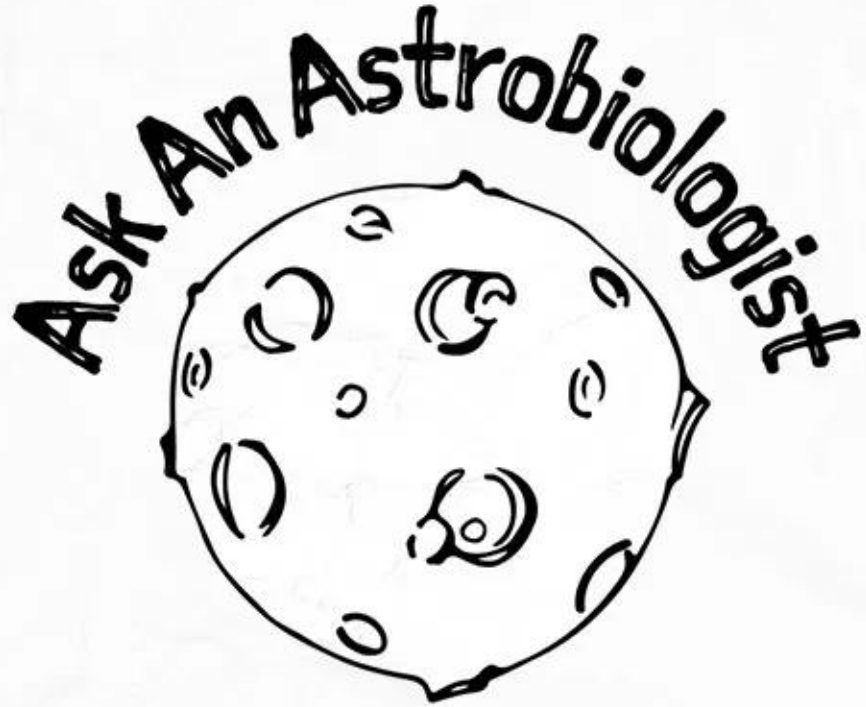

Episode 21: April 18th, 2019

Dr. Gordon 'Oz' Osinski

NASA Astrobiology Program

1
00:00:00,500 --> 00:00:29,380
[Music]

