Ask An Astrobiologist

Episode 25: October 23rd, 2019

Dr. Laurie Barge

NASA Astrobiology Program

1
00:00:00,690 --> 00:00:29,300
[Music]

2
00:00:33,500 --> 00:00:31,070
greetings friends of astrobiology

3
00:00:35,479 --> 00:00:33,510
welcome back to ask an astrobiologist a

4
00:00:37,490 --> 00:00:35,489
show where we celebrate science and

5
00:00:39,110 --> 00:00:37,500
celebrate scientists my name is Sanjay

6
00:00:40,880 --> 00:00:39,120
saman this program is made possible by

7
00:00:43,640 --> 00:00:40,890
contributions from the NASA Astrobiology

8
00:00:46,790 --> 00:00:43,650
program and a non profit blue marble

9
00:00:49,160 --> 00:00:46,800
space last month my fiercely soon-to-be

10
00:00:51,619 --> 00:00:49,170
ferociously bearded co-host D Cosmo

11
00:00:53,299 --> 00:00:51,629
biologist dr. Graham Lau had a wonderful

12
00:00:56,150 --> 00:00:53,309
conversation with our guest of the Bruce

13
00:00:57,920 --> 00:00:56,160

Damer and we talked about origin of life

14
00:01:00,530 --> 00:00:57,930
research we talked about asteroid

15
00:01:02,090 --> 00:01:00,540
capture and so this month to give it

16
00:01:04,310 --> 00:01:02,100
another shot at the origin of life

17
00:01:06,050 --> 00:01:04,320
thought and on the latest science behind

18
00:01:08,060 --> 00:01:06,060
it know we have none other than

19
00:01:10,639 --> 00:01:08,070
astrobiologists extraordinaire dr.

