus is a place we can go and

461
00:15:58,949 --> 00:15:56,800
potentially learn about the very early

462
00:16:02,310 --> 00:15:58,959
evolution of the earth

463
00:16:04,069 --> 00:16:02,320

that's fantastic to have and it's right

464
00:16:06,310 --> 00:16:04,079
there it's right next door

465
00:16:07,350 --> 00:16:06,320
um well something i do want to talk

466
00:16:10,389 --> 00:16:07,360
about so

467
00:16:12,470 --> 00:16:10,399
there's plate tectonics there's the

468
00:16:13,749 --> 00:16:12,480
not yet but we're the subduction is

469
00:16:16,389 --> 00:16:13,759
there or the

470
00:16:17,350 --> 00:16:16,399
theory of subduction is there um but

471
00:16:21,509 --> 00:16:17,360
let's talk about

472
00:16:22,310 --> 00:16:21,519
if actually if we go to the video number

473
00:16:23,829 --> 00:16:22,320
seven

474
00:16:25,749 --> 00:16:23,839
um that gives us a good look at some of

475
00:16:27,910 --> 00:16:25,759
this too sure yeah

476
00:16:29,590 --> 00:16:27,920
so this is some data from magellan and

477
00:16:32,470 --> 00:16:29,600
you're seeing topography

478
00:16:33,990 --> 00:16:32,480
and uh just giving it the volcanic shape

479
00:16:37,110 --> 00:16:34,000
and you're seeing um

480
00:16:39,189 --> 00:16:37,120
the bright zones are uh rough lava flow

481
00:16:39,829 --> 00:16:39,199
so it's it's reflecting the radar waves

482
00:16:41,430 --> 00:16:39,839
back

483
00:16:43,189 --> 00:16:41,440
uh so this is one of the prominent

484
00:16:44,470 --> 00:16:43,199
volcanoes and we think it's been

485
00:16:46,550 --> 00:16:44,480
recently active

486
00:16:48,389 --> 00:16:46,560
this um color data that you're seeing

487
00:16:50,790 --> 00:16:48,399
now uh the red

488
00:16:52,230 --> 00:16:50,800

red and hot colors are areas where we

489
00:16:55,189 --> 00:16:52,240
think there has been

490
00:16:55,749 --> 00:16:55,199
relatively recent volcanism from looking

491
00:16:59,189 --> 00:16:55,759
at the

492
00:17:00,389 --> 00:16:59,199
the first order changes in the surface

493
00:17:02,710 --> 00:17:00,399
composition we think

494
00:17:04,069 --> 00:17:02,720
that that lava erupted relatively

495
00:17:05,750 --> 00:17:04,079
recently and hasn't really

496
00:17:07,350 --> 00:17:05,760
changed its composition to interact with

497
00:17:09,990 --> 00:17:07,360
the atmosphere yet so

498
00:17:10,710 --> 00:17:10,000
it's you know one of the the you know

499
00:17:12,150 --> 00:17:10,720
handful of

500
00:17:14,309 --> 00:17:12,160
volcanoes that was covered with this

501
00:17:16,069 --> 00:17:14,319
data and we think there are many more

502
00:17:18,630 --> 00:17:16,079
volcanoes like this uh that could be

503
00:17:22,789 --> 00:17:18,640
active on the surface

504
00:17:25,029 --> 00:17:22,799
um if we go to image 11 actually

505
00:17:26,230 --> 00:17:25,039
we could we've got a bunch of other

506
00:17:27,990 --> 00:17:26,240
great um

507
00:17:29,990 --> 00:17:28,000
images from this and how how do we how

508
00:17:30,310 --> 00:17:30,000
did magellan really get these how did we

509
00:17:33,669 --> 00:17:30,320
get

510
00:17:36,789 --> 00:17:33,679
what we're looking at here yeah so um

511
00:17:37,590 --> 00:17:36,799
you know venus has got this dense cloud

512
00:17:40,870 --> 00:17:37,600
layer

513
00:17:43,990 --> 00:17:40,880

so we have to use radar to

514
00:17:45,110 --> 00:17:44,000
transmit those long wavelength signals

515
00:17:48,150 --> 00:17:45,120
to the surface

516
00:17:49,270 --> 00:17:48,160
those radar waves bounce back and so the

517
00:17:50,150 --> 00:17:49,280
areas that you're looking at here that

518
00:17:52,870 --> 00:17:50,160
are bright

519
00:17:53,990 --> 00:17:52,880
those are rough surfaces uh you know

520
00:17:58,470 --> 00:17:54,000
like a

521
00:18:01,190 --> 00:17:58,480