2
00:00:33,799 --> 00:00:31,580
greetings friends of astrobiology

3
00:00:35,810 --> 00:00:33,809
welcome to a brand-new episode of ask an

4
00:00:38,600 --> 00:00:35,820
astrobiologist a show where we celebrate

5
00:00:39,950 --> 00:00:38,610
science and celebrate scientists my name

6
00:00:41,660 --> 00:00:39,960
is Sanjay saman this program is made

7
00:00:44,240 --> 00:00:41,670
possible by contributions from the NASA

8
00:00:47,420 --> 00:00:44,250
Astrobiology program and the non profit

9
00:00:49,340 --> 00:00:47,430
blue marble space last month my fiercely

10
00:00:52,340 --> 00:00:49,350
bearded at wonderful co-host dr. Graham

11
00:00:54,290 --> 00:00:52,350
Lau interviewed dr. Jason writes and

12
00:00:56,209 --> 00:00:54,300
they were speaking about exoplanets and

13
00:00:58,220 --> 00:00:56,219

this month we can come slamming back to

14
00:01:01,069 --> 00:00:58,230
the earth literally with a wonderful

15
00:01:03,229 --> 00:01:01,079
guest dr. Gordon izinski a professor at

16
00:01:05,929 --> 00:01:03,239
Western University in Canada and an

17
00:01:08,179 --> 00:01:05,939
expert in Impact cratering processes at

18
00:01:10,969 --> 00:01:08,189
first it's time for you favorite

19
00:01:14,840 --> 00:01:10,979
background quiz Mike if you could put up

20
00:01:17,270 --> 00:01:14,850
the background from last month it was

21
00:01:19,010 --> 00:01:17,280
this beautiful geyser many of you got it

22
00:01:21,710 --> 00:01:19,020
right it is of course the stroke or

23
00:01:24,350 --> 00:01:21,720
geyser in Iceland look located in the

24
00:01:27,109 --> 00:01:24,360
height of the Loire Valley also of

25
00:01:29,240 --> 00:01:27,119
course in Iceland it's the most active

26
00:01:32,270 --> 00:01:29,250
geyser in the world erupting roughly

27
00:01:35,090 --> 00:01:32,280
every five minutes but nearby not even

28
00:01:38,450 --> 00:01:35,100
50 meters away lies a much bigger pool

29
00:01:40,249 --> 00:01:38,460
of guys II the geyser that gives its

30
00:01:43,399 --> 00:01:40,259
name to all other geysers in the world

31
00:01:45,620 --> 00:01:43,409
guys eel erupts much less frequently on

32
00:01:48,080 --> 00:01:45,630
the order of years it's a much bigger

33
00:01:51,020 --> 00:01:48,090
much more intimidating pools locals have

34
00:01:53,300 --> 00:01:51,030
known to have made it erupt by making

35
00:01:55,340 --> 00:01:53,310
the lower the sorry by downing the the

36
00:01:57,020 --> 00:01:55,350
water the water level in it which

37
00:01:58,910 --> 00:01:57,030
triggers an eruption and some have also

38
00:02:00,830 --> 00:01:58,920

thrown soap in it that I've also

39
00:02:02,959 --> 00:02:00,840
triggered an eruption of course that's

40
00:02:04,550 --> 00:02:02,969
frowned upon today for environmental

41
00:02:06,889 --> 00:02:04,560
concerns it's not the largest geyser

42
00:02:10,040 --> 00:02:06,899
however the largest geyser is in the

43
00:02:11,839 --> 00:02:10,050
Waimea value of New Zealand and but it's

44
00:02:12,380 --> 00:02:11,849
now extinct last erupted I think in the

45
00:02:15,500 --> 00:02:12,390
nineteen

46
00:02:18,470 --> 00:02:15,510
tens so we have three winners and the

47
00:02:19,910 --> 00:02:18,480
winners are our first prize goes to at

48
00:02:21,380 --> 00:02:19,920
Geo twits

49
00:02:24,080 --> 00:02:21,390
congratulations who got it right with

50
00:02:28,340 --> 00:02:24,090
the hug code or Valley the second place

51
00:02:30,590 --> 00:02:28,350
goes to male at male SC and sorry the

52
00:02:33,230 --> 00:02:30,600
third place is geo to its second place

53
00:02:34,250 --> 00:02:33,240
at male SC in the first place is Mike

54
00:02:36,530 --> 00:02:34,260
the LAN

55
00:02:38,120 --> 00:02:36,540
tweeting as at for Mike's sake so

56
00:02:39,590 --> 00:02:38,130
congratulations to all of three of you

57
00:02:43,250 --> 00:02:39,600
you'll get to the prizes which is a

58
00:02:45,650 --> 00:02:43,260
combination of the astrobiology comic

59
00:02:46,880 --> 00:02:45,660
books the mugs and some other prizes

60
00:02:48,350 --> 00:02:46,890
that I don't have a top of my head

61
00:02:50,150 --> 00:02:48,360
because today is spring cleaning and I

62
00:02:52,070 --> 00:02:50,160
don't have the items with me but it's

63
00:02:53,660 --> 00:02:52,080

all good I also want to give a shout out

64
00:02:55,910 --> 00:02:53,670
to all of you who are doing a lot of

65
00:02:57,830 --> 00:02:55,920
efforts tweeting about our show and on

66
00:02:59,780 --> 00:02:57,840
facebook on twitter on sega net and

67
00:03:02,560 --> 00:02:59,790
elsewhere please keep doing that we're

68
00:03:05,150 --> 00:03:02,570
very grateful to try and increase our

69
00:03:06,650 --> 00:03:05,160
participant levels every episode so I

70
00:03:08,420 --> 00:03:06,660
thank you so much for those of you who

71
00:03:11,330 --> 00:03:08,430
who spread the word and in order to

72
00:03:13,520 --> 00:03:11,340
reward that we started an ambassador of

73
00:03:15,259 --> 00:03:13,530
the month for asking astrobiologists so

74
00:03:16,850 --> 00:03:15,269
though one of you that we see is the

75
00:03:18,710 --> 00:03:16,860
most active at helping us spread the

76
00:03:21,500 --> 00:03:18,720
word about ask an astrobiologist will be

77
00:03:25,910 --> 00:03:21,510
called our ambassador for the month so

78
00:03:28,400 --> 00:03:25,920
the ambassador for april 2019 is Marian

79
00:03:29,780 --> 00:03:28,410
Denton who is amazing who has been an

80
00:03:31,640 --> 00:03:29,790
amazing supporter of the show so

81
00:03:34,520 --> 00:03:31,650
congrats and Marianne you'll be

82
00:03:36,500 --> 00:03:34,530
receiving the background the actual

83
00:03:38,240 --> 00:03:36,510
background of the show will be sent to

84
00:03:40,130 --> 00:03:38,250
your home so congratulations again help

85
00:03:41,360 --> 00:03:40,140
us share the word about aspen

86
00:03:43,220 --> 00:03:41,370
astrobiologists it's a show we're really

87
00:03:44,479 --> 00:03:43,230
excited about and I hope you are too if

88
00:03:47,569 --> 00:03:44,489

you have any questions during the

89
00:03:49,970 --> 00:03:47,579
program for dr. Osinski please use

90
00:03:52,100 --> 00:03:49,980
hashtag asked Astro bio on Twitter or

91
00:03:55,400 --> 00:03:52,110
ask them directly on Facebook live in

92
00:03:56,990 --> 00:03:55,410
the comments down below and on Signet of

93
00:03:59,060 --> 00:03:57,000
course the home of ask and

94
00:04:01,039 --> 00:03:59,070
astrobiologists so without any do it is

95
00:04:03,770 --> 00:04:01,049
my great pleasure to introduce dr.