20
00:01:12,859 --> 00:01:10,649
Laurie barge from NASA JPL which is

21
00:01:14,540 --> 00:01:12,869
located just outside of Los Angeles in

22
00:01:16,219 --> 00:01:14,550
California we'll be talking about

23
00:01:18,410 --> 00:01:16,229
galaxies we'll be talking about Mars

24
00:01:20,330 --> 00:01:18,420
we'll be talking about ocean exploration

25
00:01:22,190 --> 00:01:20,340
hydrothermal vents origin of life and a

26
00:01:23,660 --> 00:01:22,200
whole lot more so I hope you're all

27
00:01:26,210 --> 00:01:23,670
excited as I am for this wonderful

28
00:01:29,029 --> 00:01:26,220
conversation but first it's time for

29
00:01:31,010 --> 00:01:29,039
your monthly background quiz Mike if you

30
00:01:34,640 --> 00:01:31,020
could put up the background that Graham

31
00:01:37,070 --> 00:01:34,650
had last month a few of you got it right

32
00:01:39,620 --> 00:01:37,080
as you can recognize it was the Ionian

33
00:01:41,990 --> 00:01:39,630
islands in the Mediterranean home of the

34
00:01:44,000 --> 00:01:42,000
majestic volcano Stromboli which has

35
00:01:46,190 --> 00:01:44,010
been continuously erupting roughly for

36
00:01:47,810 --> 00:01:46,200
the past 2000 years the Romans know

37
00:01:50,179 --> 00:01:47,820
about it and we know about it today

38
00:01:51,620 --> 00:01:50,189

because the last explosive eruption was

39
00:01:53,510 --> 00:01:51,630
actually just this past August

40
00:01:55,370 --> 00:01:53,520
it rises about almost at a thousand

41
00:01:58,190 --> 00:01:55,380
meters above sea level and it's a lovely

42
00:02:00,319 --> 00:01:58,200
ride from Sicily on a beautiful ferry to

43
00:02:03,260 --> 00:02:00,329
get to the Aeolian Islands Sicily of

44
00:02:05,810 --> 00:02:03,270
course is home to the massive volcano

45
00:02:08,930 --> 00:02:05,820
and so a few of you got it right but our

46
00:02:12,020 --> 00:02:08,940
winner who's gonna win the NASA stickers

47
00:02:15,140 --> 00:02:12,030
as well as the astrobiology graphics

48
00:02:18,259 --> 00:02:15,150
novel is Jaime Cordova who is tweeting

49
00:02:20,390 --> 00:02:18,269
at Jaime core underscore 94

50
00:02:22,280 --> 00:02:20,400
congratulations and thank you very much

51
00:02:24,920 --> 00:02:22,290
for playing and we also want to

52
00:02:26,750 --> 00:02:24,930
recognize our ambassador of the month to

53
00:02:29,449 --> 00:02:26,760
make this show successful we need all of

54
00:02:30,470 --> 00:02:29,459
your help in tweeting and retweeting and

55
00:02:32,900 --> 00:02:30,480
telling your friends and telling

56
00:02:34,729 --> 00:02:32,910
teachers about our program and the

57
00:02:37,130 --> 00:02:34,739
person who does it the most during the

58
00:02:40,670 --> 00:02:37,140
the previous previous to this episode

59
00:02:41,770 --> 00:02:40,680
gets the award and this month again for

60
00:02:43,710 --> 00:02:41,780
the second time is very

61
00:02:46,150 --> 00:02:43,720
Denton thank you so much Marianne and

62
00:02:48,610 --> 00:02:46,160
really grateful for all the support and

63
00:02:50,680 --> 00:02:48,620

for your or you love the show we love to

64
00:02:51,670 --> 00:02:50,690
have fans like you and fans for all of

65
00:02:53,830 --> 00:02:51,680
you from all of you from all over the

66
00:02:57,130 --> 00:02:53,840
world and thank you again for all you're

67
00:02:58,059 --> 00:02:57,140
doing for the program okay so to get

68
00:02:59,559 --> 00:02:58,069
things started

69
00:03:01,059 --> 00:02:59,569
Lori barges and incredible

70
00:03:03,370 --> 00:03:01,069
astrobiologist has been really hard to

71
00:03:05,710 --> 00:03:03,380
decide where to start so but like we

72
00:03:07,449 --> 00:03:05,720
like to do in the in this in this series

73
00:03:10,449 --> 00:03:07,459
is turn back the wheels of time a little

74
00:03:13,000 --> 00:03:10,459
bit and and welcome Lori and perhaps you

75
00:03:14,949 --> 00:03:13,010
can tell us a little bit how or what

76
00:03:17,710 --> 00:03:14,959
events got you started thinking about

77
00:03:19,479 --> 00:03:17,720
science when you're perhaps a kid well

78
00:03:21,250 --> 00:03:19,489
I've always actually been really

79
00:03:23,530 --> 00:03:21,260
interested in space I don't even really

80
00:03:25,540 --> 00:03:23,540
know why this began but I was kind of

81
00:03:28,000 --> 00:03:25,550
like a nerdy kid who liked space but not

82
00:03:30,160 --> 00:03:28,010
exclusively I liked a lot of stuff and I

83
00:03:32,140 --> 00:03:30,170
was reading like the little kid books

84
00:03:34,390 --> 00:03:32,150
about stars and planets and things like

85
00:03:36,370 --> 00:03:34,400
that and and I remember one big thing

86
00:03:39,370 --> 00:03:36,380
though was when the Voyager flyby of

87
00:03:41,410 --> 00:03:39,380
Neptune happened in 1989 and that was a

88
00:03:43,120 --> 00:03:41,420

big deal because I just never never seen

89
00:03:45,370 --> 00:03:43,130
Neptune before really up close like none

90
00:03:46,810 --> 00:03:45,380
of us had and so it was really it was on

91
00:03:49,180 --> 00:03:46,820
the news and I got to stay up late and

92
00:03:51,160 --> 00:03:49,190
look at it and it was really cool and so

93
00:03:52,390 --> 00:03:51,170
I think that was one of the things that

94
00:03:54,130 --> 00:03:52,400
made me think you know maybe I'll

95
00:03:56,350 --> 00:03:54,140
actually go work for NASA I didn't know

96
00:03:58,210 --> 00:03:56,360
what that meant I was young yeah that

97
00:04:00,100 --> 00:03:58,220
was one thing and then I just kind of

98
00:04:02,020 --> 00:04:00,110
threw out I guess my elementary school

99
00:04:03,130 --> 00:04:02,030
in high school I was always kind of

100
00:04:04,930 --> 00:04:03,140
interested in the stuff in the

101
00:04:06,160 --> 00:04:04,940
background among other other types of

102
00:04:08,020 --> 00:04:06,170
interests and it wasn't really until

103
00:04:09,539 --> 00:04:08,030
college that I decided that I was going

104
00:04:13,690 --> 00:04:09,549
to do this as a career

105
00:04:16,479 --> 00:04:13,700
wonderful yeah I remember fly by as well

106
00:04:17,890 --> 00:04:16,489
of Neptune in 1989 I was eight years old

107
00:04:20,770 --> 00:04:17,900
and is still very much ingrained in my

108
00:04:23,200 --> 00:04:20,780
memory and a big part of why I became a

109
00:04:24,310 --> 00:04:23,210
scientist as well but even in college

110
00:04:26,080 --> 00:04:24,320
from what I understand you're not

111
00:04:27,370 --> 00:04:26,090
entirely sure what it to follow a career

112
00:04:30,070 --> 00:04:27,380
in science you have a very strong

113
00:04:31,600 --> 00:04:30,080

interest in theater as well right that's

114
00:04:33,880 --> 00:04:31,610
right and actually in high school

115
00:04:35,320 --> 00:04:33,890
theater was my huge thing like I was

116
00:04:37,300 --> 00:04:35,330
really into it it's what I spent all my

117
00:04:38,680 --> 00:04:37,310
time on and so I thought well I don't

118
00:04:41,080 --> 00:04:38,690
know what I want to major in maybe

119
00:04:43,210 --> 00:04:41,090
theater maybe astronomy because I like

120
00:04:45,190 --> 00:04:43,220
the Stars and I just didn't know and I

121
00:04:47,620 --> 00:04:45,200
actually I applied for college in

122
00:04:49,150 --> 00:04:47,630
theater like I I sent in applications

123
00:04:51,040 --> 00:04:49,160
for theater schools and I made a

124
00:04:52,570 --> 00:04:51,050
portfolio and everything but I also

125
00:04:53,580 --> 00:04:52,580
applied for being a physics and

126
00:04:56,190 --> 00:04:53,590
astronomy major

127
00:04:58,800 --> 00:04:56,200
and in the end I got into a school that

128
00:05:00,810 --> 00:04:58,810
had no theatre degree for undergrad and

129
00:05:02,790 --> 00:05:00,820
so I got the minor instead and I was

130
00:05:04,890 --> 00:05:02,800
just doing student theatre but again in

131
00:05:06,629 --> 00:05:04,900
college I was super into it and I spent

132
00:05:08,670 --> 00:05:06,639
I'd say way more time doing that than I

133
00:05:10,650 --> 00:05:08,680
was doing maybe equal I say to what I

134
00:05:12,180 --> 00:05:10,660
was doing with my astronomy and so it

135
00:05:14,460 --> 00:05:12,190
was it was a real tough thing and I'd

136
00:05:15,810 --> 00:05:14,470
say it wasn't until maybe like junior

137
00:05:17,850 --> 00:05:15,820
year senior year of college when I

138
00:05:19,050 --> 00:05:17,860

really decided I'm gonna get a PhD in

139
00:05:23,070 --> 00:05:19,060
science and this is going to be the

140
00:05:24,870 --> 00:05:23,080
career those of you are watching now

141
00:05:27,210 --> 00:05:24,880
don't forget you can ask questions in

142
00:05:29,190 --> 00:05:27,220
the chat boxes on Signet or on Twitter

143
00:05:30,450 --> 00:05:29,200
please use hashtag ask a sir bio if

144
00:05:32,610 --> 00:05:30,460
you're watching on Facebook ask the

145
00:05:35,190 --> 00:05:32,620
questions - I will I will chew them up

146
00:05:36,990 --> 00:05:35,200
for dr. Barger later on in the show so

147
00:05:39,600 --> 00:05:37,000
you ended up getting a bachelor's degree

148
00:05:42,120 --> 00:05:39,610
in astronomy lorry's that right and then

149
00:05:48,210 --> 00:05:42,130
you're studying then the Magellan

150
00:05:49,950 --> 00:05:48,220
Magellanic Clouds tell us more so I I

151
00:05:52,469 --> 00:05:49,960
think I started this sophomore year I

152
00:05:53,940 --> 00:05:52,479
was doing research on binary stars which

153
00:05:56,460 --> 00:05:53,950
is where you have two stars that orbit

154
00:05:58,110 --> 00:05:56,470
each other and that was pretty

155
00:06:00,210 --> 00:05:58,120
interesting because you can measure

156
00:06:02,010 --> 00:06:00,220
their mass and their brightness and then

157
00:06:03,570 --> 00:06:02,020
you can get the periodicity of the orbit

158
00:06:05,430 --> 00:06:03,580
and from that you can try to get at

159
00:06:07,620 --> 00:06:05,440
their distance and so I was trying to

160
00:06:09,090 --> 00:06:07,630
understand you know from these spectral

161
00:06:10,800 --> 00:06:09,100
observations where you see that the

162
00:06:12,000 --> 00:06:10,810
spectral lines kind of shift with

163
00:06:13,800 --> 00:06:12,010

redshift or blueshift

164
00:06:15,600 --> 00:06:13,810
can you tell you know how these are

165
00:06:17,610 --> 00:06:15,610
orbiting and what what their properties

166
00:06:19,710 --> 00:06:17,620
might be so that was my research as an

167
00:06:21,360 --> 00:06:19,720
undergraduate and the binary systems I

168
00:06:23,400 --> 00:06:21,370
studied were in the small Magellanic

169
00:06:25,500 --> 00:06:23,410
Cloud which is a small galaxy that

170
00:06:26,850 --> 00:06:25,510
orbits the Milky Way and it was funny

171
00:06:28,800 --> 00:06:26,860
because those you can always see from

172
00:06:30,450 --> 00:06:28,810
the southern hemisphere of Earth and so

173
00:06:32,310 --> 00:06:30,460
I never actually seen them before start

174
00:06:34,409 --> 00:06:32,320
studying stuff that I'd never seen so

175
00:06:36,350 --> 00:06:34,419
later much later I was able to see them

176
00:06:39,029 --> 00:06:36,360
in the sky and that was really awesome I

177
00:06:41,460 --> 00:06:39,039
think the sky in the southern hemisphere

178
00:06:43,710 --> 00:06:41,470
is a lot more beautiful than it is in

179
00:06:45,360 --> 00:06:43,720
northern hemisphere I mean the Milky Way

180
00:06:46,529 --> 00:06:45,370
is gorgeous then you can see the two

181
00:06:49,529 --> 00:06:46,539
Magellanic Clouds which are of course

182
00:06:50,850 --> 00:06:49,539
not clouds but galaxies just there in

183
00:06:52,140 --> 00:06:50,860
the distance and for scale you know

184
00:06:54,900 --> 00:06:52,150
there are of course at different

185
00:06:56,610 --> 00:06:54,910
distances and they are but 10 or 10

186
00:06:59,219 --> 00:06:56,620
times smaller than our own galaxy but

187
00:07:00,690 --> 00:06:59,229
nonetheless extremely impressive so and

188
00:07:02,370 --> 00:07:00,700

so what happened after you got your

189
00:07:06,340 --> 00:07:02,380
bachelor's in astronomy because you

190
00:07:09,010 --> 00:07:06,350
ended up working in on Mars geology for

191
00:07:11,200 --> 00:07:09,020
it's cool to start with no yeah it was

192
00:07:13,450 --> 00:07:11,210
it was interesting I was basically all

193
00:07:15,490 --> 00:07:13,460
those time just following what I like

194
00:07:17,530 --> 00:07:15,500
doing and I would have you know a few

195
00:07:18,970 --> 00:07:17,540
things that I really enjoyed and I would

196
00:07:20,710 --> 00:07:18,980
do them more and then I would discover

197
00:07:22,330 --> 00:07:20,720
something new that I enjoyed know do

198
00:07:25,600 --> 00:07:22,340
that and then that's kind of snow what

199
00:07:26,980 --> 00:07:25,610
I'm doing and so when I was a college

200
00:07:29,260 --> 00:07:26,990
student I was doing this research and I

201
00:07:32,050 --> 00:07:29,270
liked that taking classes and I enjoyed

202
00:07:33,610 --> 00:07:32,060
astronomy we took a class called I can't

203
00:07:35,230 --> 00:07:33,620
even remember I think it's meteorology

204
00:07:37,450 --> 00:07:35,240
of the planets and we each had to do a

205
00:07:39,430 --> 00:07:37,460
report on a planet so I got the planet

206
00:07:41,590 --> 00:07:39,440
Venus and I did this report and I got so

207
00:07:43,360 --> 00:07:41,600
into it and it was super exciting and I

208
00:07:45,250 --> 00:07:43,370
thought wow planets are awesome like I

209
00:07:46,750 --> 00:07:45,260
wish I could study the planets but when

210
00:07:48,250 --> 00:07:46,760
I was reading the books about Venus I

211
00:07:50,590 --> 00:07:48,260
didn't know what these names meant like

212
00:07:52,030 --> 00:07:50,600
the salt or granite you know so I

213
00:07:54,940 --> 00:07:52,040

thought I'd better get I better learn

214
00:07:56,890 --> 00:07:54,950
geology but I'm also afraid to change my

215
00:07:58,240 --> 00:07:56,900
field because you can't just go to grad

216
00:07:59,830 --> 00:07:58,250
school and a whole different major than

217
00:08:02,350 --> 00:07:59,840
what your undergrad major was right and

218
00:08:04,570 --> 00:08:02,360
so that's what I thought the time so I

219
00:08:07,510 --> 00:08:04,580
applied to grad school in in astronomy

220
00:08:09,970 --> 00:08:07,520
and but also in geology like just a few

221
00:08:11,980 --> 00:08:09,980
applications for geology and I actually

222
00:08:13,930 --> 00:08:11,990
got into one school for geology and I

223
00:08:15,610 --> 00:08:13,940
was really scared to accept actually

224
00:08:17,290 --> 00:08:15,620
because I thought I can't I can't go get

225
00:08:19,360 --> 00:08:17,300
a PhD and something I did not major in

226
00:08:21,820 --> 00:08:19,370
so I'm really glad that I you know took

227
00:08:23,830 --> 00:08:21,830
that leap and did that and then actually

228
00:08:25,450 --> 00:08:23,840
also the summer after my undergraduate

229
00:08:27,850 --> 00:08:25,460
degree I did an internship at NASA

230
00:08:30,130 --> 00:08:27,860
Goddard where I was working on Mars

231
00:08:32,080 --> 00:08:30,140
chemical analysis type stuff like bio

232
00:08:33,790 --> 00:08:32,090
signatures but again it was not a

233
00:08:36,190 --> 00:08:33,800
chemistry major so this is all very new

234
00:08:39,219 --> 00:08:36,200
to me and I just kept doing stuff that

235
00:08:40,450 --> 00:08:39,229
was very new but really exciting I think

236
00:08:42,339 --> 00:08:40,460
that's the hallmark of being in

237
00:08:43,810 --> 00:08:42,349
astrobiologists to be able to take a