ever seen uh

522
00:18:02,710 --> 00:18:01,200
you know images of very rough lava flows

523
00:18:04,950 --> 00:18:02,720
in hawaii these are these are really

524
00:18:07,590 --> 00:18:04,960
rough lava flows that have the bright

525
00:18:09,669 --> 00:18:07,600
uh reflections in radar but there's just

526
00:18:11,430 --> 00:18:09,679
all kinds of crazy uh volcanic

527
00:18:13,430 --> 00:18:11,440
features all over the surface of venus

528
00:18:15,270 --> 00:18:13,440
you know like this volcano

529
00:18:17,990 --> 00:18:15,280
on the right it's it's like nine

530
00:18:22,470 --> 00:18:18,000
kilometers tall so like five miles tall

531
00:18:27,590 --> 00:18:25,990
that's um i know there's going to be

532
00:18:28,870 --> 00:18:27,600
some good questions about the volcanism

533
00:18:31,110 --> 00:18:28,880
there usually is

534
00:18:32,630 --> 00:18:31,120
from particular students out there but i

535
00:18:33,110 --> 00:18:32,640
want to actually take another look at

536
00:18:35,350 --> 00:18:33,120
image

537
00:18:36,789 --> 00:18:35,360
10 actually and come back to subduction

538
00:18:38,150 --> 00:18:36,799

which you were talking about before but

539
00:18:44,230 --> 00:18:38,160
this is an artist image

540
00:18:45,510 --> 00:18:44,240
based on actual data for venus but it is

541
00:18:49,029 --> 00:18:45,520
an artist image

542
00:18:52,150 --> 00:18:49,039
and um you can see that kind of a curved

543
00:18:55,669 --> 00:18:52,160
uh trough in the foreground and uh

544
00:18:57,270 --> 00:18:55,679
with the volcano in the center and

545
00:18:59,110 --> 00:18:57,280
you know we think this is how uh

546
00:18:59,669 --> 00:18:59,120
subduction actually starts where you

547
00:19:01,830 --> 00:18:59,679
have

548
00:19:03,350 --> 00:19:01,840
hot material coming up in a plume from

549
00:19:04,390 --> 00:19:03,360
inside the planet just like we have in

550
00:19:06,950 --> 00:19:04,400
hawaii which

551
00:19:07,750 --> 00:19:06,960
uh pushes the topography up and it can

552
00:19:10,150 --> 00:19:07,760
break through

553
00:19:11,669 --> 00:19:10,160
that that strong outer lithosphere the

554
00:19:14,390 --> 00:19:11,679
volcanism that forms

555
00:19:15,270 --> 00:19:14,400
can um push that broken lithosphere

556
00:19:17,110 --> 00:19:15,280
downward

557
00:19:18,870 --> 00:19:17,120
so what you're seeing there is that the

558
00:19:20,549 --> 00:19:18,880
um volcanism is

559
00:19:23,029 --> 00:19:20,559
creating the subduction and it's just

560
00:19:25,750 --> 00:19:23,039
philosophy has just started to fold down

561
00:19:28,070 --> 00:19:25,760
into that trough and the volcanoes are

562
00:19:30,070 --> 00:19:28,080
continuing to form new crust there

563
00:19:32,230 --> 00:19:30,080

that that's our interpretation and uh

564
00:19:35,430 --> 00:19:32,240
it's depicted very dramatically here in

565
00:19:37,750 --> 00:19:35,440
this in this artist's conception

566
00:19:39,510 --> 00:19:37,760
very cool um it seems like we do have a

567
00:19:40,789 --> 00:19:39,520
volcano question that we'll bring in

568
00:19:42,630 --> 00:19:40,799
from online

569
00:19:45,510 --> 00:19:42,640
and then we'll talk about a mission

570
00:19:49,190 --> 00:19:45,520
that's close to your heart

571
00:19:51,110 --> 00:19:49,200
lindsay yep so laney on

572
00:19:52,789 --> 00:19:51,120
facebook is curious to know can

573
00:19:55,029 --> 00:19:52,799
scientists or engineers

574
00:19:56,710 --> 00:19:55,039
learn anything from the earth geologists

575
00:19:58,549 --> 00:19:56,720
who study volcanoes

576
00:20:03,350 --> 00:19:58,559
on ways to manage science through

577
00:20:09,910 --> 00:20:07,350
well we can certainly learn a lot about

578
00:20:11,430 --> 00:20:09,920
processes on earth from um

579
00:20:14,149 --> 00:20:11,440
[Music]