96
00:04:06,560 --> 00:04:03,780
Gordon Osinski a professor at the

97
00:04:07,970 --> 00:04:06,570
Western University in Canada dr. zimsky

98
00:04:08,420 --> 00:04:07,980
thank you so much for being with us

99
00:04:13,550 --> 00:04:08,430
today

100
00:04:15,110 --> 00:04:13,560
oh it's a pleasure enjoy the the concept

101
00:04:16,550 --> 00:04:15,120
of impact cratering is something we

102
00:04:19,400 --> 00:04:16,560
think about is happening on other

103
00:04:20,960 --> 00:04:19,410
planets the Moon and Mars but it's also

104
00:04:22,880 --> 00:04:20,970
has happened quite a bit on earth

105
00:04:24,320 --> 00:04:22,890
perhaps we can start this conversation

106
00:04:25,880 --> 00:04:24,330
by you telling us about what is an

107
00:04:26,210 --> 00:04:25,890
impact cratering process and why it

108
00:04:28,670 --> 00:04:26,220
isn't

109
00:04:30,380 --> 00:04:28,680
portal to study for sure yeah you know

110
00:04:33,290 --> 00:04:30,390
it's it's one of those processes that

111
00:04:36,440 --> 00:04:33,300
even undergrad geologists often don't

112
00:04:38,210 --> 00:04:36,450
get you know during during teaching and

113
00:04:40,580 --> 00:04:38,220

so it's it's a bit of a you know off

114
00:04:42,470 --> 00:04:40,590
topic it's not mainstream often people

115
00:04:45,080 --> 00:04:42,480
know about volcanoes and plate tectonics

116
00:04:46,550 --> 00:04:45,090
perhaps on earth but really over the

117
00:04:49,550 --> 00:04:46,560
last couple of decades in particular

118
00:04:51,020 --> 00:04:49,560
we've become aware that as you say you

119
00:04:53,090 --> 00:04:51,030
know you can look up on the moon on a

120
00:04:55,490 --> 00:04:53,100
clear night and see all these pop marks

121
00:04:57,830 --> 00:04:55,500
surfaces you know various Rovers have

122
00:05:00,080 --> 00:04:57,840
been tootling along the surface of Mars

123
00:05:01,880 --> 00:05:00,090
for a number of decades too often going

124
00:05:03,740 --> 00:05:01,890
from crater to crater and so we know

125
00:05:05,870 --> 00:05:03,750
other planetary objects have been hit by

126
00:05:07,400 --> 00:05:05,880
asteroids and comets since they were

127
00:05:10,040 --> 00:05:07,410
formed you know four and a half billion

128
00:05:11,900 --> 00:05:10,050
years ago on earth you know around the

129
00:05:14,480 --> 00:05:11,910
turn of the century a meteor or a

130
00:05:16,150 --> 00:05:14,490
Barringer crater in Arizona was kind of

131
00:05:18,880 --> 00:05:16,160
first proposed to be an impact crater

132
00:05:21,200 --> 00:05:18,890
but it wasn't until the 1960s and 70s

133
00:05:23,750 --> 00:05:21,210
where you know people really started

134
00:05:25,430 --> 00:05:23,760
realizing oh yeah you know things do hit

135
00:05:27,290 --> 00:05:25,440
the earth perhaps it sounds a bit

136
00:05:29,500 --> 00:05:27,300
ridiculous now that you know the earth

137
00:05:32,150 --> 00:05:29,510
would everything would bypass the earth

138
00:05:34,580 --> 00:05:32,160

and in fact you know because earth is

139
00:05:36,860 --> 00:05:34,590
bigger than the moon more because of

140
00:05:38,240 --> 00:05:36,870
larger gravitation or cross-section you

141
00:05:40,790 --> 00:05:38,250
know we should look worse off than the

142
00:05:44,930 --> 00:05:40,800
moon but Shira speaks to how active our

143
00:05:47,300 --> 00:05:44,940
planet is fascinating so how did you

144
00:05:48,590 --> 00:05:47,310
become interested in impact processes

145
00:05:51,430 --> 00:05:48,600
you mentioned that it's not typically

146
00:05:53,900 --> 00:05:51,440
taught in the classical geological

147
00:05:56,360 --> 00:05:53,910
curriculum and perhaps you can share

148
00:05:59,240 --> 00:05:56,370
your experience when you first went to a

149
00:06:01,250 --> 00:05:59,250
crater yourself probably as a student

150
00:06:03,950 --> 00:06:01,260
like how was it like how do you feel was

151
00:06:05,780 --> 00:06:03,960
it a humbling experience yeah for sure

152
00:06:08,360 --> 00:06:05,790
so yeah I mean I did a very traditional

153
00:06:09,620 --> 00:06:08,370
undergraduate degree in geology at the

154
00:06:12,560 --> 00:06:09,630
University of st. Andrews in Scotland

155
00:06:14,930 --> 00:06:12,570
and you know I really recall hearing the

156
00:06:17,420 --> 00:06:14,940
word Sudbury related to economic

157
00:06:19,670 --> 00:06:17,430
deposits there but even that was debated

158
00:06:22,100 --> 00:06:19,680
that surgery was an impact in class I do

159
00:06:23,870 --> 00:06:22,110
remember that but that was about it you

160
00:06:27,110 --> 00:06:23,880
know we had a little bit of a planetary

161
00:06:28,700 --> 00:06:27,120
component in that degree and so it was

162
00:06:30,740 --> 00:06:28,710
honestly approaching the end of my

163
00:06:31,880 --> 00:06:30,750

undergrad I think like many students you

164
00:06:34,909 --> 00:06:31,890
know wondering what I was going to do

165
00:06:37,460 --> 00:06:34,919
with my life and I thought I'd like to

166
00:06:39,650 --> 00:06:37,470
travel overseas for you know initially

167
00:06:41,330 --> 00:06:39,660
just a masters and

168
00:06:44,060 --> 00:06:41,340
literally just stumbled across this

169
00:06:46,310 --> 00:06:44,070
project advertised you know as flee big

170
00:06:48,260 --> 00:06:46,320
things caught my eye it was working on

171
00:06:50,510 --> 00:06:48,270
impact craters which sounded fascinating

172
00:06:52,760 --> 00:06:50,520
not something I knew anything about so I

173
00:06:54,620 --> 00:06:52,770
always like to challenge I was working

174
00:06:56,720 --> 00:06:54,630
up in the Arctic which brings me onto

175
00:06:58,730 --> 00:06:56,730
the first crater I visited and it was

176
00:07:01,120 --> 00:06:58,740
also working you know with NASA room

177
00:07:04,700 --> 00:07:01,130
with space kind of organizes Asians and

178
00:07:07,190 --> 00:07:04,710
so which I finished my undergrad had my

179
00:07:09,290 --> 00:07:07,200
vibra week later I was on a plane to

180
00:07:12,350 --> 00:07:09,300
Canada to New Brunswick where I did my

181
00:07:14,450 --> 00:07:12,360
PhD and then about two weeks later after

182
00:07:17,270 --> 00:07:14,460
that you know I kind of did some crash

183
00:07:19,130 --> 00:07:17,280
reading in impact craters and then you

184
00:07:20,810 --> 00:07:19,140
know my first crater that I ever stepped

185
00:07:22,970 --> 00:07:20,820
foot on is probably one was you know

186
00:07:24,320 --> 00:07:22,980
beautiful and fresh and well preserved

187
00:07:25,970 --> 00:07:24,330
in the world and that's the horton

188
00:07:28,640 --> 00:07:25,980

crater on Devon island in the Canadian

189
00:07:31,520 --> 00:07:28,650
Arctic so you know from that standpoint

190
00:07:34,100 --> 00:07:31,530
absolutely spoiled that you know that

191
00:07:35,800 --> 00:07:34,110
was my first introduction to to impact

192
00:07:38,420 --> 00:07:35,810
craters and what they looked like and

193
00:07:40,460 --> 00:07:38,430
you know Devon Island is not just an

194
00:07:42,500 --> 00:07:40,470
impact crater but it's a barren polar

195
00:07:44,480 --> 00:07:42,510
desert environment too so you know it's

196
00:07:48,170 --> 00:07:44,490
just a beautiful beautiful part of the

197
00:07:49,640 --> 00:07:48,180
world and some spectacular geology so

198
00:07:51,890 --> 00:07:49,650
how long did you spend up there what do

199
00:07:53,900 --> 00:07:51,900
you do and what differentiates a crater

200
00:07:55,340 --> 00:07:53,910
from a larger big depression in the