238
00:08:45,580 --> 00:08:43,820

bunch of different disciplines that tie

239
00:08:47,770 --> 00:08:45,590
them all together to focus on a science

240
00:08:49,720 --> 00:08:47,780
question and you know I did the same

241
00:08:50,940 --> 00:08:49,730
thing you know changed my majors after

242
00:08:53,260 --> 00:08:50,950
my master's degree in engineering

243
00:08:55,330 --> 00:08:53,270
towards the Earth Sciences so it's very

244
00:08:56,800 --> 00:08:55,340
possible those of you who are who are

245
00:08:58,030 --> 00:08:56,810
watching on our students you know

246
00:08:59,620 --> 00:08:58,040
wondering what to major in to do

247
00:09:00,820 --> 00:08:59,630
astrobiology actually can major in

248
00:09:02,380 --> 00:09:00,830
really whatever you want it is a

249
00:09:04,930 --> 00:09:02,390
scientific question thereafter that

250
00:09:06,820 --> 00:09:04,940
makes you an astrobiologist but Laurie

251
00:09:08,290 --> 00:09:06,830
after getting I think your masters in in

252
00:09:10,210 --> 00:09:08,300
geology and looking at the blueberries

253
00:09:11,890 --> 00:09:10,220
on Mars right past we can talk about the

254
00:09:13,150 --> 00:09:11,900
significance of those blueberries those

255
00:09:15,340 --> 00:09:13,160
tiny spherules

256
00:09:17,920 --> 00:09:15,350
of of hematite and iron oxide that

257
00:09:18,900 --> 00:09:17,930
contain sand grains they tell us

258
00:09:21,930 --> 00:09:18,910
something about the

259
00:09:24,810 --> 00:09:21,940
environment of Mars no yeah and actually

260
00:09:26,790 --> 00:09:24,820
I started grad school in 2004 so that

261
00:09:28,710 --> 00:09:26,800
was when the Mars exploration Rovers had

262
00:09:30,270 --> 00:09:28,720
landed and they had opportunity Rover

263
00:09:32,400 --> 00:09:30,280

had discovered these blueberries which

264
00:09:34,980 --> 00:09:32,410
are little little tiny few rules of iron

265
00:09:36,660 --> 00:09:34,990
oxide and at the time people didn't know

266
00:09:39,120 --> 00:09:36,670
how they formed and maybe it had to do

267
00:09:41,790 --> 00:09:39,130
with water and maybe not and it was you

268
00:09:43,410 --> 00:09:41,800
know interesting mystery and so I was

269
00:09:45,420 --> 00:09:43,420
meanwhile learning geology for the first

270
00:09:47,250 --> 00:09:45,430
time and also kind of like the chemistry

271
00:09:49,110 --> 00:09:47,260
and so I got really interested in this

272
00:09:50,700 --> 00:09:49,120
and I thought well maybe I can try to

273
00:09:52,320 --> 00:09:50,710
make these in the lab or maybe

274
00:09:54,060 --> 00:09:52,330
understand could they have been related

275
00:09:57,000 --> 00:09:54,070
to organics or something like that and

276
00:09:59,820 --> 00:09:57,010
so I did my thesis work on looking at

277
00:10:02,790 --> 00:09:59,830
how patterns form in geologic things

278
00:10:04,230 --> 00:10:02,800
without life but can organics affect the

279
00:10:07,110 --> 00:10:04,240
pattern and what does that all mean for

280
00:10:08,880 --> 00:10:07,120
looking for life elsewhere so I think

281
00:10:11,610 --> 00:10:08,890
that that seeded your brain the

282
00:10:13,710 --> 00:10:11,620
possibilities of laboratory synthesis

283
00:10:15,420 --> 00:10:13,720
right of creating stuff you see in real

284
00:10:17,460 --> 00:10:15,430
world in the lab to really focus

285
00:10:20,610 --> 00:10:17,470
scientific questions and answering

286
00:10:24,270 --> 00:10:20,620
processes or how life affects them or

287
00:10:26,850 --> 00:10:24,280
not right yeah and you know lab work was

288
00:10:28,170 --> 00:10:26,860

it was a challenge then because I don't

289
00:10:31,350 --> 00:10:28,180
really do a lot of lab work as an

290
00:10:33,210 --> 00:10:31,360
astronomy major and so when I got to

291
00:10:35,670 --> 00:10:33,220
grad school I was learning for the first

292
00:10:37,500 --> 00:10:35,680
time just simple techniques and like you

293
00:10:39,840 --> 00:10:37,510
know how to do chemicals and and all

294
00:10:41,910 --> 00:10:39,850
that and so that was that was

295
00:10:44,160 --> 00:10:41,920
challenging but learning to do that it

296
00:10:45,540 --> 00:10:44,170
was it was more than just focusing on

297
00:10:47,370 --> 00:10:45,550
this project it was a whole new

298
00:10:49,230 --> 00:10:47,380
technique and field of science that I

299
00:10:51,240 --> 00:10:49,240
once I got into it I realized I could

300
00:10:53,250 --> 00:10:51,250
apply it to all kinds of stuff so that

301
00:10:54,690 --> 00:10:53,260
kind of room I guess over the years and

302
00:10:55,800 --> 00:10:54,700
grad school and then by the end I

303
00:10:57,120 --> 00:10:55,810
thought well there's so many things I

304
00:10:58,520 --> 00:10:57,130
could do now with all these different

305
00:11:02,310 --> 00:10:58,530
types of science field

306
00:11:04,110 --> 00:11:02,320
so how did your interests change from

307
00:11:05,910 --> 00:11:04,120
looking at the Martian surface geology

308
00:11:07,830 --> 00:11:05,920
and interpretation of the rocks to say

309
00:11:09,180 --> 00:11:07,840
something about the environment so what

310
00:11:12,450 --> 00:11:09,190
you're doing now which is trying to

311
00:11:15,780 --> 00:11:12,460
simulate hydrothermal hot springs or

312
00:11:17,880 --> 00:11:15,790
hydrothermal chimneys in the lab well

313
00:11:20,280 --> 00:11:17,890

it's it's funny it's kind of it was a

314
00:11:22,230 --> 00:11:20,290
planned transition and it kind of the

315
00:11:24,330 --> 00:11:22,240
stuff that just happened like I was

316
00:11:27,240 --> 00:11:24,340
really interested in bio signatures and

317
00:11:28,920 --> 00:11:27,250
also in grad school I started getting a

318
00:11:30,840 --> 00:11:28,930
lot more involved with astrobiology as a

319
00:11:32,640 --> 00:11:30,850
field even though technically my my

320
00:11:34,860 --> 00:11:32,650
degree was not astrobiology so this is

321
00:11:36,540 --> 00:11:34,870
all outside activities that I was doing

322
00:11:38,280 --> 00:11:36,550
to try to see if this is a field I

323
00:11:40,860 --> 00:11:38,290
wanted to be in sorry did all these

324
00:11:42,900 --> 00:11:40,870
astrobiology things and then when

325
00:11:44,640 --> 00:11:42,910
thinking about bio signatures it's

326
00:11:46,440 --> 00:11:44,650
interesting because my research found

327
00:11:48,660 --> 00:11:46,450
that when we added organics to these

328
00:11:50,490 --> 00:11:48,670
systems of minerals but patterns that

329
00:11:52,110 --> 00:11:50,500
were formed would change and so you

330
00:11:53,760 --> 00:11:52,120
could sort of use those patterns is a

331
00:11:55,230 --> 00:11:53,770
diagnostic trace of whether they were

332
00:11:57,840 --> 00:11:55,240
organics there in the first place and

333
00:11:59,760 --> 00:11:57,850
then I thought well you know it's only a

334
00:12:01,320 --> 00:11:59,770
small leap from saying organics effect

335
00:12:03,180 --> 00:12:01,330
minerals and you can use that as a

336
00:12:04,980 --> 00:12:03,190
diagnostic tool just saying well if

337
00:12:07,230 --> 00:12:04,990
organics and minerals are so intertwined

338
00:12:09,780 --> 00:12:07,240

then is that a you know can you actually

339
00:12:11,160 --> 00:12:09,790
go toward biology that way I mean maybe

340
00:12:13,470 --> 00:12:11,170
part of the reason it looks so much like

341
00:12:15,870 --> 00:12:13,480
life is because it's related to how life

342
00:12:18,480 --> 00:12:15,880
began and so I had an interest in origin

343
00:12:19,920 --> 00:12:18,490
of life and I hadn't really planned to

344
00:12:21,870 --> 00:12:19,930
start working on a mission related stuff

345
00:12:23,760 --> 00:12:21,880
but through the people I met at

346
00:12:25,650 --> 00:12:23,770
conferences I ended up getting a postdoc

347
00:12:27,660 --> 00:12:25,660
at JPL that was focused on Europa

348
00:12:30,150 --> 00:12:27,670
focused on icy worlds in particular and

349
00:12:31,440 --> 00:12:30,160
so I kind of threw myself into that and

350
00:12:32,520 --> 00:12:31,450
I learned that the ocean is really

351
00:12:34,770 --> 00:12:32,530
awesome and there's a whole bunch of

352
00:12:37,170 --> 00:12:34,780
research there too and so now I'd say

353
00:12:39,870 --> 00:12:37,180
about half of my work is kind of soil

354
00:12:41,400 --> 00:12:39,880
science mineralogy organic related it is

355
00:12:43,590 --> 00:12:41,410
a little bit in some ways related to

356
00:12:45,420 --> 00:12:43,600
what I did as a PhD student but then the

357
00:12:47,850 --> 00:12:45,430
other half is oceanography and you know

358
00:12:49,080 --> 00:12:47,860
missions to the deep sea and how you can

359
00:12:51,690 --> 00:12:49,090
explore vents and what that might mean

360
00:12:54,150 --> 00:12:51,700
for life another world and so my

361
00:12:56,640 --> 00:12:54,160
patterns of minerals are you saying that

362
00:12:59,400 --> 00:12:56,650
the shape that some minerals inside

363
00:13:01,140 --> 00:12:59,410

rocks can take is a signature of whether

364
00:13:04,320 --> 00:13:01,150
they've been affected by biological

365
00:13:05,970 --> 00:13:04,330
processes well it might be a signature

366
00:13:07,800 --> 00:13:05,980
of that or it could be a signature of

367
00:13:10,200 --> 00:13:07,810
whether organics have been there and

368
00:13:12,420 --> 00:13:10,210
organics don't have to be biological so

369
00:13:14,730 --> 00:13:12,430
that was that was one of the main things

370
00:13:16,560 --> 00:13:14,740
that that I found is that you can you

371
00:13:18,690 --> 00:13:16,570
can tweak systems a lot within the lab

372
00:13:20,310 --> 00:13:18,700
by adding organics and organics will

373
00:13:22,710 --> 00:13:20,320
change the minerals and the minerals can

374
00:13:23,730 --> 00:13:22,720
affect the organics but it doesn't have

375
00:13:25,530 --> 00:13:23,740
to be biological

376
00:13:28,050 --> 00:13:25,540
although biology can also do this

377
00:13:29,760 --> 00:13:28,060
sometimes and so when you're trying to

378
00:13:31,620 --> 00:13:29,770
understand you know whether or not life

379
00:13:33,510 --> 00:13:31,630
caused a certain effect you have to

380
00:13:35,940 --> 00:13:33,520
think about why exactly would life cause

381
00:13:37,140 --> 00:13:35,950
that and is it just because organics can

382
00:13:38,520 --> 00:13:37,150
cause it and how do you tell the

383
00:13:41,810 --> 00:13:38,530
difference it's a really complicated

384
00:13:44,720 --> 00:13:41,820
problem that sounds like it's

385
00:13:47,190 --> 00:13:44,730
geological or geochemical processes

386
00:13:49,620 --> 00:13:47,200
essentially water and rocks interacting

387
00:13:52,470 --> 00:13:49,630
and with certain in a certain way can

388
00:13:55,920 --> 00:13:52,480

create the components that life can take

389
00:13:58,020 --> 00:13:55,930
advantage of to then evolve from I mean

390
00:13:59,730 --> 00:13:58,030
I think so and that's you know a lot of

391
00:14:02,400 --> 00:13:59,740
research in this field has been showing

392
00:14:04,740 --> 00:14:02,410
now how there's a lot of energy sources

393
00:14:06,330 --> 00:14:04,750
and geological settings very interesting

394
00:14:09,120 --> 00:14:06,340
organic chemistry can emerge a

395
00:14:10,980 --> 00:14:09,130
non-biological system and the complexity

396
00:14:13,590 --> 00:14:10,990
that you can get in organic chemical

397
00:14:15,120 --> 00:14:13,600
systems is really huge and you can see

398
00:14:17,130 --> 00:14:15,130
this from all the all the work in the

399
00:14:18,630 --> 00:14:17,140
urgent applied field you know there's

400
00:14:20,820 --> 00:14:18,640
not microbes doing these things

401
00:14:23,340 --> 00:14:20,830
it's a biotic lab chemistry and yet it's

402
00:14:25,740 --> 00:14:23,350
so complex and so how much of that

403
00:14:27,180 --> 00:14:25,750
happened on other planets we know at

404
00:14:29,640 --> 00:14:27,190
least would happen on earth to make life

405
00:14:31,680 --> 00:14:29,650
but how far did it go on Mars if at all

406
00:14:33,930 --> 00:14:31,690
but what about places like Ceres are in

407
00:14:35,970 --> 00:14:33,940
celibates so it's really interesting to

408
00:14:38,520 --> 00:14:35,980
tweak the geological condition and see

409
00:14:40,380 --> 00:14:38,530
what are their effects you can get so

410
00:14:42,630 --> 00:14:40,390
you can create really complex molecules

411
00:14:47,250 --> 00:14:42,640
from really simple building blocks using

412
00:14:50,070 --> 00:14:47,260
kind of the the thermal water system as

413
00:14:52,140 --> 00:14:50,080

the engine right yeah and I mean some of

414
00:14:54,330 --> 00:14:52,150
this some chemistry can emerge in

415
00:14:55,980 --> 00:14:54,340
hydrothermal vents of a deep-sea system

416
00:14:58,650 --> 00:14:55,990
where you have these gradients of

417
00:15:00,630 --> 00:14:58,660
temperature and pH and redox potential

418
00:15:02,820 --> 00:15:00,640
and chemistry and you can get a lot of

419
00:15:05,010 --> 00:15:02,830
interesting chemistry there and vent

420
00:15:06,750 --> 00:15:05,020
systems are so diverse you have all

421
00:15:08,310 --> 00:15:06,760
types of gradients you have different

422
00:15:10,890 --> 00:15:08,320
depths and you know different types of

423
00:15:12,630 --> 00:15:10,900
cycling and whatnot and so it's it's a

424
00:15:14,550 --> 00:15:12,640
whole this this whole interesting world

425
00:15:16,200 --> 00:15:14,560
to explore of what our Ganic chemistry

426
00:15:18,030 --> 00:15:16,210
can do but there's other environments

427
00:15:19,950 --> 00:15:18,040
too they can do things and so it's not

428
00:15:21,720 --> 00:15:19,960
so much about exactly what environment

429
00:15:23,880 --> 00:15:21,730
it is it's more about what conditions

430
00:15:25,890 --> 00:15:23,890
can lead to what types the products and

431
00:15:27,720 --> 00:15:25,900
what types of systems and then it's

432
00:15:29,160 --> 00:15:27,730
possible you might have a condition that

433
00:15:32,040 --> 00:15:29,170
could be found in multiple environments

434
00:15:34,260 --> 00:15:32,050
right and so maybe the origin of life

435
00:15:36,660 --> 00:15:34,270
has multiple possibilities or multiple

436
00:15:39,360 --> 00:15:36,670
possible outcomes and and it starts to

437
00:15:41,100 --> 00:15:39,370
get very philosophical you think it was

438
00:15:42,810 --> 00:15:41,110

a unique setting for the origin of life

439
00:15:44,220 --> 00:15:42,820
or different planet or environments

440
00:15:47,790 --> 00:15:44,230
created the different things that then

441
00:15:50,430 --> 00:15:47,800
came together to promote the chemistry

442
00:15:51,690 --> 00:15:50,440
that led to life you know I don't

443
00:15:54,140 --> 00:15:51,700
actually know I mean nobody knows really

444
00:15:55,550 --> 00:15:54,150
and I don't know

445
00:15:59,150 --> 00:15:55,560
the right question to be asking because

446
00:16:01,160 --> 00:15:59,160
it's not I don't think about what exact

447
00:16:01,840 --> 00:16:01,170
environment cause the origin of life is

448
00:16:04,160 --> 00:16:01,850
I think that's

449
00:16:05,630 --> 00:16:04,170
misdirecting because you don't know what

450
00:16:07,550 --> 00:16:05,640
conditions different environments and

451
00:16:09,050 --> 00:16:07,560
have and important thing is like

452
00:16:11,540 --> 00:16:09,060
conditions that are needed for the

453
00:16:13,160 --> 00:16:11,550
chemistry to occur are present and as

454
00:16:14,720 --> 00:16:13,170
long as those conditions are present any

455
00:16:17,660 --> 00:16:14,730