580
00:20:15,029 --> 00:20:14,159
you know from both studying venus and

581
00:20:18,070 --> 00:20:15,039
studying earth

582
00:20:21,350 --> 00:20:18,080
now in terms of the extreme temperature

583
00:20:23,350 --> 00:20:21,360
sure you know there are um lots of

584
00:20:25,270 --> 00:20:23,360
uh engineering applications on the earth

585
00:20:27,029 --> 00:20:25,280
for um

586
00:20:29,029 --> 00:20:27,039
devices that have to work at very high

587
00:20:32,230 --> 00:20:29,039
temperature uh you know where we

588
00:20:34,390 --> 00:20:32,240

are uh trying to apply uh lessons that

589
00:20:35,750 --> 00:20:34,400
people are developing for very high

590
00:20:36,310 --> 00:20:35,760
temperature electronics you know to

591
00:20:39,029 --> 00:20:36,320
perhaps

592
00:20:40,470 --> 00:20:39,039
operate um sensors inside a nuclear

593
00:20:42,630 --> 00:20:40,480
reactor for example

594
00:20:43,990 --> 00:20:42,640
to uh take that kind of technology to

595
00:20:46,950 --> 00:20:44,000
the surface of the earth

596
00:20:48,310 --> 00:20:46,960
uh surface of venus rather and also you

597
00:20:51,510 --> 00:20:48,320
know people uh

598
00:20:53,029 --> 00:20:51,520
use devices that go down um inside our

599
00:20:56,310 --> 00:20:53,039
planet that drill holes

600
00:20:57,190 --> 00:20:56,320
to um look at uh how much heat's coming

601
00:20:59,909 --> 00:20:57,200
out of our planet

602
00:21:00,470 --> 00:20:59,919
or to you know look for oil or you know

603
00:21:02,070 --> 00:21:00,480
there are a lot of

604
00:21:04,070 --> 00:21:02,080
reasons that people drill into the in

605
00:21:07,029 --> 00:21:04,080
into the earth and so those are also

606
00:21:07,750 --> 00:21:07,039
um engineering approaches that we take

607
00:21:11,270 --> 00:21:07,760
from earth

608
00:21:12,870 --> 00:21:11,280
to venus uh but also it we have learned

609
00:21:15,830 --> 00:21:12,880
a lot of different things

610
00:21:16,470 --> 00:21:15,840
about volcanic processes uh you know for

611
00:21:17,990 --> 00:21:16,480
example

612
00:21:20,310 --> 00:21:18,000
um you know we want to know what's

613
00:21:22,390 --> 00:21:20,320

coming out of the volcanic gases

614
00:21:24,149 --> 00:21:22,400
and people who are studying the

615
00:21:26,070 --> 00:21:24,159
atmosphere of venus

616
00:21:27,909 --> 00:21:26,080
were actually the ones that discovered

617
00:21:30,630 --> 00:21:27,919
the ozone hole on the earth

618
00:21:32,870 --> 00:21:30,640
because they were looking for uh similar

619
00:21:34,710 --> 00:21:32,880
kinds of chemical processes

620
00:21:36,549 --> 00:21:34,720
uh in the in the atmosphere of the earth

621
00:21:38,789 --> 00:21:36,559
so you know there are

622
00:21:40,070 --> 00:21:38,799
both scientific and engineering lessons

623
00:21:43,590 --> 00:21:40,080
that both planets have

624
00:21:43,600 --> 00:21:46,950
very cool

625
00:21:51,110 --> 00:21:49,510
i think there's one more uh volcano

626
00:21:53,110 --> 00:21:51,120
question and then we'll get on to we'll

627
00:21:55,990 --> 00:21:53,120
talk about that mission

628
00:21:58,390 --> 00:21:56,000
cool yeah sue folks are really excited

629
00:21:59,590 --> 00:21:58,400
about the volcano so cali on facebook

630
00:22:01,750 --> 00:21:59,600
wants to know

631
00:22:04,310 --> 00:22:01,760
how are there volcanoes without plate

632
00:22:07,110 --> 00:22:04,320
tectonics

633
00:22:08,630 --> 00:22:07,120
yeah well um it's true that a lot of the

634
00:22:11,830 --> 00:22:08,640
volcanoes on the earth

635
00:22:13,270 --> 00:22:11,840
are a result of plate tectonics

636
00:22:14,710 --> 00:22:13,280
in particular subduction you know like

637
00:22:16,070 --> 00:22:14,720
the ring of fire that you hear about

638
00:22:18,390 --> 00:22:16,080

around the pacific where there's all

639
00:22:21,350 --> 00:22:18,400
those giant volcanoes that edge

640
00:22:22,310 --> 00:22:21,360
uh the the pacific ocean well most of

641
00:22:25,110 --> 00:22:22,320
those are actually

642
00:22:26,470 --> 00:22:25,120
a result of subduction and um you know

643
00:22:27,669 --> 00:22:26,480
that's where so one plate is being

644
00:22:28,870 --> 00:22:27,679
pushed underneath the other and when

645
00:22:31,510 --> 00:22:28,880
that down going plate

646
00:22:31,909 --> 00:22:31,520
melts those volcanoes are created and

647
00:22:33,270 --> 00:22:31,919
that's

648
00:22:34,950 --> 00:22:33,280
basically that process that we're

649
00:22:35,669 --> 00:22:34,960
looking at in that in that previous

650
00:22:37,590 --> 00:22:35,679
image

651
00:22:39,270 --> 00:22:37,600
so you know maybe maybe at least a few

652
00:22:42,630 --> 00:22:39,280
of the volcanoes on

653
00:22:44,070 --> 00:22:42,640
venus may be related to subduction but

654
00:22:46,630 --> 00:22:44,080
in addition there are other kinds of

655
00:22:49,430 --> 00:22:46,640
volcanoes like iceland like

656
00:22:50,390 --> 00:22:49,440
like hawaii and those are formed when

657
00:22:52,710 --> 00:22:50,400
there's hot material

658
00:22:53,669 --> 00:22:52,720
rising up from the core metal boundary

659
00:22:55,510 --> 00:22:53,679
and uh

660
00:22:57,110 --> 00:22:55,520
creating volcanism at the surface so

661
00:22:59,190 --> 00:22:57,120
even though a lot of volcanoes

662
00:23:00,950 --> 00:22:59,200
um on earth are related to plant

663
00:23:02,710 --> 00:23:00,960

tectonics we do have even on earth we