201
00:07:58,730 --> 00:07:55,350
ground like how do you tell that it was

202
00:08:02,540 --> 00:07:58,740
in fact an impact for sure so you know

203
00:08:03,980 --> 00:08:02,550
Oder my PhD a lot of it was and what

204
00:08:06,110 --> 00:08:03,990
attracted me to geology in the first

205
00:08:07,820 --> 00:08:06,120
place there's actually you know the

206
00:08:10,159 --> 00:08:07,830
fieldwork the field aspects of things

207
00:08:11,930 --> 00:08:10,169
being outside and so you know for the

208
00:08:14,030 --> 00:08:11,940
first three years of my PhD I spent a

209
00:08:15,290 --> 00:08:14,040
couple of months up there and you know

210
00:08:17,810 --> 00:08:15,300
that's pushing it up in the High Arctic

211
00:08:19,820 --> 00:08:17,820
I'm still going back there but basically

212
00:08:22,130 --> 00:08:19,830
it's snowing in June when the snow

213
00:08:24,320 --> 00:08:22,140

starts again in August and even enjoy it

214
00:08:27,890 --> 00:08:24,330
snows so you know he got a very short

215
00:08:30,020 --> 00:08:27,900
window for field seasons so a lot of

216
00:08:31,909 --> 00:08:30,030
geological mapping actually created a

217
00:08:33,800 --> 00:08:31,919
geological map with a Horton crater you

218
00:08:35,839 --> 00:08:33,810
know which meant I could apply my

219
00:08:38,719 --> 00:08:35,849
traditional geological tools to this

220
00:08:40,880 --> 00:08:38,729
kind of new new topic and then you know

221
00:08:46,610 --> 00:08:40,890
a lot of sample work back in back in the

222
00:08:48,829 --> 00:08:46,620
lab yeah so NASA is also very interested

223
00:08:50,030 --> 00:08:48,839
in Impact cratering prices for reasons

224
00:08:53,120 --> 00:08:50,040
that are obvious in the sense that they

225
00:08:53,450 --> 00:08:53,130
exist in higher density on the moon on

226
00:08:55,610 --> 00:08:53,460
Mars

227
00:08:57,950 --> 00:08:55,620
and in fact have been useful for analog

228
00:09:00,560 --> 00:08:57,960
studies in terms of training astronauts

229
00:09:02,270 --> 00:09:00,570
in in you know in geological processes

230
00:09:03,620 --> 00:09:02,280
and that has been done at Heartland

231
00:09:05,650 --> 00:09:03,630
crater and I think you've been involved

232
00:09:07,400 --> 00:09:05,660
in some of these simulation missions

233
00:09:09,620 --> 00:09:07,410
could you tell us a little bit about

234
00:09:12,770 --> 00:09:09,630
these yeah for sure so yeah I mean

235
00:09:14,450 --> 00:09:12,780
you're my PhD it was the peak of this

236
00:09:16,520 --> 00:09:14,460
hot and Mars project that was led by

237
00:09:19,520 --> 00:09:16,530
Connor SETI and Amma's Institute at NASA

238
00:09:21,980 --> 00:09:19,530

Ames and yeah I know I got to meet

239
00:09:24,860 --> 00:09:21,990
amazing people and astronauts during my

240
00:09:26,780 --> 00:09:24,870
PhD bunch of NASA Ames folks

241
00:09:29,000 --> 00:09:26,790
Terry fallin in his group what kind of

242
00:09:31,970 --> 00:09:29,010
robots up there to attest and develop I

243
00:09:34,370 --> 00:09:31,980
got to wear a prototype spacesuit from a

244
00:09:37,070 --> 00:09:34,380
company which was you know as a green

245
00:09:39,890 --> 00:09:37,080
PhD student from the UK who actually

246
00:09:42,350 --> 00:09:39,900
really didn't have much of a you know I

247
00:09:46,400 --> 00:09:42,360
came into the my PhD not being you know

248
00:09:48,140 --> 00:09:46,410
a super big space advocate and didn't

249
00:09:50,540 --> 00:09:48,150
really grow up you know wanting to be an

250
00:09:53,060 --> 00:09:50,550
astronaut perhaps like other people and

251
00:09:55,340 --> 00:09:53,070
so I was just immersed in that and you

252
00:09:57,080 --> 00:09:55,350
know I learned a lot to my peers to you

253
00:09:58,600 --> 00:09:57,090
about you know planetary science in

254
00:10:02,750 --> 00:09:58,610
general which again I didn't really have

255
00:10:04,850 --> 00:10:02,760
before I came to Canada yeah and you

256
00:10:06,950 --> 00:10:04,860
know these analog sites we've I've

257
00:10:09,410 --> 00:10:06,960
continued that since not just on Devon

258
00:10:12,050 --> 00:10:09,420
Island - and actually just yesterday the

259
00:10:13,970 --> 00:10:12,060
Canadian Space Agency announced award

260
00:10:16,220 --> 00:10:13,980
we've got which is actually focusing on

261
00:10:18,410 --> 00:10:16,230
of the moon services not raster

262
00:10:21,380 --> 00:10:18,420
biological regions but you know impact

263
00:10:25,550 --> 00:10:21,390

craters from a geological standpoint you

264
00:10:27,560 --> 00:10:25,560
know really calculate that all over the

265
00:10:29,750 --> 00:10:27,570
moon and you know it's an important

266
00:10:33,620 --> 00:10:29,760
process to understand there and you know

267
00:10:35,000 --> 00:10:33,630
for retrieving samples from to cool very

268
00:10:37,190 --> 00:10:35,010
cool I've never done such a simulation

269
00:10:38,960 --> 00:10:37,200
so it's like a lot of fun and so there

270
00:10:40,700 --> 00:10:38,970
are two main causes of impact craters

271
00:10:42,560 --> 00:10:40,710
right could be an asteroid strike or a

272
00:10:44,510 --> 00:10:42,570
comet strike yeah is there a way to tell

273
00:10:46,040 --> 00:10:44,520
the difference from the fields or is it

274
00:10:48,230 --> 00:10:46,050
something that you need to do more

275
00:10:49,070 --> 00:10:48,240
advanced calculations to determine yeah

276
00:10:50,870 --> 00:10:49,080
for sure

277
00:10:52,610 --> 00:10:50,880
no there's there's no way of knowing

278
00:10:54,350 --> 00:10:52,620
when you're out there and you know you

279
00:10:55,700 --> 00:10:54,360
actually ask an earlier question to that

280
00:10:57,140 --> 00:10:55,710
I didn't answer which is you know how do

281
00:11:00,100 --> 00:10:57,150
you even know you're in a meteorite

282
00:11:03,050 --> 00:11:00,110
impact crater and so there's only one

283
00:11:04,970 --> 00:11:03,060
diagnostic feature it just so happens

284
00:11:06,800 --> 00:11:04,980
that Horton has a lot of these and these

285
00:11:08,269 --> 00:11:06,810
are shatter cones yeah

286
00:11:10,730 --> 00:11:08,279
very good eyes on the shelf behind me

287
00:11:12,950 --> 00:11:10,740
hangover bunch laying up there but these

288
00:11:14,720 --> 00:11:12,960

are essentially chemists rated surfaces

289
00:11:17,030 --> 00:11:14,730
that the intense pressures and

290
00:11:20,360 --> 00:11:17,040
temperatures of the weekly impact event

291
00:11:22,250 --> 00:11:20,370
caused in the rock and then really

292
00:11:24,110 --> 00:11:22,260
everything else and I'm back to your

293
00:11:25,820 --> 00:11:24,120
kind of comic versus asteroid question

294
00:11:27,650 --> 00:11:25,830
really involves a lot of laboratory

295
00:11:30,340 --> 00:11:27,660
based research a lot of microscopy

296
00:11:33,410 --> 00:11:30,350
electron microprobe scanning electron

297
00:11:35,540 --> 00:11:33,420
microscope work to differentiate between

298
00:11:37,780 --> 00:11:35,550
comets and asteroids you know you get

299
00:11:39,980 --> 00:11:37,790
into various different isotopic systems

300
00:11:42,079 --> 00:11:39,990
you know looking for things like iridium

301
00:11:43,370 --> 00:11:42,089
is maybe the one most people might be

302
00:11:44,350 --> 00:11:43,380
familiar with you know you're looking

303
00:11:46,880 --> 00:11:44,360
for

304
00:11:48,410 --> 00:11:46,890
elements that are not very abundant or

305
00:11:49,820 --> 00:11:48,420
absent on the surface of the earth but

306