environment that provides them to be

456
00:16:20,300 --> 00:16:17,670
fine and that also kind of opens up for

457
00:16:22,010 --> 00:16:20,310
separate planetary exploration if we

458
00:16:24,830 --> 00:16:22,020
talk about what conditions evening then

459
00:16:26,840 --> 00:16:24,840
you can say you know do let's say event

460
00:16:29,180 --> 00:16:26,850
on Enceladus and Europa have that

461
00:16:31,730 --> 00:16:29,190
condition or if you have it on like a

462
00:16:34,220 --> 00:16:31,740
pool on Mars in the ancient past or

463
00:16:36,020 --> 00:16:34,230

something our subsurface today and so I

464
00:16:40,010 --> 00:16:36,030
don't really think about it as it has to

465
00:16:41,870 --> 00:16:40,020
be this environment that environment but

466
00:16:43,580 --> 00:16:41,880
yet you study hydrothermal systems in

467
00:16:46,220 --> 00:16:43,590
the labs and very curious first of all

468
00:16:48,050 --> 00:16:46,230
how does one create such hydrothermal

469
00:16:50,270 --> 00:16:48,060
systems in the lab and then once you

470
00:16:53,870 --> 00:16:50,280
have created them how do you measure

471
00:16:55,850 --> 00:16:53,880
interesting chemistry in them yeah so I

472
00:16:57,650 --> 00:16:55,860
think it's really fun to study what

473
00:16:59,150 --> 00:16:57,660
happens at the sea floor because that's

474
00:17:01,400 --> 00:16:59,160
the majority of the surface of the earth

475
00:17:02,900 --> 00:17:01,410
is an ocean and also on other worlds

476
00:17:03,830 --> 00:17:02,910
like you're open and sell it is or you

477
00:17:05,690 --> 00:17:03,840
don't have any land

478
00:17:08,720 --> 00:17:05,700
what would is possible even in these

479
00:17:10,250 --> 00:17:08,730
systems and so we look at vents we see

480
00:17:12,530 --> 00:17:10,260
that there's there's all these sub

481
00:17:14,540 --> 00:17:12,540
seafloor kind of fluid alteration

482
00:17:16,070 --> 00:17:14,550
processes and then the fluids come up

483
00:17:17,840 --> 00:17:16,080
and they interact and they interface

484
00:17:19,970 --> 00:17:17,850
with the ocean and you can grow these

485
00:17:22,130 --> 00:17:19,980
sediments and chimneys and there's a lot

486
00:17:24,079 --> 00:17:22,140
of huge types of chimneys that can form

487
00:17:25,760 --> 00:17:24,089
on earth they form they can be very

488
00:17:28,130 --> 00:17:25,770

quick forming they can be very slow

489
00:17:30,560 --> 00:17:28,140
forming and so in the lab we actually

490
00:17:32,630 --> 00:17:30,570
will simulate some of this by having a

491
00:17:34,610 --> 00:17:32,640
little vessel that is full of ocean

492
00:17:36,560 --> 00:17:34,620
water and so this could be early Earth

493
00:17:38,780 --> 00:17:36,570
modern earth you know whatever ocean you

494
00:17:41,390 --> 00:17:38,790
want and then we slowly inject a

495
00:17:43,190 --> 00:17:41,400
hydrothermal solution which mimics how

496
00:17:45,320 --> 00:17:43,200
the solutions come up from the sea floor

497
00:17:47,390 --> 00:17:45,330
so if you inject that slowly from the

498
00:17:49,670 --> 00:17:47,400
bottom you can grow chimneys in the lab

499
00:17:51,470 --> 00:17:49,680
and you can see how that chemistry might

500
00:17:55,970 --> 00:17:51,480
be similar to stuff that you see in

501
00:18:00,430 --> 00:17:55,980
nature Wow so how big are your chimneys

502
00:18:05,390 --> 00:18:03,020
little chimney is like Brady bottles

503
00:18:07,610 --> 00:18:05,400
this big chimney is this big and it's

504
00:18:09,260 --> 00:18:07,620
more about the gradients you can you

505
00:18:11,600 --> 00:18:09,270
have chemistry occurring in a small

506
00:18:14,120 --> 00:18:11,610
system or a big system it just depends

507
00:18:15,950 --> 00:18:14,130
on what minerals and materials are

508
00:18:18,560 --> 00:18:15,960
present and what gradients are there and

509
00:18:20,330 --> 00:18:18,570
we can simulate a lot of the important

510
00:18:22,520 --> 00:18:20,340
properties of vents in the lab with a

511
00:18:23,840 --> 00:18:22,530
small chimneys but for some cases you do

512
00:18:26,180 --> 00:18:23,850
need to go to the field and look at the

513
00:18:27,680 --> 00:18:26,190

much bigger ones and then we're going to

514
00:18:30,140 --> 00:18:27,690
talk about field work in a second but

515
00:18:32,720 --> 00:18:30,150
imperious because the gradients are the

516
00:18:34,610 --> 00:18:32,730
the boundary between the chimney and the

517
00:18:36,530 --> 00:18:34,620
ocean water rights how do you measure in

518
00:18:38,450 --> 00:18:36,540
the lab what's going on there you have

519
00:18:39,799 --> 00:18:38,460
special equipment is it something you

520
00:18:41,900 --> 00:18:39,809
have to touch or you shine a laser

521
00:18:44,630 --> 00:18:41,910
through or like what are your techniques

522
00:18:47,299 --> 00:18:44,640
well so one of the techniques we use is

523
00:18:49,400 --> 00:18:47,309
using electrodes and so kind of like a

524
00:18:50,600 --> 00:18:49,410
battery if you have two electrodes and

525
00:18:52,640 --> 00:18:50,610
you put them where you're going to have

526
00:18:54,260 --> 00:18:52,650
one kind of end of your redox potential

527
00:18:55,880 --> 00:18:54,270
and one where you have the other end you

528
00:18:57,830 --> 00:18:55,890
can measure the potential and the

529
00:18:59,600 --> 00:18:57,840
current that's generated and so we

530
00:19:01,370 --> 00:18:59,610
figure a chimney and you put an

531
00:19:02,900 --> 00:19:01,380
electrode inside the chimney and you

532
00:19:04,820 --> 00:19:02,910
have another one that's outside in the

533
00:19:05,990 --> 00:19:04,830
ocean water and you can measure the

534
00:19:08,120 --> 00:19:06,000
potential that that chimney is

535
00:19:10,190 --> 00:19:08,130
generating and you can also measure say

536
00:19:11,540 --> 00:19:10,200
electrical current and so on so it's a

537
00:19:13,250 --> 00:19:11,550
little bit similar to how if you have a

538
00:19:14,900 --> 00:19:13,260

battery and you put you know your two

539
00:19:16,430 --> 00:19:14,910
ends of the multimeter on it you can

540
00:19:18,950 --> 00:19:16,440
measure the battery and so the chimney

541
00:19:21,110 --> 00:19:18,960
is like a battery too and so we did some

542
00:19:23,120 --> 00:19:21,120
research where we generated energy

543
00:19:25,310 --> 00:19:23,130
electrical energy from a chimney in the

544
00:19:27,169 --> 00:19:25,320
lab and we linked several of those to

545
00:19:29,450 --> 00:19:27,179
muse together in order to light a little

546
00:19:31,190 --> 00:19:29,460
LED light so just the show that you know

547
00:19:32,780 --> 00:19:31,200
these do generate energy and the

548
00:19:35,510 --> 00:19:32,790
chimneys are like little batteries and

549
00:19:37,250 --> 00:19:35,520
so instead you can imagine that instead

550
00:19:38,900 --> 00:19:37,260
of light bulbs it's its energy for

551
00:19:41,270 --> 00:19:38,910
chemical reactions and you might be able

552
00:19:44,090 --> 00:19:41,280
to do things like say provide organic

553
00:19:47,180 --> 00:19:44,100
compounds that might not exist before so

554
00:19:48,740 --> 00:19:47,190
cool success requires energy and so

555
00:19:50,990 --> 00:19:48,750
you're able to measure the voltage

556
00:19:54,740 --> 00:19:51,000
inside the chimney in the ocean which is

557
00:19:58,549 --> 00:19:54,750
an expression of energy and and so such

558
00:20:00,950 --> 00:19:58,559
settings could trigger situations where

559
00:20:03,350 --> 00:20:00,960
life can take advantage of that yeah

560
00:20:04,940 --> 00:20:03,360
that's right and you know life the

561
00:20:07,820 --> 00:20:04,950
origin of life means energy but life

562
00:20:09,919 --> 00:20:07,830
also extant life needs energy too and so

563
00:20:11,930 --> 00:20:09,929

kind of understanding what level of

564
00:20:13,580 --> 00:20:11,940
redox potentials you have in vents and

565
00:20:14,720 --> 00:20:13,590
what different energy sources and energy

566
00:20:16,280 --> 00:20:14,730
sinks are

567
00:20:18,140 --> 00:20:16,290
there can help you understand what types

568
00:20:19,850 --> 00:20:18,150
of life could be there because life can

569
00:20:21,770 --> 00:20:19,860
use you can use things that are coming

570
00:20:23,539 --> 00:20:21,780
out of the event and fluid it can use

571
00:20:25,100 --> 00:20:23,549
things with seawater it can use the

572
00:20:27,350 --> 00:20:25,110
actual minerals of the chimney itself

573
00:20:29,180 --> 00:20:27,360
just so it depends and understanding

574
00:20:31,580 --> 00:20:29,190
what life can live in what type of

575
00:20:33,280 --> 00:20:31,590
system it may be help us predict how we

576
00:20:35,630 --> 00:20:33,290
would look for life on other planets

577
00:20:38,630 --> 00:20:35,640
very cool so all the life we see around

578
00:20:40,880 --> 00:20:38,640
us today ultimately depends on sunlight

579
00:20:42,440 --> 00:20:40,890
but of course life at the seafloor there

580
00:20:45,020 --> 00:20:42,450
is no sunlight and we think about life

581
00:20:47,270 --> 00:20:45,030
on those icy worlds around you our on

582
00:20:49,100 --> 00:20:47,280
Saturn or around Jupiter there's also no

583
00:20:50,840 --> 00:20:49,110
sunlight at the seafloor and so the

584
00:20:52,760 --> 00:20:50,850
chemistry you're exploring is a source

585
00:20:54,260 --> 00:20:52,770
of energy for potential biology that's

586
00:20:56,600 --> 00:20:54,270
down there that's absolutely fascinating

587
00:20:59,120 --> 00:20:56,610
now how do you measure that in real life

588
00:21:02,840 --> 00:20:59,130

suppose we had a mission to go to these

589
00:21:04,730 --> 00:21:02,850
Extra Terrestrial oceans and we could go

590
00:21:06,080 --> 00:21:04,740
to the seafloor how would one understand

591
00:21:08,299 --> 00:21:06,090
them and I understand you've been

592
00:21:10,310 --> 00:21:08,309
recently funded by NASA to develop

593
00:21:12,830 --> 00:21:10,320
search technologies tell us more about

594
00:21:14,990 --> 00:21:12,840
that yeah so this is a project called

595
00:21:16,850 --> 00:21:15,000
invader which is the Institute vent

596
00:21:19,070 --> 00:21:16,860
analysis dive bot for EXO biology

597
00:21:21,950 --> 00:21:19,080
research it's led by pedlow so Brown at

598
00:21:23,720 --> 00:21:21,960
SETI and I'm the science bi and so this

599
00:21:26,060 --> 00:21:23,730
is this is a project where we're gonna

600
00:21:28,760 --> 00:21:26,070
send an underwater laser to event in the

601
00:21:30,380 --> 00:21:28,770
Pacific Ocean and if you if you run

602
00:21:31,669 --> 00:21:30,390
another planet and you had a vent that

603
00:21:32,840 --> 00:21:31,679
you wanted to look at I mean even

604
00:21:34,159 --> 00:21:32,850
finding the vent would be a real

605
00:21:36,289 --> 00:21:34,169
challenge right because you don't know

606
00:21:38,450 --> 00:21:36,299
exactly where they are and also there's

607
00:21:40,340 --> 00:21:38,460
not going to be technology to have

608
00:21:42,260 --> 00:21:40,350
immediate decision-making when you're in

609
00:21:44,210 --> 00:21:42,270
that situation so the mission would have

610
00:21:46,100 --> 00:21:44,220
to be able to say is this a good vantage

611
00:21:47,870 --> 00:21:46,110
of study how long should I study it

612
00:21:50,659 --> 00:21:47,880
which types of data should it take for

613
00:21:52,549 --> 00:21:50,669

how long it's cetera and so also you

614
00:21:54,680 --> 00:21:52,559
wouldn't really necessarily be able to

615
00:21:56,450 --> 00:21:54,690
take samples from the chimney a lot of

616
00:21:58,100 --> 00:21:56,460
work that's being done in oceanography

617
00:22:00,140 --> 00:21:58,110
you can actually take samples and

618
00:22:00,560 --> 00:22:00,150
analyze fluids but if you couldn't do

619
00:22:02,270 --> 00:22:00,570
that

620
00:22:03,680 --> 00:22:02,280
how much information could you get if

621
00:22:06,799 --> 00:22:03,690
you were just looking at the chimney

622
00:22:08,960 --> 00:22:06,809
from say a few meters away and so the

623
00:22:11,360 --> 00:22:08,970
invader project is going to use a laser

624
00:22:13,490 --> 00:22:11,370
a Raman laser and a-- lives to look at

625
00:22:15,110 --> 00:22:13,500
these chimneys and see can we detect

626
00:22:17,000 --> 00:22:15,120
life in this chimney of course we know

627
00:22:19,039 --> 00:22:17,010
that there's already life here but can

628
00:22:20,870 --> 00:22:19,049
we detect it with this payload and what

629
00:22:23,120 --> 00:22:20,880
information can you get about the

630
00:22:25,460 --> 00:22:23,130
astrology and the habitability of this

631
00:22:26,280 --> 00:22:25,470
environment from a standoff payload and

632
00:22:27,990 --> 00:22:26,290
then what

633
00:22:30,810 --> 00:22:28,000
is that compared to what we already know

634
00:22:33,810 --> 00:22:30,820
from things like sampling cool tell us a

635
00:22:35,610 --> 00:22:33,820
bit more about how it lives work so

636
00:22:37,980 --> 00:22:35,620
these these lasers they function in

637
00:22:39,690 --> 00:22:37,990
different ways so ellipse tells you what

638
00:22:41,520 --> 00:22:39,700

elements are in the sample and then

639
00:22:43,410 --> 00:22:41,530
Arama and will tell you elements and

640
00:22:45,930 --> 00:22:43,420
minerals and molecules and these can

641
00:22:48,330 --> 00:22:45,940
both do for solid and for liquid so

642
00:22:50,460 --> 00:22:48,340
we're gonna be testing not just in the

643
00:22:52,230 --> 00:22:50,470
deployment where we we put the laser in

644
00:22:54,510 --> 00:22:52,240
the ocean but also in the lab we'll be

645
00:22:56,400 --> 00:22:54,520
testing with lasers using actual event

646
00:22:59,130 --> 00:22:56,410
samples what does what do these look

647
00:23:01,110 --> 00:22:59,140
like and can you find life and hang out

648
00:23:02,910 --> 00:23:01,120
what other types of habitability can you

649
00:23:05,280 --> 00:23:02,920
see in these samples so things like what

650
00:23:07,260 --> 00:23:05,290
are the elements present like carbon

651
00:23:08,670 --> 00:23:07,270
phosphorus nitrogen and what minerals

652
00:23:11,220 --> 00:23:08,680
are there and are these minerals that

653
00:23:13,740 --> 00:23:11,230
can provide energy and so it's gonna be

654
00:23:15,840 --> 00:23:13,750
pretty exciting so the point of going to

655
00:23:18,570 --> 00:23:15,850
an actual event in the Pacific Ocean

656
00:23:21,990 --> 00:23:18,580
with the instrument is to look at the

657
00:23:23,580 --> 00:23:22,000
vent using those lasers and using the

658
00:23:25,410 --> 00:23:23,590
technologies you've been describing and

659
00:23:27,630 --> 00:23:25,420
then but also sampling and then

660
00:23:29,220 --> 00:23:27,640
comparing if you what information can

661
00:23:31,530 --> 00:23:29,230
gather just from the laser compared to

662
00:23:33,930 --> 00:23:31,540
what's actually there is that right yeah

663
00:23:35,640 --> 00:23:33,940

and you know this is why for these for

664
00:23:37,200 --> 00:23:35,650
some of these types of programs it's not

665
00:23:38,880 --> 00:23:37,210
just science where you're learning new

666
00:23:41,310 --> 00:23:38,890
information about a site it's also

667
00:23:42,990 --> 00:23:41,320
science operations where you know it's

668
00:23:44,400 --> 00:23:43,000
it's the techniques of how do you get

669
00:23:45,690 --> 00:23:44,410
science in the first place and how does

670
00:23:47,910 --> 00:23:45,700
this work there's a lot of

671
00:23:49,440 --> 00:23:47,920
decision-making and you know kind of if