664
00:23:05,510 --> 00:23:02,720
have volcanoes that are not

665
00:23:06,470 --> 00:23:05,520
directly related to plate tectonics and

666
00:23:08,390 --> 00:23:06,480
basically you just have to have

667
00:23:10,390 --> 00:23:08,400
mantle that's hot enough to melt which

668
00:23:10,789 --> 00:23:10,400
uh you know could be the case for venus

669
00:23:14,870 --> 00:23:10,799
which

670
00:23:17,909 --> 00:23:14,880
can allow volcanism as well very cool

671
00:23:19,270 --> 00:23:17,919
um we you've

672
00:23:20,390 --> 00:23:19,280
asked all these great questions and

673
00:23:22,310 --> 00:23:20,400
talking about all these wonderful things

674
00:23:23,830 --> 00:23:22,320
that we can study

675
00:23:25,750 --> 00:23:23,840
i imagine there are some questions right

676
00:23:29,430 --> 00:23:25,760
now are we gonna go

677
00:23:29,990 --> 00:23:29,440
study venus at any point uh i certainly

678
00:23:32,149 --> 00:23:30,000
hope so

679
00:23:33,590 --> 00:23:32,159
yeah there's uh you know a lot of

680
00:23:36,149 --> 00:23:33,600
different venus missions

681
00:23:36,870 --> 00:23:36,159
are in competition to try to go back to

682
00:23:40,149 --> 00:23:36,880
venus

683
00:23:40,789 --> 00:23:40,159
the next you know to to get launched say

684
00:23:43,669 --> 00:23:40,799
in the next

685
00:23:45,510 --> 00:23:43,679
five or six years uh you know in the us

686
00:23:47,510 --> 00:23:45,520
in europe and other countries or

687
00:23:48,789 --> 00:23:47,520
a lot of people a lot of space fairing

688
00:23:51,190 --> 00:23:48,799

nations are interested in going back to

689
00:23:53,110 --> 00:23:51,200
venus suddenly

690
00:23:55,110 --> 00:23:53,120
and the other one that's closest to my

691
00:23:56,230 --> 00:23:55,120
heart is one that we've been working on

692
00:23:58,310 --> 00:23:56,240
for some time now

693
00:24:00,310 --> 00:23:58,320
designed to answer some of the really

694
00:24:03,110 --> 00:24:00,320
fundamental questions about venus

695
00:24:04,950 --> 00:24:03,120
you know about what processes are active

696
00:24:06,789 --> 00:24:04,960
while volcanoes are active what

697
00:24:08,789 --> 00:24:06,799
can we see active faulting on the

698
00:24:10,870 --> 00:24:08,799
surface you know is there still

699
00:24:13,350 --> 00:24:10,880
water inside the planet that's that's

700
00:24:15,269 --> 00:24:13,360
being released by a volcano so

701
00:24:17,990 --> 00:24:15,279
lots of you know fundamental questions

702
00:24:19,750 --> 00:24:18,000
we'd like to answer about venus

703
00:24:21,110 --> 00:24:19,760
and that mission is called if we go to

704
00:24:22,470 --> 00:24:21,120
image number 12

705
00:24:24,549 --> 00:24:22,480
you could take a good look at it right

706
00:24:27,909 --> 00:24:24,559
here called veritas right

707
00:24:28,230 --> 00:24:27,919
truth yeah yeah yeah it's a long acronym

708
00:24:31,830 --> 00:24:28,240
but

709
00:24:32,310 --> 00:24:31,840
um yeah it's designed to study the

710
00:24:34,870 --> 00:24:32,320
surface

711
00:24:36,390 --> 00:24:34,880
using radar we would get like you know

712
00:24:38,870 --> 00:24:36,400
orders of magnitude better to

713
00:24:40,710 --> 00:24:38,880

resolution topography and radar imaging

714
00:24:43,430 --> 00:24:40,720
than we've had in the past

715
00:24:44,470 --> 00:24:43,440
and uh you know we're trying to

716
00:24:46,870 --> 00:24:44,480
understand

717
00:24:47,830 --> 00:24:46,880
you know how this big hot planet like

718
00:24:49,830 --> 00:24:47,840
venus can

719
00:24:51,430 --> 00:24:49,840
can uh operate if it doesn't have plate

720
00:24:53,990 --> 00:24:51,440
tectonics does it have some other

721
00:24:54,630 --> 00:24:54,000
system that we we uh you know don't have

722
00:24:56,950 --> 00:24:54,640
the data to

723
00:24:59,029 --> 00:24:56,960
to actually understand at this point you

724
00:24:59,990 --> 00:24:59,039
know we've gone back to mars uh you know

725
00:25:02,310 --> 00:25:00,000
time and again with

726
00:25:03,510 --> 00:25:02,320
like better and better resolution data

727
00:25:05,750 --> 00:25:03,520
and every time we

728
00:25:06,789 --> 00:25:05,760
we go back with better resolution we see

729
00:25:09,669 --> 00:25:06,799
processes that we

730
00:25:10,710 --> 00:25:09,679
just didn't anticipate and so you know i

731
00:25:12,549 --> 00:25:10,720
have a whole

732
00:25:14,630 --> 00:25:12,559
you know suite of ideas that i think

733
00:25:15,350 --> 00:25:14,640
will uh you know processes i think we'll

734
00:25:17,909 --> 00:25:15,360
see things

735
00:25:19,750 --> 00:25:17,919
that we questions that we want to answer

736
00:25:21,669 --> 00:25:19,760
um but you know

737
00:25:22,950 --> 00:25:21,679
when you get like just incredibly better

738
00:25:24,470 --> 00:25:22,960

data you're

739
00:25:26,070 --> 00:25:24,480
likely to just find things you never

740
00:25:27,909 --> 00:25:26,080
even imagined so

741
00:25:29,830 --> 00:25:27,919
you know we'll do things like look for

742
00:25:33,110 --> 00:25:29,840
um chemical fingerprints

743
00:25:33,830 --> 00:25:33,120
of water in rocks you know we like as i

744
00:25:36,870 --> 00:25:33,840
said we don't know

745
00:25:39,750 --> 00:25:36,880
how long ago that ocean uh was

746
00:25:40,470 --> 00:25:39,760
uh you know boiled off essentially but

747
00:25:42,230 --> 00:25:40,480
we think we could

748