00:11:52,730 --> 00:11:49,830
it could have been brought here by the

307
00:11:55,579 --> 00:11:52,740
projectile but even then it's incredibly

308
00:11:57,140 --> 00:11:55,589
difficult for example at houghton some

309
00:11:59,390 --> 00:11:57,150
of the best folks in the world at wrists

310
00:12:02,090 --> 00:11:59,400
have looked and have not been able to

311
00:12:04,070 --> 00:12:02,100
determine any projectile signature so

312
00:12:05,750 --> 00:12:04,080
you know we don't know have any idea of

313
00:12:07,430 --> 00:12:05,760

even what kind of asteroid - let alone

314
00:12:10,400 --> 00:12:07,440
whether it was a comment so it's a

315
00:12:12,650 --> 00:12:10,410
really difficult thing to do so there's

316
00:12:14,650 --> 00:12:12,660
not even traces of like those those high

317
00:12:17,630 --> 00:12:14,660
pressure minerals or like reverse

318
00:12:20,270 --> 00:12:17,640
stratification on the crater rim that

319
00:12:22,040 --> 00:12:20,280
sure so you see those kinds of things

320
00:12:24,500 --> 00:12:22,050
and other effects in the rock but those

321
00:12:26,329 --> 00:12:24,510
are generated you know in the rocks that

322
00:12:28,820 --> 00:12:26,339
were there in the target not brought

323
00:12:31,790 --> 00:12:28,830
there by the asteroid and you know this

324
00:12:34,310 --> 00:12:31,800
is maybe in it a bit of a sidetrack into

325
00:12:36,079 --> 00:12:34,320
you know how impact craters form you

326
00:12:38,960 --> 00:12:36,089
know what keeps me interested is that is

327
00:12:41,120 --> 00:12:38,970
unlike any other geological process you

328
00:12:42,350 --> 00:12:41,130
know the most violent volcanic explosion

329
00:12:45,230 --> 00:12:42,360
craters and I think you've got one

330
00:12:47,720 --> 00:12:45,240
behind you there you know these pale in

331
00:12:50,480 --> 00:12:47,730
comparison to what happens during an

332
00:12:53,240 --> 00:12:50,490
impact event we generate temperatures of

333
00:12:55,850 --> 00:12:53,250
tens of thousands of Kelvin and hundreds

334
00:12:57,710 --> 00:12:55,860
of giga pascals pressure and you know

335
00:13:00,440 --> 00:12:57,720
what that typically does is vaporize

336
00:13:02,180 --> 00:13:00,450
most of what came in so most of the

337
00:13:04,550 --> 00:13:02,190
asteroid and comet is just simply

338
00:13:07,370 --> 00:13:04,560

obliterated which is why it's hard to

339
00:13:09,860 --> 00:13:07,380
find a trace in these larger impact

340
00:13:11,530 --> 00:13:09,870
events but yeah absolutely you know the

341
00:13:14,570 --> 00:13:11,540
crater form these high-pressure

342
00:13:16,329 --> 00:13:14,580
polymorphs and other features we do see

343
00:13:20,090 --> 00:13:16,339
at horton and what's over the craters

344
00:13:20,690 --> 00:13:20,100
very cool yeah so the background behind

345
00:13:22,340 --> 00:13:20,700
me those

346
00:13:23,810 --> 00:13:22,350
you who are watching make sure you try

347
00:13:25,310 --> 00:13:23,820
and figure out what it is for next month

348
00:13:27,530 --> 00:13:25,320
episode and then we'll announce the

349
00:13:29,420 --> 00:13:27,540
winners then Gordon you've been talking

350
00:13:30,920 --> 00:13:29,430
about Iridium layers or in a

351
00:13:32,540 --> 00:13:30,930
conversation just a few minutes ago and

352
00:13:34,250 --> 00:13:32,550
makes me think about the Chicxulub

353
00:13:36,860 --> 00:13:34,260
impact crater perhaps the most famous

354
00:13:38,480 --> 00:13:36,870
impacts on Earth today the one that

355
00:13:41,690 --> 00:13:38,490
theoretically wiped out the dinosaurs

356
00:13:43,130 --> 00:13:41,700
about 65 million years ago are you doing

357
00:13:44,570 --> 00:13:43,140
some work there I couldn't tell us a

358
00:13:46,910 --> 00:13:44,580
little bit more about it impact and how

359
00:13:48,560 --> 00:13:46,920
are we narrowing down to it that being

360
00:13:50,870 --> 00:13:48,570
the cause for the extinction of the

361
00:13:55,220 --> 00:13:50,880
dinosaurs for sure it's a little bit of

362
00:13:58,280 --> 00:13:55,230
a controversial topic I think still yeah

363
00:14:01,370 --> 00:13:58,290

Chicxulub is probably the most famous

364
00:14:03,230 --> 00:14:01,380
impact crater in the world you know as I

365
00:14:06,740 --> 00:14:03,240
think as a community in a scientific

366
00:14:08,300 --> 00:14:06,750
community whatever you believe you know

367
00:14:10,490 --> 00:14:08,310
with respect to the mass extinction

368
00:14:11,810 --> 00:14:10,500
event we have a lot - OH - Chicxulub

369
00:14:14,360 --> 00:14:11,820
because it's one of those you know major

370
00:14:16,040 --> 00:14:14,370
points I think you know two big things

371
00:14:18,170 --> 00:14:16,050
in the last few decades that really

372
00:14:20,900 --> 00:14:18,180
spurred interest in retried impacts and

373
00:14:23,150 --> 00:14:20,910
the fact that happens today and has had

374
00:14:25,460 --> 00:14:23,160
major you know not just geologic effects

375
00:14:27,440 --> 00:14:25,470
but environmental and biological effects

376
00:14:29,450 --> 00:14:27,450
was the the impact of Comet

377
00:14:32,060 --> 00:14:29,460
shoemaker-levy 9 in Jupiter in the early

378
00:14:35,120 --> 00:14:32,070
90s and then you know beginning with

379
00:14:36,770 --> 00:14:35,130
Walter Alvarez paper in 1980 that

380
00:14:38,870 --> 00:14:36,780
suggested there was an impact at that

381
00:14:40,940 --> 00:14:38,880
time and but it then took you know to

382
00:14:43,730 --> 00:14:40,950
the 90s to discover Chicxulub and then

383
00:14:45,950 --> 00:14:43,740
to link it to that oh boundary and so it

384
00:14:47,480 --> 00:14:45,960
generated an inordinately interest and

385
00:14:50,960 --> 00:14:47,490
you know I think really brought - not

386
00:14:53,300 --> 00:14:50,970
just the Scientifics you know mindset

387
00:14:56,180 --> 00:14:53,310
but you know to the public you know big

388
00:14:58,160 --> 00:14:56,190

things happened we think and I think you

389
00:15:00,190 --> 00:14:58,170
know the pendulum swings back and forth

390
00:15:02,240 --> 00:15:00,200
a little bit but I think the over man

391
00:15:04,250 --> 00:15:02,250
overwhelming evidence is that you know

392
00:15:07,310 --> 00:15:04,260
that was a major factor perhaps not the

393
00:15:09,260 --> 00:15:07,320
only one but that impact 66 million

394
00:15:11,540 --> 00:15:09,270
years ago in what is now Yucatan

395
00:15:13,880 --> 00:15:11,550
Peninsula in Mexico did create you know

396
00:15:16,060 --> 00:15:13,890
two-thirds of species on earth including

397
00:15:18,590 --> 00:15:16,070
the well known dinosaurs to go extinct

398
00:15:20,690 --> 00:15:18,600
it was a paper it was published I think

399
00:15:23,720 --> 00:15:20,700
about a month ago which about a new

400
00:15:25,550 --> 00:15:23,730
query in in the Morrison Formation

401
00:15:28,070 --> 00:15:25,560
in the United States where they found

402
00:15:30,440 --> 00:15:28,080
apparently dinosaur bones and and fish

403
00:15:32,990 --> 00:15:30,450
all together in the same layer was like

404
00:15:34,000 --> 00:15:33,000
impact debris which is absolutely

405
00:15:37,240 --> 00:15:34,010
mind-blowing kind of

406
00:15:41,110 --> 00:15:37,250
snapshot of the catastrophe yeah that's

407
00:15:43,090 --> 00:15:41,120
true but yeah it's an amazing paper and

408
00:15:45,160 --> 00:15:43,100
yeah I think they recorded you know

409
00:15:47,650 --> 00:15:45,170
those these spare wheels thrown out by

410
00:15:49,630 --> 00:15:47,660
the Chicxulub impact in fish insight