672
00:23:50,880 --> 00:23:49,450
then if then type of stuff that goes

673
00:23:53,250 --> 00:23:50,890
into how you approach getting

674
00:23:54,870 --> 00:23:53,260
information from a site especially when

675
00:23:57,870 --> 00:23:54,880
you're limited on things like power or

676
00:24:00,150 --> 00:23:57,880
data or a number of spectra or you know

677
00:24:02,730 --> 00:24:00,160
resolution and things like that and so

678
00:24:04,530 --> 00:24:02,740
just understanding questions like if

679
00:24:06,690 --> 00:24:04,540
even if you have a perfect map of the

680
00:24:08,100 --> 00:24:06,700
chimney you know how often do you need

681
00:24:11,130 --> 00:24:08,110
that map in order to tell how it's

682
00:24:12,720 --> 00:24:11,140
changing or if you have let's say seven

683
00:24:14,340 --> 00:24:12,730
points that you can take spectra from

684
00:24:16,350 --> 00:24:14,350
where would you place those in order to

685
00:24:18,750 --> 00:24:16,360
understand if there's a mineral present

686
00:24:20,280 --> 00:24:18,760
or not and things like that you can kind

687
00:24:21,930 --> 00:24:20,290
of make predictions and test this in the

688
00:24:24,390 --> 00:24:21,940

lab and then try to prepare or what this

689
00:24:28,080 --> 00:24:24,400
might be like on a mission that's so

690
00:24:30,630 --> 00:24:28,090
cool and so I'm just curious about

691
00:24:32,820 --> 00:24:30,640
whether you're you're training in

692
00:24:36,120 --> 00:24:32,830
theater you know way back when in

693
00:24:37,860 --> 00:24:36,130
undergrad is coming back to you now does

694
00:24:39,869 --> 00:24:37,870
it help you in your in your in your

695
00:24:42,089 --> 00:24:39,879
science you know it's

696
00:24:45,569 --> 00:24:42,099
because it actually does I never thought

697
00:24:47,729 --> 00:24:45,579
it would but I mean first of all I had

698
00:24:49,469 --> 00:24:47,739
no idea when I was majoring in astronomy

699
00:24:51,569 --> 00:24:49,479
that having a being a scientist as a

700
00:24:53,759 --> 00:24:51,579
career was so dependent on public

701
00:24:55,769 --> 00:24:53,769
speaking and also on kind of the arts

702
00:24:58,229 --> 00:24:55,779
you know like graphic design and giving

703
00:25:00,779 --> 00:24:58,239
good presentations and all of that stuff

704
00:25:03,749 --> 00:25:00,789
is so important and had no idea and so

705
00:25:05,609 --> 00:25:03,759
when I was in the I think in high school

706
00:25:07,439 --> 00:25:05,619
actually took acting class a couple

707
00:25:09,749 --> 00:25:07,449
times and then in college I took some

708
00:25:11,879 --> 00:25:09,759
more acting class and I was never I was

709
00:25:14,339 --> 00:25:11,889
not an actor in theatre I was mostly

710
00:25:15,869 --> 00:25:14,349
doing the set design and costumes so I

711
00:25:18,149 --> 00:25:15,879
was really into all that but it's about

712
00:25:20,519 --> 00:25:18,159
creating a world and you know painting

713
00:25:22,829 --> 00:25:20,529

and sewing and stuff like that but also

714
00:25:24,599 --> 00:25:22,839
when you're doing theater for set design

715
00:25:26,639 --> 00:25:24,609
for example it's a lot of project

716
00:25:28,739 --> 00:25:26,649
management so you have a budget and you

717
00:25:30,599 --> 00:25:28,749
have materials and you have you know you

718
00:25:32,249 --> 00:25:30,609
have assets things like power tools and

719
00:25:33,809 --> 00:25:32,259
like your stock of paints and woods and

720
00:25:35,489 --> 00:25:33,819
whatnot and you have to manage your

721
00:25:37,619 --> 00:25:35,499
supplies and your budget and your

722
00:25:39,149 --> 00:25:37,629
personnel and your schedule and it turns

723
00:25:41,430 --> 00:25:39,159
out that science is a lot like that

724
00:25:43,199 --> 00:25:41,440
especially in chemistry because when you

725
00:25:44,669 --> 00:25:43,209
run a lab group you have a budget and

726
00:25:46,649 --> 00:25:44,679
you have supplies and you have people

727
00:25:48,419 --> 00:25:46,659
and you have deadlines and you have to

728
00:25:49,680 --> 00:25:48,429
enact these big projects or you don't

729
00:25:52,409 --> 00:25:49,690
know what the outcomes gonna quite be

730
00:25:54,599 --> 00:25:52,419
and so it turned out product management

731
00:25:58,049 --> 00:25:54,609
it was an excellent skill to learn for

732
00:26:00,629 --> 00:25:58,059
this career yeah I wonder sometimes why

733
00:26:02,669 --> 00:26:00,639
the fundamentals of business is not

734
00:26:04,829 --> 00:26:02,679
taught as part of graduate school to

735
00:26:06,419 --> 00:26:04,839
become a PI you know it seems like it's

736
00:26:08,669 --> 00:26:06,429
really useful skills to know how to

737
00:26:11,069 --> 00:26:08,679
create a Gantt chart and and find out

738
00:26:13,289 --> 00:26:11,079

where your where your your key

739
00:26:15,959 --> 00:26:13,299
milestones are that's important skills

740
00:26:17,369 --> 00:26:15,969
to be able to put together so anyways if

741
00:26:18,809 --> 00:26:17,379
those of you who are watching if you

742
00:26:20,309 --> 00:26:18,819
have any questions for dr. bard we're

743
00:26:21,930 --> 00:26:20,319
gonna open up for questions very soon

744
00:26:23,819 --> 00:26:21,940
don't forget to ask your questions right

745
00:26:26,369 --> 00:26:23,829
on this on the Signet or chat if you're

746
00:26:28,589 --> 00:26:26,379
watching on según or on Signet if you're

747
00:26:30,839 --> 00:26:28,599
on twitter please use hashtag ask a

748
00:26:33,749 --> 00:26:30,849
survey or on facebook right there in the

749
00:26:36,569 --> 00:26:33,759
in the comments down below you have a

750
00:26:38,129 --> 00:26:36,579
slew of hobbies and one of them that I

751
00:26:40,680 --> 00:26:38,139
find particularly fascinating is that

752
00:26:43,079 --> 00:26:40,690
you are you're an eclipse chaser tell us

753
00:26:45,449 --> 00:26:43,089
more about that well I've only just

754
00:26:47,249 --> 00:26:45,459
started this because the first Eclipse

755
00:26:48,870 --> 00:26:47,259
the first total eclipse in my lifetime

756
00:26:51,540 --> 00:26:48,880
in the US was

757
00:26:53,400 --> 00:26:51,550
one in 2017 so this started in Oregon

758
00:26:55,860 --> 00:26:53,410
that went all the way across the US and

759
00:26:57,990 --> 00:26:55,870
so I've never seen a total eclipse and I

760
00:26:59,880 --> 00:26:58,000
really wanted to so I went to Oregon

761
00:27:02,100 --> 00:26:59,890
with my husband and we went to Madras

762
00:27:04,410 --> 00:27:02,110
Oregon where there was this big kind of

763
00:27:06,450 --> 00:27:04,420

camping event in a field and so we

764
00:27:08,430 --> 00:27:06,460
camped for a couple days and then the

765
00:27:10,380 --> 00:27:08,440
Eclipse was around noon and so it was

766
00:27:12,540 --> 00:27:10,390
right overhead in the sky and it was

767
00:27:14,220 --> 00:27:12,550
really amazing and so I thought well I'm

768
00:27:16,410 --> 00:27:14,230
really glad I you know took the effort

769
00:27:17,910 --> 00:27:16,420
to go to exactly where totality was and

770
00:27:20,910 --> 00:27:17,920
I have to see this again because it's

771
00:27:22,980 --> 00:27:20,920
just so awesome and so then in 2019 this

772
00:27:24,960 --> 00:27:22,990
year in the summer we went to Chile with

773
00:27:27,060 --> 00:27:24,970
some friends and we saw the Eclipse in

774
00:27:28,800 --> 00:27:27,070
la serena chile this one was actually

775
00:27:30,240 --> 00:27:28,810
around 4:00 p.m. and it was over the

776
00:27:32,880 --> 00:27:30,250
ocean so that was a totally different

777
00:27:34,650 --> 00:27:32,890
thing and it was amazing and so i you

778
00:27:35,790 --> 00:27:34,660
know it's hard to get the money and the

779
00:27:37,440 --> 00:27:35,800
time to go to a lot of these because

780
00:27:39,480 --> 00:27:37,450
they're in remote locations but i do

781
00:27:42,630 --> 00:27:39,490
intend to try to go to as many as i can

782
00:27:44,910 --> 00:27:42,640
i was not too far away from you in

783
00:27:46,260 --> 00:27:44,920
oregon for the 2017 eclipse and it was

784
00:27:48,510 --> 00:27:46,270
just it's it's almost a spiritual

785
00:27:51,900 --> 00:27:48,520
experience to see the moon cover the Sun

786
00:27:56,790 --> 00:27:51,910
it's just very impressive so you're also

787
00:27:57,930 --> 00:27:56,800
an amateur winemaker yeah I did some of

788
00:28:00,150 --> 00:27:57,940

that you know my husband and I had made

789
00:28:01,590 --> 00:28:00,160
wine for a couple years and it was

790
00:28:03,300 --> 00:28:01,600
pretty fun it's like having you know

791
00:28:05,100 --> 00:28:03,310
chemistry lab here and your house and

792
00:28:06,930 --> 00:28:05,110
you can you can make some wine and it

793
00:28:08,580 --> 00:28:06,940
was fun to see the fermentation

794
00:28:10,200 --> 00:28:08,590
occurring so we did that for a couple

795
00:28:12,000 --> 00:28:10,210
years and we haven't done it in a long

796
00:28:14,100 --> 00:28:12,010
time because when you make wine you get

797
00:28:17,610 --> 00:28:14,110
so much wine and it's just it's too much

798
00:28:20,460 --> 00:28:17,620
and plus you know there's only time for

799
00:28:21,810 --> 00:28:20,470
a few hobbies at once anyway so we

800
00:28:25,200 --> 00:28:21,820
haven't done that in a while but it was

801
00:28:27,180 --> 00:28:25,210
a lot of fun very cool very cool so and

802
00:28:28,770 --> 00:28:27,190
so I guess we can we can open it up for

803
00:28:30,090 --> 00:28:28,780
questions now Lori this is fascinating

804
00:28:32,370 --> 00:28:30,100
conversation there's so many more

805
00:28:33,900 --> 00:28:32,380
questions I have but part of the beauty

806
00:28:36,780 --> 00:28:33,910
of this program is to let our viewers

807
00:28:39,900 --> 00:28:36,790
ask you questions and so the first

808
00:28:43,320 --> 00:28:39,910
question is by dr. Jim Paz who tweets as

809
00:28:44,970 --> 00:28:43,330
at Astro sociology and he asks I know

810
00:28:47,040 --> 00:28:44,980
that you value our reach and education

811
00:28:48,990 --> 00:28:47,050
as such what is your opinion about what

812
00:28:51,000 --> 00:28:49,000
the social sciences and humanities can

813
00:28:53,460 --> 00:28:51,010

add to the astrobiology bill search for

814
00:28:54,060 --> 00:28:53,470
extraterrestrial life oh that's a good

815
00:28:56,790 --> 00:28:54,070
question

816
00:28:58,200 --> 00:28:56,800
so let's see I do value outreach a lot

817
00:29:00,690 --> 00:28:58,210
and one of the things I really enjoy

818
00:29:02,320 --> 00:29:00,700
doing is in addition to the science

819
00:29:04,060 --> 00:29:02,330
itself is trying to bring

820
00:29:05,889 --> 00:29:04,070
our people in the science and trying to

821
00:29:06,970 --> 00:29:05,899
kind of break down barriers for for

822
00:29:09,639 --> 00:29:06,980
different types of people to be

823
00:29:11,560 --> 00:29:09,649
participating in NASA research and so I

824
00:29:13,930 --> 00:29:11,570
mean one of the most important things I

825
00:29:16,269 --> 00:29:13,940
think Social Sciences can contribute is

826
00:29:17,889 --> 00:29:16,279
by understanding how you know how people

827
00:29:19,870 --> 00:29:17,899
function in groups and how teams work

828
00:29:21,399 --> 00:29:19,880
and how we can best improve say

829
00:29:23,320 --> 00:29:21,409
diversity and inclusion in our

830
00:29:25,299 --> 00:29:23,330
Institute's and in our product teams and

831
00:29:26,529 --> 00:29:25,309
so on and it's not something that we're

832
00:29:28,840 --> 00:29:26,539
ever trained in you know in science

833
00:29:30,639 --> 00:29:28,850
let's understand like how do you how do

834
00:29:32,620 --> 00:29:30,649
you deal with different types of people

835
00:29:34,690 --> 00:29:32,630
and how do you manage a group and how do

836
00:29:37,090 --> 00:29:34,700
you make sure that it's fair inclusive

837
00:29:38,889 --> 00:29:37,100
and you know so this is all stuff where

838
00:29:40,690 --> 00:29:38,899

we look to I think the social scientists

839
00:29:42,159 --> 00:29:40,700
to give us tips about how best to

840
00:29:44,259 --> 00:29:42,169
proceed but I think a lot of

841
00:29:45,669 --> 00:29:44,269
astrobiologists care about this but we

842
00:29:49,690 --> 00:29:45,679
don't often know what techniques to

843
00:29:51,549 --> 00:29:49,700
apply the great answer thank you next

844
00:29:53,919 --> 00:29:51,559
question is by Elizabeth Hudson who

845
00:29:57,159 --> 00:29:53,929
tweets as asked Astro boodikka

846
00:29:59,409 --> 00:29:57,169
and she asks your research is exactly

847
00:30:01,269 --> 00:29:59,419
what I want to do what appeal sets

848
00:30:03,220 --> 00:30:01,279
should I work on that would be most

849
00:30:06,940 --> 00:30:03,230
helpful to a potential mentor doing this

850
00:30:09,039 --> 00:30:06,950
or similar research well let's see you

851
00:30:11,230 --> 00:30:09,049
know I would say of course science like

852
00:30:11,950 --> 00:30:11,240
learning about geology astronomy and

853
00:30:14,440 --> 00:30:11,960
oceanography

854
00:30:16,509 --> 00:30:14,450
of course but also I just think learning

855
00:30:18,129 --> 00:30:16,519
how to be brave and try new things is

856
00:30:20,799 --> 00:30:18,139
important because that's kind of a skill

857
00:30:22,450 --> 00:30:20,809
too and you know doing different types

858
00:30:25,960 --> 00:30:22,460
of research even if it's not something

859
00:30:28,389 --> 00:30:25,970
than before but also if you want to be a

860
00:30:29,919 --> 00:30:28,399
science PI and do it leading a team and

861
00:30:31,629 --> 00:30:29,929
so forth understanding how to be a

862
00:30:33,490 --> 00:30:31,639
leader and getting opportunities to

863
00:30:35,769 --> 00:30:33,500

practice that is very important even if

864
00:30:37,899 --> 00:30:35,779
it's not for work or for school but just

865
00:30:39,759 --> 00:30:37,909
having experience and how to lead and

866
00:30:40,690 --> 00:30:39,769
how to you know manage big projects and

867
00:30:43,899 --> 00:30:40,700
things like that I think it's very

868
00:30:45,549 --> 00:30:43,909
important yeah the opportunities to push

869
00:30:46,930 --> 00:30:45,559
yourself beyond your comfort zone is

870
00:30:48,669 --> 00:30:46,940
something that all of you who are early

871
00:30:51,120 --> 00:30:48,679
in your career should take advantage of

872
00:30:55,240 --> 00:30:51,130
so great point Lori I'm glad you made it

873
00:30:57,070 --> 00:30:55,250
Gaurav Yadav on stage Annette asks which

874
00:30:58,840 --> 00:30:57,080
type of hydrothermal vents seems to be

875
00:31:00,549 --> 00:30:58,850
the most promising to predict the origin

876
00:31:03,879 --> 00:31:00,559
of life where there's a deep-sea or

877
00:31:05,590 --> 00:31:03,889
terrestrial hot spring and why oh well I

878
00:31:07,450 --> 00:31:05,600
mean it's not just those two types right

879
00:31:09,460 --> 00:31:07,460
so each you know for example deep-sea

880
00:31:11,470 --> 00:31:09,470
vents have many different types and so I

881
00:31:12,640 --> 00:31:11,480
don't think that the point is whether

882
00:31:14,350 --> 00:31:12,650
it's on land or in the

883
00:31:16,570 --> 00:31:14,360
it's about what chemistry does it have

884
00:31:18,160 --> 00:31:16,580
and so you could have for example event

885
00:31:19,390 --> 00:31:18,170
that's kind of off the shore that's near

886
00:31:21,520 --> 00:31:19,400
the surface you could have one on the

887
00:31:23,110 --> 00:31:21,530
surface I think that the ones most

888
00:31:25,420 --> 00:31:23,120

likely for some reactions with the