00:25:43,750 --> 00:25:42,240
have the ability to see with a

749
00:25:44,870 --> 00:25:43,760
spectrometer that sees through these

750
00:25:46,470 --> 00:25:44,880
clouds

751
00:25:48,230 --> 00:25:46,480
the fingerprint of past water so that's

752
00:25:51,110 --> 00:25:48,240
that's a really big question

753
00:25:53,029 --> 00:25:51,120
and just understanding how overall that

754
00:25:54,870 --> 00:25:53,039
geology and venus works we

755
00:25:56,870 --> 00:25:54,880
really don't have the resolution right

756
00:25:59,269 --> 00:25:56,880
now to understand that the planet as a

757
00:26:05,029 --> 00:26:02,310
the fingerprint of past that's a great

758
00:26:06,470 --> 00:26:05,039
sentiment right there um in just a

759
00:26:10,390 --> 00:26:06,480
second we're going to open it up

760
00:26:12,070 --> 00:26:10,400
to to get some more questions in but i i

761
00:26:14,789 --> 00:26:12,080
do want to give you one moment because

762
00:26:17,510 --> 00:26:14,799
this is your favorite planet um one last

763
00:26:20,390 --> 00:26:17,520

kind of moment of

764
00:26:21,350 --> 00:26:20,400
of what is it that you love about it why

765
00:26:27,190 --> 00:26:21,360
why

766
00:26:29,510 --> 00:26:27,200
you know i've continued to study venus

767
00:26:31,750 --> 00:26:29,520
for decades uh despite the lack of data

768
00:26:32,789 --> 00:26:31,760
and that's because it is such an

769
00:26:35,510 --> 00:26:32,799
incredible

770
00:26:36,310 --> 00:26:35,520
laboratory for understanding our home

771
00:26:40,070 --> 00:26:36,320
planet

772
00:26:41,029 --> 00:26:40,080
really understanding the evolution of

773
00:26:43,190 --> 00:26:41,039
planets

774
00:26:44,789 --> 00:26:43,200
um you know as we've learned more and

775
00:26:46,710 --> 00:26:44,799
more about the earth

776
00:26:47,830 --> 00:26:46,720
uh you know all those lessons we can

777
00:26:49,510 --> 00:26:47,840
take and

778
00:26:51,350 --> 00:26:49,520
uh put in the context of venus to

779
00:26:55,190 --> 00:26:51,360
understand how it formed

780
00:26:57,269 --> 00:26:55,200
you know for example um uh

781
00:26:59,110 --> 00:26:57,279
30 years ago we thought that most of a

782
00:27:01,750 --> 00:26:59,120
planet's water

783
00:27:02,789 --> 00:27:01,760
comes from comets that come into the

784
00:27:04,470 --> 00:27:02,799
planet late

785
00:27:06,710 --> 00:27:04,480
and what we've learned since then is

786
00:27:10,789 --> 00:27:06,720
that most reverse water

787
00:27:13,110 --> 00:27:10,799
actually um is a result of the original

788
00:27:15,190 --> 00:27:13,120

you know rocky butt bits of planet the

789
00:27:17,029 --> 00:27:15,200
planetesimals that it formed from

790
00:27:18,310 --> 00:27:17,039
and that it's the process of volcanism

791
00:27:20,710 --> 00:27:18,320
that primarily

792
00:27:22,310 --> 00:27:20,720
releases that water from the interior to

793
00:27:23,110 --> 00:27:22,320
form our atmosphere and to form our

794
00:27:24,630 --> 00:27:23,120
oceans

795
00:27:26,950 --> 00:27:24,640
and you know we think that venus may

796
00:27:27,990 --> 00:27:26,960
have actually more water still locked in

797
00:27:30,630 --> 00:27:28,000
the interior

798
00:27:32,630 --> 00:27:30,640
than the earth so you know as we learn

799
00:27:34,549 --> 00:27:32,640
more about our solar system

800
00:27:36,149 --> 00:27:34,559
how rocky planets evolve uh you know

801
00:27:38,310 --> 00:27:36,159
have this chance to

802
00:27:39,909 --> 00:27:38,320
use venus you know earth's twin as a

803
00:27:41,830 --> 00:27:39,919
laboratory to understand

804
00:27:44,149 --> 00:27:41,840
uh overall how processes work you know

805
00:27:45,909 --> 00:27:44,159
we know so much about the earth how much

806
00:27:47,590 --> 00:27:45,919
how the geology works here but it's only

807
00:27:47,990 --> 00:27:47,600
one planet you know and we have this

808
00:27:51,990 --> 00:27:48,000
chance

809
00:27:53,110 --> 00:27:52,000
to uh study a a planet that's almost the

810
00:27:54,710 --> 00:27:53,120
same size

811
00:27:56,950 --> 00:27:54,720
uh should have a lot of activity and

812
00:27:58,870 --> 00:27:56,960
obvious has a very young surface

813
00:28:00,710 --> 00:27:58,880

compared to like mars and mercury and so

814
00:28:02,149 --> 00:28:00,720
forth you know those those planetary

815
00:28:03,110 --> 00:28:02,159
surfaces are billions and billions of

816
00:28:06,070 --> 00:28:03,120
years old

817
00:28:06,389 --> 00:28:06,080
um venus is less than a billion years

818
00:28:08,389 --> 00:28:06,399
old

819
00:28:10,149 --> 00:28:08,399
and in some ways very comparable to the

820
00:28:11,990 --> 00:28:10,159
earth and you know the other the other

821
00:28:14,310 --> 00:28:12,000
great thing about it that makes it a you

822
00:28:16,149 --> 00:28:14,320
know a geologist's dream planet is that

823
00:28:18,389 --> 00:28:16,159
there's hardly any erosion

824
00:28:19,269 --> 00:28:18,399
um there's you know today there's no

825
00:28:22,149 --> 00:28:19,279
water

826
00:28:23,909 --> 00:28:22,159
um that dense atmosphere doesn't erode

827
00:28:25,430 --> 00:28:23,919
the rock very rapidly

828
00:28:27,110 --> 00:28:25,440
uh you know on earth most of the erosion

829
00:28:29,990 --> 00:28:27,120
occurs from water and so

830
00:28:30,630 --> 00:28:30,000
you know tons of processes get buried by

831
00:28:32,789 --> 00:28:30,640
uh

832