411
00:15:51,580 --> 00:15:49,640
fish you know so they were literally

412
00:15:53,380 --> 00:15:51,590
choking on the ejecta thrown out by the

413
00:15:55,240 --> 00:15:53,390

Chicxulub impact you know what is so

414
00:15:58,210 --> 00:15:55,250
even then would be you know hundreds of

415
00:15:59,980 --> 00:15:58,220
thousands of kilometers away and yeah I

416
00:16:03,130 --> 00:15:59,990
mean I think this is the major aspect of

417
00:16:05,110 --> 00:16:03,140
impacts and people may be wondering

418
00:16:07,690 --> 00:16:05,120
where we're talking about impacts in

419
00:16:10,090 --> 00:16:07,700
astrobiology are setting and in a scone

420
00:16:12,610 --> 00:16:10,100
astrobiologists because a lot of people

421
00:16:14,470 --> 00:16:12,620
think of these destructive effects but

422
00:16:16,030 --> 00:16:14,480
what I've been interested in more and

423
00:16:19,290 --> 00:16:16,040
actually what I'm studying at Chicxulub

424
00:16:21,970 --> 00:16:19,300
is the potential astral astrobiological

425
00:16:24,100 --> 00:16:21,980
significance of impacts so after they

426
00:16:27,130 --> 00:16:24,110
formed they actually I think provide

427
00:16:28,480 --> 00:16:27,140
benefits for microbial life and so I've

428
00:16:30,580 --> 00:16:28,490
got a student actually working on

429
00:16:33,100 --> 00:16:30,590
studying how the Chicxulub impact

430
00:16:36,130 --> 00:16:33,110
created a hydrothermal system and that

431
00:16:37,720 --> 00:16:36,140
large crater yes that's what we mean my

432
00:16:40,920 --> 00:16:37,730
next question in a sense we think about

433
00:16:43,180 --> 00:16:40,930
impact processes as being devastating to

434
00:16:44,920 --> 00:16:43,190
planetary surface and to the life on it

435
00:16:47,050 --> 00:16:44,930
but ironically enough it can create

436
00:16:49,060 --> 00:16:47,060
environments local and even planetary

437
00:16:50,440 --> 00:16:49,070
wide that can sustain at least a

438
00:16:51,730 --> 00:16:50,450

habitable environment for longer

439
00:16:53,800 --> 00:16:51,740
duration as it has been habit

440
00:16:55,690 --> 00:16:53,810
hypothesize for Mars and also locally

441
00:16:57,160 --> 00:16:55,700
via those hydrothermal systems so

442
00:16:58,630 --> 00:16:57,170
perhaps you can tell us more about how

443
00:17:00,220 --> 00:16:58,640
those hydrothermal systems form

444
00:17:02,290 --> 00:17:00,230
following an impact and how does that

445
00:17:04,390 --> 00:17:02,300
can maintain an environment for life and

446
00:17:06,010 --> 00:17:04,400
perhaps how long did you even last yeah

447
00:17:07,600 --> 00:17:06,020
for sure I mean what's the question is

448
00:17:09,880 --> 00:17:07,610
you just throw at me so remind me if I

449
00:17:11,980 --> 00:17:09,890
forgotten to answer them all but yeah

450
00:17:13,420 --> 00:17:11,990
you know this is a this is really the

451
00:17:15,430 --> 00:17:13,430
last kind of couple of decades that it's

452
00:17:17,560 --> 00:17:15,440
the realization that yeah and I viewed

453
00:17:20,140 --> 00:17:17,570
this in proposals that impacts create

454
00:17:22,390 --> 00:17:20,150
beneficial effects and definitely the

455
00:17:25,600 --> 00:17:22,400
primary one the most obvious I think and

456
00:17:28,660 --> 00:17:25,610
the most kind of spatially extensive in

457
00:17:31,330 --> 00:17:28,670
common are hydrothermal systems so you

458
00:17:32,800 --> 00:17:31,340
know hydrothermal systems form anywhere

459
00:17:35,110 --> 00:17:32,810
on Earth today where you have a heat

460
00:17:36,940 --> 00:17:35,120
source plus water in close proximity so

461
00:17:39,640 --> 00:17:36,950
really give Yellowstone National Park

462
00:17:41,350 --> 00:17:39,650
Iceland New Zealand I had the the Geezer

463
00:17:46,080 --> 00:17:41,360

you know the image of the month from

464
00:17:47,710 --> 00:17:46,090
last last gas go ask and astrobiologist

465
00:17:49,779 --> 00:17:47,720
was a Giza

466
00:17:52,060 --> 00:17:49,789
so you know it basically have volcanic

467
00:17:53,799 --> 00:17:52,070
Li active regions so you have hot rocks

468
00:17:56,249 --> 00:17:53,809
even magma at depth

469
00:17:59,139 --> 00:17:56,259
if groundwater or rain or sea water

470
00:18:01,269 --> 00:17:59,149
interacts with those hot rocks that

471
00:18:04,210 --> 00:18:01,279
water heats up can dissolve you know

472
00:18:06,190 --> 00:18:04,220
minerals and rocks in one area rises to

473
00:18:08,049 --> 00:18:06,200
the surface sometimes as geezers and as

474
00:18:11,230 --> 00:18:08,059
hot springs goes down and then you know

475
00:18:13,210 --> 00:18:11,240
recirculates essentially and I don't

476
00:18:15,009 --> 00:18:13,220
think it comes as a surprise today

477
00:18:17,320 --> 00:18:15,019
although it did when people first looked

478
00:18:19,330 --> 00:18:17,330
at this but you know impact deposit a

479
00:18:22,360 --> 00:18:19,340
huge amount of energy into the crust of

480
00:18:24,909 --> 00:18:22,370
any planet most of their energy ends up

481
00:18:28,690 --> 00:18:24,919
being essentially you know deposited as

482
00:18:30,850 --> 00:18:28,700
heat so you can generate many cubic

483
00:18:33,310 --> 00:18:30,860
kilometers of what we call impact melt

484
00:18:35,560 --> 00:18:33,320
so essentially you melt large portions

485
00:18:37,299 --> 00:18:35,570
of planetary crusts and then that you

486
00:18:38,980 --> 00:18:37,309
know magma essentially sits on the

487
00:18:40,840 --> 00:18:38,990
surface of a planet for sometimes

488
00:18:43,060 --> 00:18:40,850

hundreds of thousands of years cooling

489
00:18:46,149 --> 00:18:43,070
down so that's one of the major heat

490
00:18:48,789 --> 00:18:46,159
drivers the other and you know the it

491
00:18:50,980 --> 00:18:48,799
gets becomes a more major component in

492
00:18:53,499 --> 00:18:50,990
these bigger craters if we go back to

493
00:18:55,779 --> 00:18:53,509
Chicxulub we know in these large craters

494
00:18:57,789 --> 00:18:55,789
of the rocks in the center of lifted

495
00:19:01,600 --> 00:18:57,799
from depth and sometimes you know as

496
00:19:03,369 --> 00:19:01,610
many as 10 20 even 30 kilometers and we

497
00:19:05,080 --> 00:19:03,379
know as you go down in the Earth's crust

498
00:19:07,659 --> 00:19:05,090
and in any planet the rocks get hotter

499
00:19:09,129 --> 00:19:07,669
and so he kind of instantaneously bring

500
00:19:12,220 --> 00:19:09,139
hot rocks that were originally you know

501
00:19:14,980 --> 00:19:12,230
20 kilometers down to the surface and

502
00:19:16,960 --> 00:19:14,990
then depending on ascetic chick she'll

503
00:19:19,029 --> 00:19:16,970
have actually impacted into a shallow

504
00:19:21,100 --> 00:19:19,039
sea so you know you had a lot of sea

505
00:19:22,659 --> 00:19:21,110
water running in causing a rains on

506
00:19:25,060 --> 00:19:22,669
earth but it could be melting ice and

507
00:19:27,100 --> 00:19:25,070
other locations put those two together

508
00:19:29,710 --> 00:19:27,110
and you can generate a hydrothermal

509
00:19:31,810 --> 00:19:29,720
system and those are really important

510
00:19:34,539 --> 00:19:31,820
because the the chemical energy in these

511
00:19:36,009 --> 00:19:34,549
waters can be utilized by life so life

512
00:19:37,509 --> 00:19:36,019
does not necessarily need to be at the

513
00:19:39,580 --> 00:19:37,519

surface and depend on light you have

514
00:19:41,680 --> 00:19:39,590
plenty of life on Earth that exists in

515
00:19:43,539 --> 00:19:41,690