889
00:31:27,790 --> 00:31:25,430
alkaline so that's a higher pH event and

890
00:31:29,440 --> 00:31:27,800
not too hot so not ones that are so

891
00:31:31,600 --> 00:31:29,450
superheated like hundreds of degrees

892
00:31:34,180 --> 00:31:31,610
like the ones that the black smokers for

893
00:31:35,770 --> 00:31:34,190
example but different chemistry is the

894
00:31:37,150 --> 00:31:35,780
important thing and so just because it's

895
00:31:38,740 --> 00:31:37,160
a hot spring doesn't mean it's going to

896
00:31:40,150 --> 00:31:38,750
have the right chemistry you might have

897
00:31:42,400 --> 00:31:40,160
different chemistry's and the same is

898
00:31:47,050 --> 00:31:42,410
true for the deep-sea vents so I would

899
00:31:52,210 --> 00:31:50,320
Sudeep B swats on say Gannett asks were

900
00:31:53,860 --> 00:31:52,220
terrestrial hot springs in prebiotic

901
00:31:55,270 --> 00:31:53,870
times the same is higher thermal vents

902
00:31:59,170 --> 00:31:55,280
today when it comes to the origin of

903
00:32:02,200 --> 00:31:59,180
molecules not necessarily so there were

904
00:32:04,330 --> 00:32:02,210
similarities but a lot a lot would

905
00:32:05,530 --> 00:32:04,340
depend on the types of rocks so for

906
00:32:07,210 --> 00:32:05,540
Earth you know that may have been

907
00:32:08,800 --> 00:32:07,220
similar but for other planets the types

908
00:32:10,210 --> 00:32:08,810
of rock that you're circulating water

909
00:32:12,010 --> 00:32:10,220
through could be very different so that

910
00:32:13,780 --> 00:32:12,020
could lead to differences but also the

911
00:32:15,370 --> 00:32:13,790
ocean on early Earth is very different

912
00:32:17,380 --> 00:32:15,380
and one of the important thing is is

913
00:32:19,000 --> 00:32:17,390

that it didn't have oxygen so when you

914
00:32:20,470 --> 00:32:19,010
don't have oxygen in the ocean you can

915
00:32:22,900 --> 00:32:20,480
have a lot more dissolved metals like

916
00:32:24,580 --> 00:32:22,910
iron nickel and so forth and that leads

917
00:32:27,160 --> 00:32:24,590
to a different type of mineral being

918
00:32:28,780 --> 00:32:27,170
precipitated so that's one main thing is

919
00:32:30,760 --> 00:32:28,790
that you get you get a lot of new types

920
00:32:32,890 --> 00:32:30,770
of reactive minerals that are possible

921
00:32:34,660 --> 00:32:32,900
when you don't have oxygen so that's one

922
00:32:39,600 --> 00:32:34,670
of the main differences I think that

923
00:32:42,940 --> 00:32:39,610
affected interesting yep

924
00:32:44,980 --> 00:32:42,950
sir hot chef Jen if I pronounced that

925
00:32:46,690 --> 00:32:44,990
properly on say Gannett ask a question

926
00:32:49,030 --> 00:32:46,700
it's very similar to some of we

927
00:32:51,840 --> 00:32:49,040
discussed before but he focuses he or

928
00:32:53,890 --> 00:32:51,850
she focuses on kind of more particular

929
00:32:56,170 --> 00:32:53,900
hypothesis for the origin of life and

930
00:32:58,390 --> 00:32:56,180
and you'll recognize it in a second so

931
00:33:00,550 --> 00:32:58,400
he or she asks the origin of life on

932
00:33:02,500 --> 00:33:00,560
Earth is attributed by a some two

933
00:33:03,940 --> 00:33:02,510
special alkaline vents

934
00:33:06,190 --> 00:33:03,950
can you explain what kind of specific

935
00:33:08,530 --> 00:33:06,200
geochemistry alkaline vents have that

936
00:33:11,230 --> 00:33:08,540
could result there urgent of life on

937
00:33:14,440 --> 00:33:11,240
Earth and why do black smokers are not

938
00:33:16,750 --> 00:33:14,450

thought to be involved yeah so the

939
00:33:19,240 --> 00:33:16,760
alkaline vents are there they're very

940
00:33:20,210 --> 00:33:19,250
interesting because they if you assume

941
00:33:22,580 --> 00:33:20,220
that the early Earth

942
00:33:23,779 --> 00:33:22,590
has you know some co2 dissolves in it

943
00:33:26,090 --> 00:33:23,789
which it would have because the

944
00:33:27,440 --> 00:33:26,100
atmosphere had more co2 and the ocean is

945
00:33:29,690 --> 00:33:27,450
a little more acidic than it is today

946
00:33:31,399 --> 00:33:29,700
and so the event itself is producing

947
00:33:33,680 --> 00:33:31,409
alkaline fluids so you have a different

948
00:33:35,570 --> 00:33:33,690
type of pH gradient and if you compare

949
00:33:37,430 --> 00:33:35,580
that to a black smoker the black smoker

950
00:33:39,799 --> 00:33:37,440
is acidic usually and so that would be

951
00:33:41,419 --> 00:33:39,809
not quite the right pH gradient so the

952
00:33:43,759 --> 00:33:41,429
alkaline vent gives you a pH gradient

953
00:33:45,200 --> 00:33:43,769
that is similar to life and it's thought

954
00:33:48,590 --> 00:33:45,210
to have driven some origin of life

955
00:33:50,240 --> 00:33:48,600
processes but also the alkaline vent has

956
00:33:51,980 --> 00:33:50,250
a temperature that's pretty mild so

957
00:33:53,840 --> 00:33:51,990
you're not you're not superheated in

958
00:33:56,779 --> 00:33:53,850
destroying organic molecules it's around

959
00:33:58,340 --> 00:33:56,789
like 50 to 90 degrees Celsius which is a

960
00:34:00,919 --> 00:33:58,350
good temperature for a lot of reactions

961
00:34:02,720 --> 00:34:00,929
to occur so the pH gradient temperature

962
00:34:04,580 --> 00:34:02,730
if it's not too hot and also the types

963
00:34:07,970 --> 00:34:04,590

of minerals that are in that vent that

964
00:34:10,040 --> 00:34:07,980
are very reactive and interesting thank

965
00:34:11,869 --> 00:34:10,050
you yes again it's those gradients and

966
00:34:13,940 --> 00:34:11,879
chemistry that are so important to

967
00:34:15,440 --> 00:34:13,950
jumpstart the chemistry that can sustain

968
00:34:19,250 --> 00:34:15,450
life or perhaps create the molecules

969
00:34:23,540 --> 00:34:19,260
that can begin life so fascinating

970
00:34:26,359 --> 00:34:23,550
fascinating science again great question

971
00:34:29,230 --> 00:34:26,369
what are the odds of abiogenesis still

972
00:34:32,899 --> 00:34:29,240
occurring today or is our so saturated

973
00:34:35,180 --> 00:34:32,909
right so saturated with life that it

974
00:34:36,440 --> 00:34:35,190
simply isn't necessary or does earth no

975
00:34:39,379 --> 00:34:36,450
longer have the conditions for

976
00:34:41,960 --> 00:34:39,389
abiogenesis that's a great one it's I

977
00:34:44,720 --> 00:34:41,970
think about this a lot and so you know

978
00:34:46,309 --> 00:34:44,730
abiogenesis it so there's two things one

979
00:34:48,230 --> 00:34:46,319
is that early Earth environments are

980
00:34:49,790 --> 00:34:48,240
different and so you need some of that

981
00:34:51,770 --> 00:34:49,800
difference in order for origin of life

982
00:34:53,990 --> 00:34:51,780
to occur so things like having an ocean

983
00:34:54,800 --> 00:34:54,000
that's anoxic and rich and iron and

984
00:34:57,260 --> 00:34:54,810
things like that

985
00:34:58,730 --> 00:34:57,270
but also even if you assume that maybe

986
00:35:00,650 --> 00:34:58,740
some origin of life stuff could happen

987
00:35:03,140 --> 00:35:00,660
today the problem is that life would

988
00:35:05,450 --> 00:35:03,150

just eat it because life is dominant on

989
00:35:07,910 --> 00:35:05,460
every area of this planet now it's a

990
00:35:09,890 --> 00:35:07,920
complete biosphere right and so if you

991
00:35:11,690 --> 00:35:09,900
had any kind of abiotic thing happening

992
00:35:13,339 --> 00:35:11,700
it would be vastly out competed by life

993
00:35:15,020 --> 00:35:13,349
and so you don't really have the

994
00:35:17,720 --> 00:35:15,030
opportunity anymore for this kind of

995
00:35:18,770 --> 00:35:17,730
complexity to emerge by itself because

996
00:35:20,599 --> 00:35:18,780
life was there and it's way more

997
00:35:22,010 --> 00:35:20,609
advanced and it will just consume it and

998
00:35:23,750 --> 00:35:22,020
so when we look for life elsewhere

999
00:35:25,609 --> 00:35:23,760
actually this is one of the things is

1000
00:35:27,800 --> 00:35:25,619
that if you didn't have an entire

1001
00:35:29,839 --> 00:35:27,810
biosphere at this point you might have

1002
00:35:32,430 --> 00:35:29,849
life maybe in certain you know small

1003
00:35:34,079 --> 00:35:32,440
areas but maybe if you had origin of

1004
00:35:36,180 --> 00:35:34,089
processes that never quite made it to

1005
00:35:37,680 --> 00:35:36,190
life you might see more complex stuff

1006
00:35:39,870 --> 00:35:37,690
than you see on earth in an abiotic

1007
00:35:41,670 --> 00:35:39,880
sense so we don't really know so yeah

1008
00:35:43,620 --> 00:35:41,680
it's a great question and I think the

1009
00:35:45,660 --> 00:35:43,630
presence of life on earth makes Earth

1010
00:35:47,849 --> 00:35:45,670
not a great analog for understanding a

1011
00:35:50,670 --> 00:35:47,859
biotic possibilities because they're so

1012
00:35:53,160 --> 00:35:50,680
suppressed at this point totally fully

1013
00:35:55,410 --> 00:35:53,170

great question Elizabeth thank you next

1014
00:35:58,920 --> 00:35:55,420
question is by a spooky tardigrade who

1015
00:36:00,450 --> 00:35:58,930
tweets as at just guelda and they ask

1016
00:36:02,750 --> 00:36:00,460
what do you advise for getting more

1017
00:36:06,030 --> 00:36:02,760
young students involved in astrobiology

1018
00:36:08,010 --> 00:36:06,040
um well I think that it's it would be

1019
00:36:09,930 --> 00:36:08,020
really important for the students to

1020
00:36:11,910 --> 00:36:09,940
kind of seek out mentors in the young

1021
00:36:13,920 --> 00:36:11,920
science community so people even in you

1022
00:36:16,260 --> 00:36:13,930
know grad students but also postdocs and

1023
00:36:17,940 --> 00:36:16,270
early career scientists because we are

1024
00:36:19,829 --> 00:36:17,950
often very happy to talk about our work

1025
00:36:21,930 --> 00:36:19,839
and we want to help and all that but

1026
00:36:23,520 --> 00:36:21,940
also participating in events is a lot of

1027
00:36:25,230 --> 00:36:23,530
different depending on where you are in

1028
00:36:26,940 --> 00:36:25,240
the world what type of science you like

1029
00:36:28,770 --> 00:36:26,950
there's a lot of different events and

1030
00:36:30,300 --> 00:36:28,780
programs that you can participate in

1031
00:36:32,339 --> 00:36:30,310
that will get you more experience in

1032
00:36:33,839 --> 00:36:32,349
this area and then for scientists who

1033
00:36:35,940 --> 00:36:33,849
want to bring young scientists in I

1034
00:36:37,770 --> 00:36:35,950
think it's important to you know not

1035
00:36:39,599 --> 00:36:37,780
just wait for people to come to you but

1036
00:36:40,950 --> 00:36:39,609
actually try to recruit so going out to

1037
00:36:42,660 --> 00:36:40,960
schools and saying you know here is

1038
00:36:44,640 --> 00:36:42,670

research and it's cool and you should

1039
00:36:46,319 --> 00:36:44,650
join it and here I have this internships

1040
00:36:48,210 --> 00:36:46,329
at JPL or at NASA and you should apply

1041
00:36:50,280 --> 00:36:48,220
for them and so I think with kind of

1042
00:36:52,020 --> 00:36:50,290
both ends doing things then we can we

1043
00:36:54,540 --> 00:36:52,030
can establish a lot more presence of

1044
00:36:56,339 --> 00:36:54,550
people in science could you tell us a

1045
00:36:58,290 --> 00:36:56,349
little bit Laurie how you benefited from

1046
00:36:59,910 --> 00:36:58,300
mentors and what you're doing today - I

1047
00:37:01,470 --> 00:36:59,920
know your lab is full of early career

1048
00:37:03,839 --> 00:37:01,480
people and I want to make sure you talk

1049
00:37:05,760 --> 00:37:03,849
about that because that's important yeah

1050
00:37:07,170 --> 00:37:05,770
I think mentors are really important

1051
00:37:08,700 --> 00:37:07,180
they've been important for me I've had

1052
00:37:11,700 --> 00:37:08,710
various ones from you know different

1053
00:37:13,319 --> 00:37:11,710
stages of my career and it's important

1054
00:37:15,390 --> 00:37:13,329
to have different types of mentors even

1055
00:37:17,190 --> 00:37:15,400
you know for just one person you need

1056
00:37:19,859 --> 00:37:17,200
more than one mentor you have mentors

1057
00:37:21,270 --> 00:37:19,869
who are let's say your PhD advisor you

1058
00:37:22,890 --> 00:37:21,280
can advise you and how your science is

1059
00:37:25,380 --> 00:37:22,900
going but you may also have mentors that

1060
00:37:27,630 --> 00:37:25,390
are sort of general career mentors or if

1061
00:37:29,250 --> 00:37:27,640
you have a certain interest like if you

1062
00:37:30,720 --> 00:37:29,260
want to work for NASA in particular you

1063
00:37:32,220 --> 00:37:30,730

might want to have a mentor that works

1064
00:37:35,040 --> 00:37:32,230
for NASA or know something about that

1065
00:37:36,480 --> 00:37:35,050
and so I have I have cultivated

1066
00:37:38,430 --> 00:37:36,490
different mentors throughout my career

1067
00:37:40,260 --> 00:37:38,440
and I continue to do so and it's good to

1068
00:37:41,970 --> 00:37:40,270
have people who are both you know much

1069
00:37:43,710 --> 00:37:41,980
older than you or more advanced who know

1070
00:37:45,359 --> 00:37:43,720
about like the far future but also

1071
00:37:45,900 --> 00:37:45,369
people who are just a few years ahead

1072
00:37:47,789 --> 00:37:45,910
who

1073
00:37:50,640 --> 00:37:47,799
sort of advise you on your next steps

1074
00:37:52,920 --> 00:37:50,650
and so forth and so I also am interested

1075
00:37:54,750 --> 00:37:52,930
in being a mentor so I mentor various

1076
00:37:57,390 --> 00:37:54,760
students and postdocs in my group and

1077
00:37:59,309 --> 00:37:57,400
it's a lot of early career people and I

1078
00:38:01,380 --> 00:37:59,319
find it really fulfilling it's fun to

1079
00:38:03,480 --> 00:38:01,390
help other people find the science and

1080
00:38:04,770 --> 00:38:03,490
the career they want and try to use my

1081
00:38:07,020 --> 00:38:04,780
knowledge to help them get where they

1082
00:38:08,789 --> 00:38:07,030
want to be absolutely and I agree with

1083
00:38:10,319 --> 00:38:08,799
you it was the fulfilling part that's

1084
00:38:13,500 --> 00:38:10,329
one of my favorite aspects of being a

1085
00:38:15,809 --> 00:38:13,510
scientist is to take early careers bring

1086
00:38:17,520 --> 00:38:15,819
them through your scientific process and

1087
00:38:18,900 --> 00:38:17,530
then give them wings for them to do

1088
00:38:21,240 --> 00:38:18,910

science by themselves it's very

1089
00:38:24,630 --> 00:38:21,250
rewarding we're a growing field in that

1090
00:38:27,140 --> 00:38:24,640
sense Satish Chandra on Facebook asks

1091
00:38:31,380 --> 00:38:27,150
how can astrobiology help with human

1092
00:38:31,890 --> 00:38:31,390
colonization of other planets that's a

1093
00:38:34,440 --> 00:38:31,900
good one

1094
00:38:36,630 --> 00:38:34,450
so in a lot of ways it depends on the

1095
00:38:39,359 --> 00:38:36,640
planet of course and what exactly people

1096
00:38:41,789 --> 00:38:39,369
want to do but understanding you know

1097
00:38:43,500 --> 00:38:41,799
how to look for life elsewhere it's very

1098
00:38:44,940 --> 00:38:43,510
important and also because you want to

1099
00:38:47,010 --> 00:38:44,950
know I think one of the things for

1100
00:38:49,109 --> 00:38:47,020
colonization is we want to know how life

1101
00:38:51,089 --> 00:38:49,119
could affect a planet and we have a good

1102
00:38:52,799 --> 00:38:51,099
example of that here on earth have all

1103
00:38:54,870 --> 00:38:52,809
life over the four billion years has

1104