00:28:33,990 --> 00:28:32,799
the by erosion by sediments being

833
00:28:35,830 --> 00:28:34,000
deposited on it so

834
00:28:37,350 --> 00:28:35,840
you know the surface that we look at on

835
00:28:39,110 --> 00:28:37,360
on the earth for the most part it's not

836
00:28:41,430 --> 00:28:39,120
the primary surface that

837
00:28:42,630 --> 00:28:41,440
was created uh in the original geology

838
00:28:44,870 --> 00:28:42,640

on venus it's

839
00:28:46,149 --> 00:28:44,880
you know the original geology is sitting

840
00:28:47,909 --> 00:28:46,159
right there at the surface

841
00:28:49,190 --> 00:28:47,919
so we have a chance to uh you know look

842
00:28:51,590 --> 00:28:49,200
at that processes like

843
00:28:52,950 --> 00:28:51,600
you know like i work with um a uh

844
00:28:54,230 --> 00:28:52,960
terrestrial geologist who studies

845
00:28:56,230 --> 00:28:54,240
subduction zones

846
00:28:57,990 --> 00:28:56,240
on the earth and and she's you know very

847
00:28:59,350 --> 00:28:58,000
you know frustrated by the fact that she

848
00:29:01,590 --> 00:28:59,360
can't see the faults

849
00:29:02,549 --> 00:29:01,600
in in most subduction zones because of

850
00:29:04,310 --> 00:29:02,559
all the sediment

851
00:29:05,909 --> 00:29:04,320
on venus we go look at these these

852
00:29:08,310 --> 00:29:05,919
possible seduction zones you can see the

853
00:29:10,149 --> 00:29:08,320
fractures exposed right at the surface

854
00:29:11,909 --> 00:29:10,159
so you know there's just so many ways

855
00:29:13,590 --> 00:29:11,919
that that venus is an incredible

856
00:29:15,830 --> 00:29:13,600
laboratory to understand

857
00:29:17,110 --> 00:29:15,840
um processes that are important on earth

858
00:29:20,789 --> 00:29:17,120
and um

859
00:29:21,510 --> 00:29:20,799
you know maybe maybe a lot of other

860
00:29:23,269 --> 00:29:21,520
places you know

861
00:29:25,350 --> 00:29:23,279
what and i guess the ultimate question

862
00:29:26,870 --> 00:29:25,360
for me is why is why is earth the only

863
00:29:29,269 --> 00:29:26,880

place with plate tectonics

864
00:29:30,789 --> 00:29:29,279
is it is are we really unique you know

865
00:29:32,070 --> 00:29:30,799
and if so why

866
00:29:34,470 --> 00:29:32,080
that you know that's kind of the

867
00:29:36,549 --> 00:29:34,480
question i would love to answer

868
00:29:38,310 --> 00:29:36,559
it's it's all right there let's go take

869
00:29:40,470 --> 00:29:38,320
a look at it um

870
00:29:41,909 --> 00:29:40,480
let's open it up for for a few minutes

871
00:29:43,669 --> 00:29:41,919
of questions from the

872
00:29:45,430 --> 00:29:43,679
from our live audience they've been had

873
00:29:49,269 --> 00:29:45,440
great questions so far

874
00:29:55,190 --> 00:29:52,470
yeah so a really great question that we

875
00:29:57,590 --> 00:29:55,200
have from jonathan on facebook

876
00:29:59,909 --> 00:29:57,600
is what are the major complexities for

877
00:30:04,389 --> 00:29:59,919
keeping a camera or other instruments

878
00:30:08,870 --> 00:30:07,350
yeah the major problem is the

879
00:30:10,310 --> 00:30:08,880
temperature that's the first problem

880
00:30:12,470 --> 00:30:10,320
that'll get to you

881
00:30:14,470 --> 00:30:12,480
you know the landers that have gone to

882
00:30:17,669 --> 00:30:14,480
the surface successfully so far

883
00:30:19,350 --> 00:30:17,679
have basically been like diving bells

884
00:30:22,710 --> 00:30:19,360
these enormous

885
00:30:25,750 --> 00:30:22,720
you know steel vacuum chambers

886
00:30:28,789 --> 00:30:25,760
and um they are

887
00:30:30,870 --> 00:30:28,799
super well insulated uh and so

888
00:30:32,149 --> 00:30:30,880

um you know it actually takes the

889
00:30:34,310 --> 00:30:32,159
atmosphere so dense it actually takes

890
00:30:35,909 --> 00:30:34,320
like an hour to fall through the surface

891
00:30:37,990 --> 00:30:35,919
from the am from you know coming in

892
00:30:39,750 --> 00:30:38,000
extremely fast and then you

893
00:30:41,350 --> 00:30:39,760
they slow down in the atmosphere fall to

894
00:30:43,669 --> 00:30:41,360
the surface uh

895
00:30:45,350 --> 00:30:43,679
and they really only last a few hours

896
00:30:47,110 --> 00:30:45,360
and in those few hours

897
00:30:49,750 --> 00:30:47,120
uh because of that incredible insulation

898
00:30:52,630 --> 00:30:49,760
they actually cook from the inside out

899
00:30:53,110 --> 00:30:52,640
so uh you know they they start off cool

900
00:30:54,710 --> 00:30:53,120
but

901
00:30:56,230 --> 00:30:54,720
uh with the insulation they just they

902
00:30:58,230 --> 00:30:56,240
just begin to

903
00:30:59,269 --> 00:30:58,240
cook uh and then the next problem is the

904
00:31:01,269 --> 00:30:59,279
sulfuric acid

905
00:31:02,470 --> 00:31:01,279
you know things are it's extremely

906
00:31:05,909 --> 00:31:02,480
corrosive

907
00:31:07,830 --> 00:31:05,919
and in fact the the carbon dioxide at

908
00:31:09,269 --> 00:31:07,840
the surface the co2

909
00:31:11,509 --> 00:31:09,279
is in a state that's called

910
00:31:12,149 --> 00:31:11,519
supercritical so it has some of the

911
00:31:16,950 --> 00:31:12,159
properties

912
00:31:18,710 --> 00:31:16,960
a liquid and supercritical co2

913
00:31:20,149 --> 00:31:18,720

is actually used as an industrial

914
00:31:22,870 --> 00:31:20,159
solvent so

915
00:31:24,070 --> 00:31:22,880
um yeah those are some of the the first