the subsurface that survives based on

516
00:19:44,950 --> 00:19:43,549
the chemical energy that's released by

517
00:19:47,350 --> 00:19:44,960
the dissolution of minerals and rocks

518
00:19:48,669 --> 00:19:47,360
which is awesome so it really makes you

519
00:19:50,799 --> 00:19:48,679
think about where else in the solar

520
00:19:52,749 --> 00:19:50,809
system or in the in the galaxy or in the

521
00:19:55,960 --> 00:19:52,759
universe you could potentially find life

522
00:19:57,879 --> 00:19:55,970
yeah for sure and I mean you know again

523
00:19:59,440 --> 00:19:57,889
it's debated like almost everything in

524
00:20:00,970 --> 00:19:59,450
science you know but we still think one

525
00:20:01,250 --> 00:20:00,980
of the places life on Earth may ever

526
00:20:03,650 --> 00:20:01,260
reach

527
00:20:05,180 --> 00:20:03,660
it is in hydrothermal systems you know

528
00:20:07,580 --> 00:20:05,190
typically in documentaries it's the

529
00:20:10,640 --> 00:20:07,590
black smoker type of idea you know the

530
00:20:13,430 --> 00:20:10,650
mid-ocean ridges so associated with

531
00:20:15,350 --> 00:20:13,440
volcanic heat sources but yeah what this

532
00:20:18,580 --> 00:20:15,360
really does is open the door is you kind

533
00:20:21,260 --> 00:20:18,590
of hinted at - you know many planets

534
00:20:23,690 --> 00:20:21,270
most of the objects in the solar system

535
00:20:26,030 --> 00:20:23,700
may have been active volcanic ly early

536
00:20:28,250 --> 00:20:26,040
on but they're not today you know so the

537
00:20:30,140 --> 00:20:28,260
surface is a relatively cold but you

538
00:20:31,790 --> 00:20:30,150

know even on present-day Mars one could

539
00:20:33,560 --> 00:20:31,800
speculate that you have an asteroid

540
00:20:35,090 --> 00:20:33,570
slamming into the northern plains where

541
00:20:37,370 --> 00:20:35,100
there's lots of ice in the subsurface

542
00:20:39,740 --> 00:20:37,380
and you know it would likely be sure to

543
00:20:42,170 --> 00:20:39,750
lift but that could melt you know any

544
00:20:44,600 --> 00:20:42,180
h2o that's around and generating you

545
00:20:47,690 --> 00:20:44,610
know a transient hydrothermal system no

546
00:20:49,370 --> 00:20:47,700
asteroids you know the small other

547
00:20:52,370 --> 00:20:49,380
objects that we may not have thought

548
00:20:54,200 --> 00:20:52,380
about having the habitats for life you

549
00:20:55,880 --> 00:20:54,210
know the very mad fact that asteroids

550
00:20:58,280 --> 00:20:55,890
and comets don't really care what they

551
00:21:00,500 --> 00:20:58,290
hit you know pervade the solar system

552
00:21:03,140 --> 00:21:00,510
and other solar systems outside our own

553
00:21:05,830 --> 00:21:03,150
solar system again it kind of opens the

554
00:21:09,650 --> 00:21:05,840
dotter rethinking planetary habitability

555
00:21:12,470 --> 00:21:09,660
and so thinking about Mars in that same

556
00:21:15,830 --> 00:21:12,480
vein there's obviously this controversy

557
00:21:17,240 --> 00:21:15,840
between the warm early Mars under call

558
00:21:20,420 --> 00:21:17,250
the dry Mars because we see these

559
00:21:22,280 --> 00:21:20,430
evidence of flowing river beds of course

560
00:21:22,880 --> 00:21:22,290
not flowing today but there dry

561
00:21:25,040 --> 00:21:22,890
riverbeds

562
00:21:26,510 --> 00:21:25,050
on Mars suggesting that water was

563
00:21:28,880 --> 00:21:26,520

flowing for a fair amount of time in the

564
00:21:31,580 --> 00:21:28,890
early days which contrasts to the the

565
00:21:33,260 --> 00:21:31,590
very thin atmosphere we see today and so

566
00:21:35,420 --> 00:21:33,270
what one theory among many others is

567
00:21:36,920 --> 00:21:35,430
that they had large enough impacts in

568
00:21:38,690 --> 00:21:36,930
the early days of the solar system that

569
00:21:40,730 --> 00:21:38,700
could actually that are large enough to

570
00:21:43,370 --> 00:21:40,740
create a temporary planetary atmosphere

571
00:21:45,080 --> 00:21:43,380
that can sustain liquid water for you

572
00:21:46,220 --> 00:21:45,090
know tens of thousands maybe hundreds of

573
00:21:48,200 --> 00:21:46,230
thousands of years which is a long time

574
00:21:50,390 --> 00:21:48,210
as a human an instant you know

575
00:21:52,580 --> 00:21:50,400
geologically but again like you can

576
00:21:54,620 --> 00:21:52,590
change the surface environment of a

577
00:21:57,020 --> 00:21:54,630
planet based on high energy impacts

578
00:21:58,400 --> 00:21:57,030
right absolutely absolutely yeah and I

579
00:22:01,520 --> 00:21:58,410
mean we could take that even one step

580
00:22:03,530 --> 00:22:01,530
further and you know this is clays on

581
00:22:05,720 --> 00:22:03,540
Mars you know another big reason we

582
00:22:07,280 --> 00:22:05,730
think people have suggested Mars was

583
00:22:09,950 --> 00:22:07,290
warmer and wetter in the past is because

584
00:22:12,350 --> 00:22:09,960
we see lots of minerals that have you

585
00:22:14,600 --> 00:22:12,360
know that are what we call hydrated they

586
00:22:16,700 --> 00:22:14,610
have water another

587
00:22:19,670 --> 00:22:16,710
sulphates is another girl example where

588
00:22:22,400 --> 00:22:19,680

you know they require water to be around

589
00:22:24,290 --> 00:22:22,410
for their formation we see clays all or

590
00:22:26,390 --> 00:22:24,300
really heavily cratered Highlands and

591
00:22:28,310 --> 00:22:26,400
you know most people think that those

592
00:22:31,280 --> 00:22:28,320
are just being excavated from depth by

593
00:22:33,260 --> 00:22:31,290
impacts but you know my research

594
00:22:34,850 --> 00:22:33,270
scientist Liberatore Nibbana here and I

595
00:22:36,890 --> 00:22:34,860
published on this and you know we're

596
00:22:39,170 --> 00:22:36,900
thrown out the idea that you know not

597
00:22:40,490 --> 00:22:39,180
all don't don't get is wrong but you

598
00:22:42,200 --> 00:22:40,500
know maybe many of those clay

599
00:22:44,690 --> 00:22:42,210
occurrences we're seeing on the surface

600
00:22:47,240 --> 00:22:44,700
of Mars are actually generated in impact

601
00:22:49,490 --> 00:22:47,250
generated hydrothermal systems and ice

602
00:22:51,620 --> 00:22:49,500
are very localized then and the answers

603
00:22:53,510 --> 00:22:51,630
don't care about the surface climate you

604
00:22:56,270 --> 00:22:53,520
know this could be happening on a cold

605
00:22:58,220 --> 00:22:56,280
early Mars generating clays in these

606
00:23:00,680 --> 00:22:58,230
impact generated hydrothermal systems

607
00:23:02,840 --> 00:23:00,690
and so yeah I think the more we learn

608
00:23:06,200 --> 00:23:02,850
the more we study impacts you know I

609
00:23:08,690 --> 00:23:06,210
think it's becoming I hope I hope anyway

610
00:23:11,360 --> 00:23:08,700
increasingly understood as a driver of

611
00:23:14,450 --> 00:23:11,370
planetary evolution and in a revolution

612
00:23:16,730 --> 00:23:14,460
of the biosphere - all right cool yeah

613
00:23:19,010 --> 00:23:16,740

cuz clays I extremely find pieces of

614
00:23:20,540 --> 00:23:19,020
rock called mush together so the common

615
00:23:21,890 --> 00:23:20,550
thought is that been transported

616
00:23:23,510 --> 00:23:21,900
draughts have been transported over a

617
00:23:24,950 --> 00:23:23,520
long time and breaking down over the

618
00:23:27,230 --> 00:23:24,960
transport process eventually be

619
00:23:29,450 --> 00:23:27,240
sedimented out of a water environment

620
00:23:31,160 --> 00:23:29,460