00:38:56,190 --> 00:38:54,880
really affected this planet and if

1105
00:38:57,779 --> 00:38:56,200
you're going to go to another planet how

1106
00:38:59,370 --> 00:38:57,789
might you affect that planet but how

1107
00:39:01,170 --> 00:38:59,380
might life have already affected it and

1108
00:39:02,849 --> 00:39:01,180
so on and I think it would also be

1109
00:39:04,620 --> 00:39:02,859
important too you know we have to be

1110
00:39:07,710 --> 00:39:04,630
careful if we go to another planet as

1111
00:39:09,210 --> 00:39:07,720
humans to not destroy or mess up any

1112
00:39:11,279 --> 00:39:09,220
other stuff that might be there that we

1113
00:39:12,930 --> 00:39:11,289

still wanted to study so you know

1114
00:39:15,630 --> 00:39:12,940
there's a lot of thoughts about the

1115
00:39:18,900 --> 00:39:15,640
preservation and ethical approaches to

1116
00:39:21,029 --> 00:39:18,910
this type of thing and that's as a group

1117
00:39:23,730 --> 00:39:21,039
for planetary protection for that exact

1118
00:39:25,890 --> 00:39:23,740
reason so yes we should explore space

1119
00:39:28,559 --> 00:39:25,900
but we should explore it respectfully

1120
00:39:30,779 --> 00:39:28,569
towards others other species whether

1121
00:39:34,049 --> 00:39:30,789
they be microbes are potentially in in

1122
00:39:37,170 --> 00:39:34,059
their own planets Ashish not on Twitter

1123
00:39:39,029 --> 00:39:37,180
asks if there are certain organisms we

1124
00:39:41,579 --> 00:39:39,039
can which can derive energy from the

1125
00:39:43,589 --> 00:39:41,589
planet itself but not the nearby star I

1126
00:39:45,329 --> 00:39:43,599
guess the question is asking can we talk

1127
00:39:47,579 --> 00:39:45,339
about habitable zones in the absence of

1128
00:39:50,190 --> 00:39:47,589
stars yeah well it goes beyond I think

1129
00:39:52,109 --> 00:39:50,200
distance from the star and so you know

1130
00:39:54,569 --> 00:39:52,119
the original definition was about

1131
00:39:54,950 --> 00:39:54,579
surface water being liquid on the planet

1132
00:39:57,890 --> 00:39:54,960
and

1133
00:40:00,230 --> 00:39:57,900
has to do with how far you are from the

1134
00:40:01,970 --> 00:40:00,240
Sun but yeah if you had to say life on

1135
00:40:04,099 --> 00:40:01,980
Europa then a habitable zone would

1136
00:40:06,170 --> 00:40:04,109
extend out to Jupiter and so as we

1137
00:40:08,540 --> 00:40:06,180
understand more about how life can be

1138
00:40:10,430 --> 00:40:08,550

how life can exist on planets and how

1139
00:40:12,410 --> 00:40:10,440
where it might emerge then the habitable

1140
00:40:15,620 --> 00:40:12,420
zone to be really anywhere where that is

1141
00:40:17,510 --> 00:40:15,630
possible so do you think water is an

1142
00:40:20,720 --> 00:40:17,520
important aspect for life or could they

1143
00:40:22,640 --> 00:40:20,730
be other solvents it's possible there

1144
00:40:24,380 --> 00:40:22,650
could be other solvents I focus on water

1145
00:40:26,240 --> 00:40:24,390
in my work but there's lots of people

1146
00:40:28,490 --> 00:40:26,250
who discuss you know different organic

1147
00:40:30,260 --> 00:40:28,500
solvents and things like that so it's

1148
00:40:32,200 --> 00:40:30,270
always possible and there's a lot of

1149
00:40:34,370 --> 00:40:32,210
really interesting work in that area

1150
00:40:36,440 --> 00:40:34,380
it's fascinating to think about life

1151
00:40:37,790 --> 00:40:36,450
that's so different than than what we

1152
00:40:39,829 --> 00:40:37,800
know about terrestrial life I even

1153
00:40:44,390 --> 00:40:39,839
wonder if we would even recognize it if

1154
00:40:47,390 --> 00:40:44,400
we saw the next question is by Ahmad

1155
00:40:49,490 --> 00:40:47,400
Aslam Khan on say Gannett who asks are

1156
00:40:51,109 --> 00:40:49,500
there any technical guides or manuals to

1157
00:40:54,650 --> 00:40:51,119
take use of data coming out from

1158
00:40:57,140 --> 00:40:54,660
missions like Cassini like the Rovers in

1159
00:40:59,630 --> 00:40:57,150
curiosity etc especially how to mine the

1160
00:41:03,230 --> 00:40:59,640
spectroscopic data and from where one

1161
00:41:06,640 --> 00:41:03,240
can mine this data in other words is

1162
00:41:09,470 --> 00:41:06,650
there ways we can use existing plant

1163
00:41:11,480 --> 00:41:09,480

spacecraft observations download them to

1164
00:41:14,810 --> 00:41:11,490
our computers and analyze the data

1165
00:41:16,579 --> 00:41:14,820
ourselves oh yeah so I don't actually

1166
00:41:18,440 --> 00:41:16,589
work on this personally so I'm not the

1167
00:41:20,630 --> 00:41:18,450
best person to ask but there's a

1168
00:41:23,089 --> 00:41:20,640
planetary data system where data is

1169
00:41:25,730 --> 00:41:23,099
posted and the NASA data from missions

1170
00:41:28,099 --> 00:41:25,740
is available mostly and so some of it is

1171
00:41:29,660 --> 00:41:28,109
easier to use than others and you know

1172
00:41:31,670 --> 00:41:29,670
if you have particular questions about a

1173
00:41:33,380 --> 00:41:31,680
certain data type that and it's good to

1174
00:41:35,300 --> 00:41:33,390
contact people who work on that on that

1175
00:41:37,640 --> 00:41:35,310
type of a media instrument or that type

1176
00:41:40,210 --> 00:41:37,650
of data but yeah generally there it is

1177
00:41:43,010 --> 00:41:40,220
possible for people to analyze these

1178
00:41:45,109 --> 00:41:43,020
yeah and the database is called PDS

1179
00:41:49,609 --> 00:41:45,119
planetary data system in fact there is a

1180
00:41:51,980 --> 00:41:49,619
middle school in California who were

1181
00:41:55,849 --> 00:41:51,990
looking at the photos coming back from

1182
00:41:59,300 --> 00:41:55,859
the Mars orbiters and they found a lava

1183
00:42:01,099 --> 00:41:59,310
cave a lava tube independent from all

1184
00:42:03,230 --> 00:42:01,109
the scientists they are middle schoolers

1185
00:42:04,550 --> 00:42:03,240
who found a new job feature on Mars

1186
00:42:06,470 --> 00:42:04,560
which is really cool so just to show

1187
00:42:07,330 --> 00:42:06,480
that anybody can download this data

1188
00:42:08,830 --> 00:42:07,340

coming back from

1189
00:42:11,170 --> 00:42:08,840
spacecraft and NASA makes a big effort

1190
00:42:13,600 --> 00:42:11,180
to make that available and potentially

1191
00:42:15,940 --> 00:42:13,610
make interesting discoveries the next

1192
00:42:18,850 --> 00:42:15,950
question is by Julie Ann Annie Hall on

1193
00:42:21,580 --> 00:42:18,860
Twitter who asks so excited to see you

1194
00:42:23,590 --> 00:42:21,590
on Aspen astrobiologist dr. de Mer

1195
00:42:25,630 --> 00:42:23,600
mentioned in last month's episode that

1196
00:42:28,390 --> 00:42:25,640
he was speaking with you about wet/dry

1197
00:42:31,770 --> 00:42:28,400
cycles do you think they are necessary

1198
00:42:34,270 --> 00:42:31,780
for origins how does this cycling work

1199
00:42:37,000 --> 00:42:34,280
yes so the reason I have talked about

1200
00:42:38,710 --> 00:42:37,010
this before and wet/dry cycles are

1201
00:42:40,600 --> 00:42:38,720
important for some chemistry because

1202
00:42:43,780 --> 00:42:40,610
they can dehydrate things so the removal

1203
00:42:46,270 --> 00:42:43,790
of water a formation of longer molecules

1204
00:42:47,890 --> 00:42:46,280
that are important and so wet/dry cycles

1205
00:42:49,630 --> 00:42:47,900
can do that you may also have

1206
00:42:51,490 --> 00:42:49,640
possibilities to make that chemistry

1207
00:42:53,290 --> 00:42:51,500
occur that are not literally drying out

1208
00:42:55,690 --> 00:42:53,300
and wetting things so for example if you

1209
00:42:57,850 --> 00:42:55,700
cycle between low water activity and

1210
00:43:00,070 --> 00:42:57,860
high water activity or say temperature

1211
00:43:01,840 --> 00:43:00,080
could do this so I think that I don't

1212
00:43:03,280 --> 00:43:01,850
know that if it's necessary or not but

1213
00:43:05,020 --> 00:43:03,290

it certainly does promote certain

1214
00:43:08,130 --> 00:43:05,030
reactions and so it is something that we

1215
00:43:10,660 --> 00:43:08,140
work on too so it's one of many

1216
00:43:15,420 --> 00:43:10,670
processes that can generate the

1217
00:43:20,980 --> 00:43:18,700
sarah.hatton asks again a great question

1218
00:43:22,510 --> 00:43:20,990
can we infer that in the early Earth you

1219
00:43:24,580 --> 00:43:22,520
did a higher inner temperature that

1220
00:43:27,280 --> 00:43:24,590
eruptions and mid-oceanic ridges were

1221
00:43:28,780 --> 00:43:27,290
ultramafic rather than assaulting a low

1222
00:43:30,190 --> 00:43:28,790
and weather alkaline vents were more

1223
00:43:32,680 --> 00:43:30,200
dominant than black smokers I think you

1224
00:43:34,840 --> 00:43:32,690
addressed this a little bit so the

1225
00:43:36,400 --> 00:43:34,850
question is really focusing on the the

1226
00:43:38,080 --> 00:43:36,410
higher temperature of early Earth and

1227
00:43:39,550 --> 00:43:38,090
and there's potentially two different

1228
00:43:41,410 --> 00:43:39,560
rocks erupted and how that could have

1229
00:43:44,470 --> 00:43:41,420
affected the chemistry of Springs of

1230
00:43:47,380 --> 00:43:44,480
events yeah I'm not actually an expert

1231
00:43:48,580 --> 00:43:47,390
on that particular thing so but I yeah

1232
00:43:49,810 --> 00:43:48,590
there would have been alkaline vents on

1233
00:43:51,730 --> 00:43:49,820
the early earth and there probably would

1234
00:43:53,140 --> 00:43:51,740
have also been black smokers it's a huge

1235
00:43:55,090 --> 00:43:53,150
planet right and so there was a lot of

1236
00:43:56,530 --> 00:43:55,100
different things and so I think that

1237
00:43:58,930 --> 00:43:56,540
even depending on which environment

1238
00:44:00,100 --> 00:43:58,940

people think is interesting and all of

1239
00:44:02,380 --> 00:44:00,110
these actually produce interesting

1240
00:44:04,600 --> 00:44:02,390
chemistry it's not just one type of vent

1241
00:44:06,550 --> 00:44:04,610
that does you know organic chemistry for

1242
00:44:08,230 --> 00:44:06,560
example and so I think that you would

1243
00:44:10,600 --> 00:44:08,240
have had a lot of different types and

1244
00:44:13,270 --> 00:44:10,610
quite a prevalence of alkaline vents and

1245
00:44:14,500 --> 00:44:13,280
early Earth I think ultimately four

1246
00:44:17,530 --> 00:44:14,510
rocks are interesting as well because

1247
00:44:20,359 --> 00:44:17,540
the the water rock reaction produces

1248
00:44:22,489 --> 00:44:20,369
more hydrogen than the water aqua

1249
00:44:24,380 --> 00:44:22,499
the Crocs would be and hydrogen's can be

1250
00:44:25,730 --> 00:44:24,390
a fundamental food source for biology so

1251
00:44:28,789 --> 00:44:25,740
that could be interesting as well kind

1252
00:44:29,599 --> 00:44:28,799
of to feed the early metabolisms on on

1253
00:44:34,220 --> 00:44:29,609
ancient earth

1254
00:44:36,289 --> 00:44:34,230
this is thought Tom Caruso hi Tom asks

1255
00:44:38,599 --> 00:44:36,299
on Facebook can you explain how the

1256
00:44:40,370 --> 00:44:38,609
conditions for life formation in your in

1257
00:44:44,420 --> 00:44:40,380
your studies connect to the conditions

1258
00:44:46,730 --> 00:44:44,430
and icy worlds sure so you know the

1259
00:44:48,170 --> 00:44:46,740
conditions that we study are mainly for

1260
00:44:51,079 --> 00:44:48,180
the formation of simple organic

1261
00:44:54,109 --> 00:44:51,089
molecules Neel system driven by specific

1262
00:44:56,269 --> 00:44:54,119
minerals and so we are looking at for

1263
00:44:57,980 --> 00:44:56,279

example an alkali and hydrothermal fluid

1264
00:44:59,749 --> 00:44:57,990
and then an ocean that's more acidic

1265
00:45:02,089 --> 00:44:59,759
with iron in it usually and sometimes we

1266
00:45:04,279 --> 00:45:02,099
do variations on that and so this is not

1267
00:45:05,989 --> 00:45:04,289
most similar to the types of events that

1268
00:45:08,089 --> 00:45:05,999
people talk about for its elegance for

1269
00:45:09,380 --> 00:45:08,099
example so they there's evidence of

1270
00:45:11,749 --> 00:45:09,390
vents on Enceladus though it's not

1271
00:45:13,609 --> 00:45:11,759
confirmed but if there are vents there

1272
00:45:15,319 --> 00:45:13,619
it might be the type similar to lost

1273
00:45:18,170 --> 00:45:15,329
city where it's an alkaline vent and you

1274
00:45:19,999 --> 00:45:18,180
have kind of a lower temperature and so

1275
00:45:21,650 --> 00:45:20,009
we're also working on temperature

1276
00:45:23,210 --> 00:45:21,660
gradients in these systems so trying to

1277
00:45:24,950 --> 00:45:23,220
heat the inside and then keep the

1278
00:45:26,749 --> 00:45:24,960
outside cold as opposed to just having

1279
00:45:28,549 --> 00:45:26,759
the whole thing be room temperature and

1280
00:45:31,309 --> 00:45:28,559
that can also affect the chemistry too

1281
00:45:33,380 --> 00:45:31,319
and then we also do different types of

1282
00:45:35,660 --> 00:45:33,390
minerals where you can even make it non

1283
00:45:37,339 --> 00:45:35,670
earth-like so things like if you had

1284
00:45:39,319 --> 00:45:37,349
let's say an ocean with different metals

1285
00:45:42,049 --> 00:45:39,329
in it or a very different pH gradient

1286
00:45:44,269 --> 00:45:42,059
and so that's that's one of the perks of

1287
00:45:45,950 --> 00:45:44,279
lab is you can you can change things up

1288
00:45:49,460 --> 00:45:45,960

such that it never existed on earth at

1289
00:45:51,529 --> 00:45:49,470
all that's a great target specific

1290
00:45:53,870 --> 00:45:51,539
environmental variables to see how that

1291
00:45:56,690 --> 00:45:53,880
affects the entire entire thing how

1292
00:45:59,479 --> 00:45:56,700
fragile are the springs the chimneys

1293
00:46:01,940 --> 00:45:59,489
that you build in your lab it really

1294
00:46:03,680 --> 00:46:01,950
depends on the type they're generally

1295
00:46:06,259 --> 00:46:03,690
very fragile for some of them that we

1296
00:46:07,849 --> 00:46:06,269
grew if you so much as like jostle the

1297
00:46:10,220 --> 00:46:07,859
experiment that chimney just falls down

1298
00:46:12,499 --> 00:46:10,230
it kind of turns into powder and so that

1299
00:46:13,910 --> 00:46:12,509
that type can be unfortunate sometimes

1300
00:46:16,160 --> 00:46:13,920
if you're trying to say analyze

1301
00:46:18,529 --> 00:46:16,170
meteorology but then other types that we

1302
00:46:20,359 --> 00:46:18,539
grow if you are careful you can remove

1303
00:46:22,069 --> 00:46:20,369
the ocean with a pipette and the chimney

1304
00:46:23,569 --> 00:46:22,079
will just stand there and you can take

1305
00:46:26,539 --> 00:46:23,579
the chimney off and then do things with

1306
00:46:28,489 --> 00:46:26,549
it so we over the years have kind of we

1307
00:46:29,690 --> 00:46:28,499
have certain ideas and recipes where we

1308
00:46:31,849 --> 00:46:29,700
know that those are going to be more

1309
00:46:32,620 --> 00:46:31,859
structurally stable and if you need to

1310
00:46:34,510 --> 00:46:32,630
do the same in

1311
00:46:36,610 --> 00:46:34,520
ecology on the chimney we will make the

1312
00:46:38,320 --> 00:46:36,620
ones that you know can remain after your

1313
00:46:39,510 --> 00:46:38,330

move evolution there's a bit of an art

1314
00:46:42,760 --> 00:46:39,520
to it for sure

1315
00:46:46,570 --> 00:46:42,770
so that's your your invader payload can

1316
00:46:48,460 --> 00:46:46,580
do mineralogy and chemistry yes I could

1317
00:46:50,710 --> 00:46:48,470
do mineralogy and chemistry and by

1318