916
00:31:29,430 --> 00:31:24,080
order problems

917
00:31:35,110 --> 00:31:33,350
so gary on facebook gary on facebook

918
00:31:37,509 --> 00:31:35,120
wants to know what would it take to

919
00:31:38,710 --> 00:31:37,519
determine how long venus has been in its

920
00:31:41,830 --> 00:31:38,720
current condition

921
00:31:42,789 --> 00:31:41,840
and how long ago the what ago the ocean

922
00:31:46,789 --> 00:31:42,799
disappeared

923
00:31:47,909 --> 00:31:46,799
and how could that be done yeah well

924
00:31:49,830 --> 00:31:47,919
there are different a lot of different

925
00:31:52,630 --> 00:31:49,840
measurements we'd like to make to

926
00:31:53,669 --> 00:31:52,640
begin to answer that question um you

927
00:31:56,389 --> 00:31:53,679
know

928
00:31:58,070 --> 00:31:56,399
what we would like to do with veritas is

929
00:31:59,430 --> 00:31:58,080
as i said look for these chemical

930
00:32:01,750 --> 00:31:59,440
fingerprints of water

931
00:32:03,190 --> 00:32:01,760
there are these uh particular types of

932
00:32:06,310 --> 00:32:03,200
geologic features

933
00:32:07,269 --> 00:32:06,320
that we think are analogous to earth's

934
00:32:11,750 --> 00:32:07,279
continents

935
00:32:13,029 --> 00:32:11,760
again they're kind of enigmatic because

936
00:32:15,350 --> 00:32:13,039
they started to form

937
00:32:16,470 --> 00:32:15,360
billions of years ago but most people

938
00:32:19,190 --> 00:32:16,480

think that

939
00:32:19,669 --> 00:32:19,200
they form when uh basalt they kind of

940
00:32:22,389 --> 00:32:19,679
the ocean

941
00:32:24,070 --> 00:32:22,399
the primary uh crust that we the planet

942
00:32:24,630 --> 00:32:24,080
forms like the oceanic crust on the

943
00:32:26,870 --> 00:32:24,640
earth

944
00:32:28,149 --> 00:32:26,880
that melts in the presence of water and

945
00:32:30,149 --> 00:32:28,159
creates a new type of rock

946
00:32:31,750 --> 00:32:30,159
that the kind of granite rocks that we

947
00:32:32,950 --> 00:32:31,760
see in continents so that's kind of rock

948
00:32:35,509 --> 00:32:32,960
that we're looking for

949
00:32:37,350 --> 00:32:35,519
to see if there's evidence of the basalt

950
00:32:38,710 --> 00:32:37,360
the volcanic rock melting

951
00:32:41,590 --> 00:32:38,720
the presence of water and we're going to

952
00:32:43,669 --> 00:32:41,600
have with the better data we can have

953
00:32:44,710 --> 00:32:43,679
hope to have a pretty good idea of how

954
00:32:45,990 --> 00:32:44,720
old those

955
00:32:48,070 --> 00:32:46,000
rocks are so we think we'll be able to

956
00:32:50,789 --> 00:32:48,080
discover more impacts in that

957
00:32:51,509 --> 00:32:50,799
impact craters in that type of terrain

958
00:32:54,950 --> 00:32:51,519
that

959
00:32:57,190 --> 00:32:54,960
is used to date the surface of rocky

960
00:32:58,630 --> 00:32:57,200
bodies um so that's one that's the thing

961
00:33:00,950 --> 00:32:58,640
we're trying to do with veritas

962
00:33:02,549 --> 00:33:00,960
uh you can also look for you can also

963
00:33:03,590 --> 00:33:02,559

composition the atmosphere in greater

964
00:33:07,190 --> 00:33:03,600
detail

965
00:33:10,230 --> 00:33:07,200
um you can use isotopes to try to

966
00:33:12,470 --> 00:33:10,240
determine uh how

967
00:33:13,590 --> 00:33:12,480
water and other volatiles have formed

968
00:33:16,149 --> 00:33:13,600
over time

969
00:33:18,630 --> 00:33:16,159
those are kind of you know divided into

970
00:33:21,830 --> 00:33:20,630
time periods and so some of those time

971
00:33:24,789 --> 00:33:21,840
periods can

972
00:33:29,909 --> 00:33:24,799
also help to pin down when that ocean

973
00:33:35,509 --> 00:33:32,789
so jeb on facebook asked what a mission

974
00:33:38,070 --> 00:33:35,519
to study the upper atmosphere of venus

975
00:33:39,830 --> 00:33:38,080
more closely be a priority in the future

976
00:33:41,750 --> 00:33:39,840
and what would you hope to discover

977
00:33:50,149 --> 00:33:41,760
there

978
00:33:51,590 --> 00:33:50,159
currently at venus and it is studying

979
00:33:54,070 --> 00:33:51,600
the atmosphere including the upper

980
00:33:55,110 --> 00:33:54,080
upper atmosphere and there was a

981
00:33:58,470 --> 00:33:55,120
european mission

982
00:34:00,310 --> 00:33:58,480
until about five or six years ago

983
00:34:02,389 --> 00:34:00,320
and that mission was also studying the

984
00:34:04,789 --> 00:34:02,399
atmosphere of venus including the uh

985
00:34:05,430 --> 00:34:04,799
upper atmosphere um yeah and one you

986
00:34:06,870 --> 00:34:05,440
know one of the

987
00:34:09,030 --> 00:34:06,880
very interesting things that has come

988
00:34:12,470 --> 00:34:09,040

out of those two atmospheric

989
00:34:15,909 --> 00:34:12,480
uh oriented orbiters is uh the fact that

990
00:34:18,389 --> 00:34:15,919
um you know oxygen is being lost

991
00:34:20,629 --> 00:34:18,399
from the atmosphere the upper atmosphere

992
00:34:23,750 --> 00:34:20,639
at a similar rate on venus

993
00:34:25,829 --> 00:34:23,760
earth and mars which is just

994
00:34:26,950 --> 00:34:25,839
crazy no one would have predicted that

995
00:34:29,270 --> 00:34:26,960
uh you know

996
00:34:30,230 --> 00:34:29,280
we think that until until recently we

997
00:34:32,230 --> 00:34:30,240
thought okay

998
00:34:33,990 --> 00:34:32,240
you know earth has a magnetic field and

999
00:34:37,270 --> 00:34:34,000
that helps shield

1000
00:34:37,750 --> 00:34:37,280
um our upper atmosphere from the solar

1001
00:34:41,909 --> 00:34:37,760
wind

1002
00:34:44,069 --> 00:34:41,919
of uh you know

1003
00:34:46,550 --> 00:34:44,079
peels off the outer atmosphere and

1004
00:34:49,829 --> 00:34:46,560
including this oxygen that's being lost

1005
00:34:52,069 --> 00:34:49,839
so um uh you know so

1006
00:34:52,869 --> 00:34:52,079
apparently neither the size of the

1007
00:34:55,270 --> 00:34:52,879
planet

1008
00:34:56,629 --> 00:34:55,280
nor the magnetic field are nearly as

1009
00:34:58,790 --> 00:34:56,639
important as we thought

1010
00:35:00,550 --> 00:34:58,800
so you know that's a very was a very

1011
00:35:01,109 --> 00:35:00,560
interesting discovery that people would

1012
00:35:04,470 --> 00:35:01,119
like to

1013
00:35:07,990 --> 00:35:06,390

all right we got time for one last

1014
00:35:09,750 --> 00:35:08,000
question

1015
00:35:11,589 --> 00:35:09,760
and sue i think this is my favorite

1016
00:35:15,270 --> 00:35:11,599
question that anyone ever asked

1017
00:35:17,670 --> 00:35:15,280
any of us at nasa um is lashonda

1018
00:35:18,390 --> 00:35:17,680
on facebook wants to know do you look

1019
00:35:22,150 --> 00:35:18,400
for life

1020
00:35:24,550 --> 00:35:22,160
under the surface of planets

1021
00:35:25,750 --> 00:35:24,560
yeah it depends on which planet you you

1022
00:35:28,069 --> 00:35:25,760
go to

1023
00:35:28,950 --> 00:35:28,079
uh venus you definitely would not look

1024
00:35:32,150 --> 00:35:28,960
for

1025
00:35:32,790 --> 00:35:32,160
present-day life near the surface um you

1026
00:35:35,349 --> 00:35:32,800
know

1027
00:35:37,109 --> 00:35:35,359
and probably because of that uh

1028
00:35:38,870 --> 00:35:37,119
present-day high temperature

1029
00:35:40,150 --> 00:35:38,880
um you know it's it's likely that you

1030
00:35:42,790 --> 00:35:40,160
might destroy

1031
00:35:43,349 --> 00:35:42,800
any evidence of microbes that might have

1032
00:35:48,390 --> 00:35:43,359
been

1033
00:35:50,470 --> 00:35:48,400
interested in trying to look for

1034
00:35:52,550 --> 00:35:50,480
microbes in the atmosphere of venus

1035
00:35:53,670 --> 00:35:52,560
you know that that cloud deck that's uh

1036
00:35:56,870 --> 00:35:53,680
you know it's about

1037
00:35:58,550 --> 00:35:56,880
uh 60 kilometers say about 40 miles up

1038
00:36:00,069 --> 00:35:58,560

uh the temperature and pressure in the

1039
00:36:02,470 --> 00:36:00,079
cloud deck

1040
00:36:03,430 --> 00:36:02,480
is actually similar to the surface of

1041
00:36:05,030 --> 00:36:03,440
the earth so

1042
00:36:07,190 --> 00:36:05,040
in theory you could have microbes in the

1043
00:36:07,510 --> 00:36:07,200
clouds of venus people are interested in

1044
00:36:11,990 --> 00:36:07,520
in

1045
00:36:14,630 --> 00:36:12,000
you know you do want to go beneath

1046
00:36:16,069 --> 00:36:14,640
the surface like mars uh you know it has

1047
00:36:17,349 --> 00:36:16,079
a lot of doesn't it doesn't have a very

1048
00:36:18,870 --> 00:36:17,359
thick atmosphere

1049
00:36:21,190 --> 00:36:18,880
and you get a lot of radiation at the

1050
00:36:21,510 --> 00:36:21,200
surface and so you know it's better to

1051
00:36:23,910 --> 00:36:21,520
go

1052
00:36:24,550 --> 00:36:23,920
a little bit under the surface to try to

1053
00:36:28,230 --> 00:36:24,560
look for

1054
00:36:30,230 --> 00:36:28,240
uh evidence of of past life um

1055
00:36:31,910 --> 00:36:30,240
uh yeah so it you know it really depends

1056
00:36:32,390 --> 00:36:31,920
on what body you're going to uh where

1057
00:36:34,470 --> 00:36:32,400
the best

1058
00:36:35,750 --> 00:36:34,480
place to look for uh look for life might

1059
00:36:38,069 --> 00:36:35,760
be or you know

1060
00:36:39,670 --> 00:36:38,079
evidence of past life let's say you know

1061
00:36:40,710 --> 00:36:39,680
typical uh so certainly if we're talking

1062
00:36:44,550 --> 00:36:40,720
about mars

1063
00:36:47,190 --> 00:36:44,560

uh who knows who knows for venus

1064
00:36:49,510 --> 00:36:47,200
very cool um that's all the time we have

1065
00:36:51,109 --> 00:36:49,520
for this evening but before we go

1066
00:36:52,710 --> 00:36:51,119
another way you at home can keep

1067
00:36:57,990 --> 00:36:52,720
exploring venus

1068
00:36:59,829 --> 00:36:58,000
is if you go to eyes.nasa.gov

1069
00:37:01,270 --> 00:36:59,839
and if we go to image number 14 you can

1070
00:37:02,230 --> 00:37:01,280
kind of see a little bit of what they

1071
00:37:04,550 --> 00:37:02,240
have what

1072
00:37:06,310 --> 00:37:04,560
they can show you on here nasa eyes will

1073
00:37:09,430 --> 00:37:06,320
be a major part of next month's talk

1074
00:37:12,870 --> 00:37:09,440
visualizing space exploration ar

1075
00:37:14,950 --> 00:37:12,880
vr and emerging tech now before we go i

1076
00:37:17,430 --> 00:37:14,960
would like to thank our speaker dr

1077
00:37:18,470 --> 00:37:17,440
seuss mercar our co-host lindsay

1078
00:37:20,390 --> 00:37:18,480
mclaurin and

1079
00:37:22,150 --> 00:37:20,400
everyone behind the scenes that makes

1080
00:37:24,710 --> 00:37:22,160
these talks possible

1081
00:37:25,829 --> 00:37:24,720
and a final thank you to you the

1082
00:37:26,950 --> 00:37:25,839
audience

1083
00:37:29,589 --> 00:37:26,960
thank you for joining us on this

1084
00:37:38,960 --> 00:37:29,599
thursday evening stay safe