00:46:52,270 --> 00:46:50,720
combining you know what minerals you see

1319
00:46:54,310 --> 00:46:52,280
and Raman let's say with elements that

1320
00:46:56,080 --> 00:46:54,320
you see and lives you can start to get

1321
00:46:58,570 --> 00:46:56,090
at you know what types of geochemistry

1322
00:47:00,160 --> 00:46:58,580
are present and you know whether there's

1323
00:47:02,440 --> 00:47:00,170
life or not and then also what other

1324
00:47:04,480 --> 00:47:02,450
elements are there as well and you can

1325
00:47:06,100 --> 00:47:04,490
see Sado that you can say all that

1326
00:47:09,040 --> 00:47:06,110
without actually touching the vent

1327
00:47:12,730 --> 00:47:09,050
system right just using lasers that's

1328
00:47:14,200 --> 00:47:12,740
right a standoff payload and so that is

1329
00:47:15,640 --> 00:47:14,210
also something to do in the lab you know

1330
00:47:18,130 --> 00:47:15,650
it's important to test in the lab that

1331
00:47:20,260 --> 00:47:18,140
that we can get the same or similar some

1332
00:47:22,000 --> 00:47:20,270
results that you can get by doing all

1333
00:47:24,700 --> 00:47:22,010
your state-of-the-art sample processing

1334
00:47:28,060 --> 00:47:24,710
so that is a part of also what we're

1335
00:47:31,090 --> 00:47:28,070
working on in my group is fascinating

1336
00:47:33,490 --> 00:47:31,100
gaurav yet Ivan sagen it asks what type

1337
00:47:38,860 --> 00:47:33,500
of molecules can be considered bio

1338
00:47:40,600 --> 00:47:38,870

signatures that you're working with so

1339
00:47:42,040 --> 00:47:40,610
that's that's a good question and I

1340
00:47:44,260 --> 00:47:42,050
don't think that there is an answer

1341
00:47:46,810 --> 00:47:44,270
honestly because you know we don't know

1342
00:47:49,690 --> 00:47:46,820
yet what types of molecules can be

1343
00:47:52,990 --> 00:47:49,700
formed abiotic ly exclusively or about

1344
00:47:54,550 --> 00:47:53,000
biologically exclusively and kind of I

1345
00:47:55,780 --> 00:47:54,560
think the field of origin of life is

1346
00:47:57,670 --> 00:47:55,790
showing us that there's a lot of

1347
00:47:59,500 --> 00:47:57,680
complexity and a lot of interesting

1348
00:48:02,620 --> 00:47:59,510
organic chemistry that can occur without

1349
00:48:04,480 --> 00:48:02,630
life and so which molecule is a bio

1350
00:48:06,190 --> 00:48:04,490
signature I think you'd have to do a

1351
00:48:07,180 --> 00:48:06,200
thorough study of making sure that

1352
00:48:09,730 --> 00:48:07,190
cannot be formed

1353
00:48:12,700 --> 00:48:09,740
abiotic ly and so we've we've begun but

1354
00:48:14,500 --> 00:48:12,710
I mean this is a huge endeavor but that

1355
00:48:16,420 --> 00:48:14,510
is the question and anytime people say

1356
00:48:17,950 --> 00:48:16,430
oh this is a bio signature we should

1357
00:48:19,660 --> 00:48:17,960
think really hard about can this be

1358
00:48:21,340 --> 00:48:19,670
formed without life and even if you

1359
00:48:23,790 --> 00:48:21,350
haven't seen it on earth yet can it be

1360
00:48:25,960 --> 00:48:23,800
done anyway so we have to figure out how

1361
00:48:26,950 --> 00:48:25,970
yeah I mean I'm saying the question of

1362
00:48:28,870 --> 00:48:26,960
whether or not we're alone in the

1363
00:48:32,230 --> 00:48:28,880

universe is such an important one to get

1364
00:48:33,730 --> 00:48:32,240
right we cannot like dabble in like oh

1365
00:48:37,540 --> 00:48:33,740
yeah perhaps no that's meaningless

1366
00:48:41,410 --> 00:48:37,550
answer so the next question is is much

1367
00:48:45,160 --> 00:48:41,420
broader in scope and it's asked by art

1368
00:48:46,360 --> 00:48:45,170
of inquiry on Twitter who asks what

1369
00:48:48,250 --> 00:48:46,370
topics of Astro bar

1370
00:48:50,500 --> 00:48:48,260
we are the most important to share with

1371
00:48:53,080 --> 00:48:50,510
young surgeons in your opinion which

1372
00:48:55,150 --> 00:48:53,090
ones excite you the most and why what

1373
00:48:59,230 --> 00:48:55,160
are the most counterintuitive findings

1374
00:49:02,320 --> 00:48:59,240
of astrobiology that's good one it's

1375
00:49:05,380 --> 00:49:02,330
very broad so I think it really depends

1376
00:49:07,420 --> 00:49:05,390
who you ask of course so for me I like

1377
00:49:08,740 --> 00:49:07,430
to share things that relate to their

1378
00:49:11,800 --> 00:49:08,750
experience because I find that that

1379
00:49:13,570 --> 00:49:11,810
helps them engage more so for example if

1380
00:49:15,130 --> 00:49:13,580
I share astrobiology thats related to

1381
00:49:17,290 --> 00:49:15,140
missions that they can currently see on

1382
00:49:19,570 --> 00:49:17,300
like on the news and they can see the

1383
00:49:21,640 --> 00:49:19,580
data coming back in real time so things

1384
00:49:23,080 --> 00:49:21,650
like the Mars rover that's there now or

1385
00:49:25,570 --> 00:49:23,090
the orbiters that are there now I think

1386
00:49:26,710 --> 00:49:25,580
is is exciting but also I think it's

1387
00:49:28,420 --> 00:49:26,720
important to share with them

1388
00:49:30,220 --> 00:49:28,430

astrobiology that relates to earth

1389
00:49:32,080 --> 00:49:30,230
science because you know it kind of

1390
00:49:34,030 --> 00:49:32,090
links together how we how we think about

1391
00:49:36,220 --> 00:49:34,040
the earth and the climate and so forth

1392
00:49:38,860 --> 00:49:36,230
and how all that related over the long

1393
00:49:40,960 --> 00:49:38,870
geological time period and how life and

1394
00:49:42,580 --> 00:49:40,970
earth have been you know Co evolving for

1395
00:49:43,930 --> 00:49:42,590
four billion years so I think it's

1396
00:49:45,670 --> 00:49:43,940
important to kind of relate it to you

1397
00:49:47,410 --> 00:49:45,680
the earth and the things that they will

1398
00:49:49,600 --> 00:49:47,420
experience and also to the missions that

1399
00:49:52,090 --> 00:49:49,610
they can see and then and then later on

1400
00:49:54,040 --> 00:49:52,100
go into stuff that is more you know

1401
00:49:55,390 --> 00:49:54,050
distant like missions in the past or

1402
00:49:58,570 --> 00:49:55,400
other types of science that might be

1403
00:50:01,750 --> 00:49:58,580
more esoteric alright cool right answer

1404
00:50:04,870 --> 00:50:01,760
thank you great question - Andrew

1405
00:50:07,930 --> 00:50:04,880
planets on cigarette hi Andrew asks if

1406
00:50:09,580 --> 00:50:07,940
all life on Earth is is related did life

1407
00:50:11,950 --> 00:50:09,590
start in one instance and then quickly

1408
00:50:13,330 --> 00:50:11,960
spread you know by catalyzing the

1409
00:50:16,150 --> 00:50:13,340
environments to make its continued

1410
00:50:17,800 --> 00:50:16,160
existence possible or if life started

1411
00:50:22,180 --> 00:50:17,810
more than once could different branches

1412
00:50:24,160 --> 00:50:22,190
have merged well we don't actually know

1413
00:50:26,890 --> 00:50:24,170

and so there's various possibilities you

1414
00:50:28,810 --> 00:50:26,900
know so one is there is just one origin

1415
00:50:30,490 --> 00:50:28,820
and then it evolved one is that there's

1416
00:50:33,010 --> 00:50:30,500
multiple origins but none of the others

1417
00:50:35,560 --> 00:50:33,020
worked one is that there were things

1418
00:50:37,570 --> 00:50:35,570
that merged and so I think the thing is

1419
00:50:39,820 --> 00:50:37,580
all you can really tell from the tree of

1420
00:50:41,170 --> 00:50:39,830
life is where the root is and you can

1421
00:50:43,090 --> 00:50:41,180
kind of go back to say like what's the

1422
00:50:45,280 --> 00:50:43,100
last ancestor but you can't go back

1423
00:50:46,570 --> 00:50:45,290
beyond that to say what was all the

1424
00:50:48,700 --> 00:50:46,580
origin of life things that happen

1425
00:50:51,340 --> 00:50:48,710
because that's not visible in that sense

1426
00:50:53,440 --> 00:50:51,350
and so it's now thought that the

1427
00:50:55,630 --> 00:50:53,450
original ancestor of life was not one

1428
00:50:57,430 --> 00:50:55,640
cell but it's a community of cells and

1429
00:50:59,440 --> 00:50:57,440
you know genetic materials being

1430
00:51:01,540 --> 00:50:59,450
exchanged and there's it's kind of hard

1431
00:51:03,820 --> 00:51:01,550
to say it's just one type of life but

1432
00:51:05,560 --> 00:51:03,830
was it from one origin or not we don't

1433
00:51:07,690 --> 00:51:05,570
really know so you have to approach this

1434
00:51:09,520 --> 00:51:07,700
kind of from top down which is that sort

1435
00:51:12,760 --> 00:51:09,530
of thing we look at life now and you say

1436
00:51:14,770 --> 00:51:12,770
how does all life relate and you can get

1437
00:51:16,930 --> 00:51:14,780
to must be somehow related to the origin

1438
00:51:19,090 --> 00:51:16,940

and then you do bottom up where you say

1439
00:51:21,160 --> 00:51:19,100
Woodall was early earth and what could

1440
00:51:23,440 --> 00:51:21,170
have happen and all those possibilities

1441
00:51:25,960 --> 00:51:23,450
which one leads you closest to what that

1442
00:51:27,160 --> 00:51:25,970
thought that top-down suggests that's

1443
00:51:28,750 --> 00:51:27,170
kind of where the different origin of

1444
00:51:30,100 --> 00:51:28,760
life people work and you try to you try

1445
00:51:32,200 --> 00:51:30,110
to meet at something that makes sense

1446
00:51:34,180 --> 00:51:32,210
from both ends but but you can't get

1447
00:51:34,650 --> 00:51:34,190
really the answer from only one or the

1448
00:51:37,420 --> 00:51:34,660
other

1449
00:51:39,340 --> 00:51:37,430
yeah I I've been thinking about the

1450
00:51:41,110 --> 00:51:39,350
analogy of using the evolution of humans

1451
00:51:43,720 --> 00:51:41,120
in a sense that we're Homo sapiens now

1452
00:51:45,880 --> 00:51:43,730
but we're not when we started and so if

1453
00:51:47,410 --> 00:51:45,890
you just used homo sapiens as your idea

1454
00:51:49,090 --> 00:51:47,420
of where humans come from you'll get it

1455
00:51:50,740 --> 00:51:49,100
wrong because there was just you know

1456
00:51:52,600 --> 00:51:50,750
Astra political travel hope it occurs

1457
00:51:54,550 --> 00:51:52,610
there was Neanderthals and so on so it's

1458
00:51:56,380 --> 00:51:54,560
it's it's right now we can only do with

1459
00:51:58,300 --> 00:51:56,390
genetics go down to Luke the last

1460
00:52:01,870 --> 00:51:58,310
Universal common ancestor boots below

1461
00:52:05,500 --> 00:52:01,880
that is up to speculation so I good

1462
00:52:08,620 --> 00:52:05,510
question Andrew TJ acharya on twitter

1463
00:52:10,360 --> 00:52:08,630

asks is there any other factor that may

1464
00:52:13,470 --> 00:52:10,370
influence development of amino acids

1465
00:52:16,720 --> 00:52:13,480
other than minerals or pH or temperature

1466
00:52:19,810 --> 00:52:16,730
well yes there's many so so many so I

1467
00:52:22,210 --> 00:52:19,820
mean my favorite ones are concentration

1468
00:52:23,860 --> 00:52:22,220
of other chemicals so for example how

1469
00:52:25,630 --> 00:52:23,870
much if you're making an amino acid you

1470
00:52:27,880 --> 00:52:25,640
have an amine right and so that's a

1471
00:52:29,830 --> 00:52:27,890
nitrogen component and so how much

1472
00:52:31,810 --> 00:52:29,840
nitrogen is in the system and what type

1473
00:52:33,580 --> 00:52:31,820
of nitrogen is it and ready to come from

1474
00:52:36,430 --> 00:52:33,590
and so I think that's one factor that

1475
00:52:38,110 --> 00:52:36,440
can affect it and then there's also I

1476
00:52:40,090 --> 00:52:38,120
think you mentioned redox but it's more

1477
00:52:41,740 --> 00:52:40,100
specific than that the redox fate of

1478
00:52:44,200 --> 00:52:41,750
minerals in the system can affect things

1479
00:52:45,610 --> 00:52:44,210
so even if you have reactive minerals if

1480
00:52:47,920 --> 00:52:45,620
they're slightly more reduced or more

1481
00:52:49,960 --> 00:52:47,930
oxidized that can affect things I also

1482
00:52:52,570 --> 00:52:49,970
bet that if you added other chemicals

1483
00:52:54,760 --> 00:52:52,580
like say sulfur phosphorus or things

1484
00:52:56,800 --> 00:52:54,770
like that it might affect that so all of

1485
00:52:59,140 --> 00:52:56,810
these systems are hugely complex

1486
00:53:00,610 --> 00:52:59,150
intertwine networks and you have to sort

1487
00:53:02,650 --> 00:53:00,620
of understand how the network of

1488
00:53:04,540 --> 00:53:02,660

chemistry is functioning under all these

1489
00:53:06,580 --> 00:53:04,550
different conditions so let's see it's a

1490
00:53:08,230 --> 00:53:06,590
quite a lot of experiments it's

1491
00:53:10,210 --> 00:53:08,240
complicated for sure that's what makes

1492
00:53:11,710 --> 00:53:10,220
it exciting Laurie I can't believe we've

1493
00:53:13,480 --> 00:53:11,720
been chatting for practically

1494
00:53:15,760 --> 00:53:13,490
our now so unfortunately we have to wrap

1495
00:53:17,020 --> 00:53:15,770
up the show I'm really grateful that you

1496
00:53:19,120 --> 00:53:17,030
took the time to talk with us today

1497
00:53:21,310 --> 00:53:19,130
perhaps you have any final words of

1498
00:53:24,250 --> 00:53:21,320
wisdom for the early career scientists

1499
00:53:25,810 --> 00:53:24,260
who are watching us um well I guess just

1500
00:53:28,300 --> 00:53:25,820
to uh you know do things that you're

1501
00:53:29,770 --> 00:53:28,310
interested in and try to discover new

1502
00:53:31,480 --> 00:53:29,780
things and don't think that you have to

1503
00:53:32,950 --> 00:53:31,490
build your career based on what your

1504
00:53:35,020 --> 00:53:32,960
college degree was in or what your first

1505
00:53:37,210 --> 00:53:35,030
internship was or whatever and it's

1506
00:53:38,980 --> 00:53:37,220
expected of course that as you get a job

1507
00:53:40,599 --> 00:53:38,990
and move forward we're going to discover

1508
00:53:42,700 --> 00:53:40,609
all types of new research and new

1509
00:53:44,109 --> 00:53:42,710
ventures that are interesting so it's

1510
00:53:46,660 --> 00:53:44,119
important to just be open to new

1511
00:53:49,420 --> 00:53:46,670
opportunity and not try to box it in so

1512
00:53:51,609 --> 00:53:49,430
early that's that's great advice your

1513
00:53:54,099 --> 00:53:51,619

university degree does not define who

1514
00:53:55,510 --> 00:53:54,109
you are as a human or as a scientist at

1515
00:53:57,970 --> 00:53:55,520
all it just shows you can solve a

1516
00:53:59,920 --> 00:53:57,980
difficult problem so thank you again

1517
00:54:01,540 --> 00:53:59,930
Arie it was absolutely awesome to have

1518
00:54:03,280 --> 00:54:01,550
you on the show I love that conversation

1519
00:54:05,109 --> 00:54:03,290
for those of you watching did you know

1520
00:54:08,380 --> 00:54:05,119
that today was the first episode of

1521
00:54:10,150 --> 00:54:08,390
season four of asking astrobiologists we

1522
00:54:12,609 --> 00:54:10,160
want to know who you'd like to see on

1523
00:54:13,960 --> 00:54:12,619
the show who should we invite and chat

1524
00:54:16,000 --> 00:54:13,970
with to have this phenomenal

1525
00:54:18,070 --> 00:54:16,010
conversations and so let us know you

1526
00:54:19,900 --> 00:54:18,080
know on all the social medias and then

1527
00:54:21,910 --> 00:54:19,910
we'll do our best to to make you guys

1528
00:54:24,460 --> 00:54:21,920
happy we're having so much fun here in

1529
00:54:27,070 --> 00:54:24,470
organizing this program so until next

1530
00:54:28,020 --> 00:54:27,080
episode everybody stay curious take care

1531
00:55:07,870 --> 00:54:28,030
now