into you know very fine clays but if you

621
00:23:32,720 --> 00:23:31,170
can form them in a complete different

622
00:23:34,850 --> 00:23:32,730
mind setting that changes the game about

623
00:23:37,610 --> 00:23:34,860
what the clays mean in terms of

624
00:23:41,150 --> 00:23:37,620
environmental markers yeah absolutely

625
00:23:44,150 --> 00:23:41,160
yeah very cool very cool so if you have

626
00:23:45,800 --> 00:23:44,160
students that are interested and among

627
00:23:47,180 --> 00:23:45,810
our viewers I'm sure are interested in

628
00:23:49,130 --> 00:23:47,190
learning more about impact cratering

629
00:23:51,440 --> 00:23:49,140
processes or even want to go to school

630
00:23:54,950 --> 00:23:51,450
to come experts and impact processes

631
00:23:57,320 --> 00:23:54,960
what advice would you have for them a

632
00:23:59,300 --> 00:23:57,330
really neat thing I think about it like

633
00:24:00,980 --> 00:23:59,310
about impact studying and meteorite

634
00:24:02,690 --> 00:24:00,990
impacts like you know planetary science

635
00:24:04,600 --> 00:24:02,700
in general is that you can come in from

636
00:24:07,790 --> 00:24:04,610
you know quite a few different angles

637
00:24:10,070 --> 00:24:07,800
you know today there's still a big role

638
00:24:11,900 --> 00:24:10,080

for you know people with a Geoscience

639
00:24:13,940 --> 00:24:11,910
background and I'm studying meteorite

640
00:24:16,400 --> 00:24:13,950
impacts you know the whole crossover

641
00:24:18,290 --> 00:24:16,410
though now into astrobiology and it was

642
00:24:20,150 --> 00:24:18,300
a need for people I think I see more

643
00:24:22,730 --> 00:24:20,160
people with you know a Geo biology

644
00:24:24,860 --> 00:24:22,740
microbiology background are working on

645
00:24:27,020 --> 00:24:24,870
impacts a lot of people that were

646
00:24:28,460 --> 00:24:27,030
modeling impact craters you know there's

647
00:24:30,890 --> 00:24:28,470
a lot of physicists in that can

648
00:24:32,930 --> 00:24:30,900
to science students out there with those

649
00:24:35,810 --> 00:24:32,940
background and we do you know we kind of

650
00:24:37,580 --> 00:24:35,820
need everything it's one of the

651
00:24:40,010 --> 00:24:37,590
challenges that you know I tell students

652
00:24:43,669 --> 00:24:40,020
and the public about impacts is it's a

653
00:24:45,200 --> 00:24:43,679
challenge but it's a something we're

654
00:24:47,330 --> 00:24:45,210
glad hasn't happened is that you know

655
00:24:48,620 --> 00:24:47,340
unlike volcanism you know what would be

656
00:24:50,750 --> 00:24:48,630
the first thing you want to do is a

657
00:24:53,630 --> 00:24:50,760
volcanologist studying old ancient

658
00:24:55,730 --> 00:24:53,640
volcanic rocks we go and witness a

659
00:24:57,110 --> 00:24:55,740
volcanic eruption happening you know so

660
00:24:58,820 --> 00:24:57,120
you looked at the protein look at the

661
00:25:01,100 --> 00:24:58,830
process to try and figure out the

662
00:25:02,960 --> 00:25:01,110
product especially the ancient product

663
00:25:05,570 --> 00:25:02,970

and you know we haven't had a large

664
00:25:08,360 --> 00:25:05,580
meteorite impact on earth and you know

665
00:25:11,419 --> 00:25:08,370
in human time scale which is good you

666
00:25:12,919 --> 00:25:11,429
know for our species but it means we're

667
00:25:15,350 --> 00:25:12,929
left you know trying to figure out

668
00:25:17,720 --> 00:25:15,360
connect the dots and so you know there's

669
00:25:19,640 --> 00:25:17,730
experimentalist this room for modelers

670
00:25:22,460 --> 00:25:19,650
is room for the gel just sound the

671
00:25:23,870 --> 00:25:22,470
biologist and so yeah you know even come

672
00:25:26,990 --> 00:25:23,880
at this from a lot of different angles

673
00:25:28,820 --> 00:25:27,000
and a lot of different perspectives it

674
00:25:31,220 --> 00:25:28,830
can be like a geologist in the

675
00:25:33,289 --> 00:25:31,230
traditional sense of looking at rocks

676
00:25:35,240 --> 00:25:33,299
and unded I need to find the minerals or

677
00:25:37,279 --> 00:25:35,250
you can come at it from the physics and

678
00:25:38,659 --> 00:25:37,289
doing computer simulations of impact

679
00:25:40,940 --> 00:25:38,669
cratering processes so it's really a

680
00:25:42,799 --> 00:25:40,950
broad approach I need a bunch of

681
00:25:44,899 --> 00:25:42,809
different scientists to really

682
00:25:47,240 --> 00:25:44,909
understand them that's very cool then

683
00:25:49,340 --> 00:25:47,250
you have events like that Chile Chilean

684
00:25:51,260 --> 00:25:49,350
scuf you know about a couple years ago

685
00:25:54,590 --> 00:25:51,270
in Russia that remind us that we live in

686
00:25:56,380 --> 00:25:54,600
a active solar system yeah we do I mean

687
00:25:59,060 --> 00:25:56,390
it's one of those things were you know

688
00:26:00,860 --> 00:25:59,070

impacts don't hit the earth very often

689
00:26:01,789 --> 00:26:00,870
but you know meteor craters only fifty

690
00:26:04,070 --> 00:26:01,799
thousand years old

691
00:26:06,350 --> 00:26:04,080
we've got records of other crater

692
00:26:09,200 --> 00:26:06,360
forming impacts and you know thousands

693
00:26:11,060 --> 00:26:09,210
of years timescale and so yeah you know

694
00:26:12,649 --> 00:26:11,070
it might be a hundred might be a

695
00:26:14,480 --> 00:26:12,659
thousand years from now but we'll have

696
00:26:17,659 --> 00:26:14,490
you know likely some small event to

697
00:26:20,720 --> 00:26:17,669
study sometimes somewhere it's in a

698
00:26:21,680 --> 00:26:20,730
remote location but yeah we're thankful

699
00:26:24,289 --> 00:26:21,690
that there's a lot there's a lot of

700
00:26:26,180 --> 00:26:24,299
ocean on the earth to to host these

701
00:26:27,320 --> 00:26:26,190
impacts if you have any questions again

702
00:26:29,810 --> 00:26:27,330
doesn't follow you who are watching

703
00:26:31,460 --> 00:26:29,820
please use hash tag ask Astro bio on

704
00:26:33,350 --> 00:26:31,470
Twitter or ask them on Facebook live and

705
00:26:35,390 --> 00:26:33,360
the questions down below or on Sagan

706
00:26:36,740 --> 00:26:35,400
there directly and so perhaps my last

707
00:26:38,149 --> 00:26:36,750
question before we open it up to

708
00:26:39,620 --> 00:26:38,159
questions I mean that I love this

709
00:26:41,299 --> 00:26:39,630
conversation I could go on forever but

710
00:26:42,300 --> 00:26:41,309
I'm already seeing the teleprompter

711
00:26:43,530 --> 00:26:42,310
explode for

712
00:26:45,750 --> 00:26:43,540
from our audience wanting to ask you

713
00:26:47,700 --> 00:26:45,760

questions and press you can tell us some

714
00:26:50,100 --> 00:26:47,710
of the places on earth where you've

715
00:26:52,380 --> 00:26:50,110
traveled to to explore different craters

716
00:26:55,290 --> 00:26:52,390
you have any fun adventures or stories

717
00:26:56,910 --> 00:26:55,300
that that occurred in them yeah you know

718
00:26:58,230 --> 00:26:56,920
I mean again I kind of hinted at it

719
00:27:00,540 --> 00:26:58,240
earlier one of the things that got me

720
00:27:02,400 --> 00:27:00,550
into geology in the first place after

721
00:27:04,530 --> 00:27:02,410
school because I think again like most

722
00:27:08,040 --> 00:27:04,540
geology is not something taught too much

723
00:27:09,540 --> 00:27:08,050
in schools was that you know the love of

724
00:27:11,760 --> 00:27:09,550
the outdoors you know in my spare time

725
00:27:13,410 --> 00:27:11,770
the real time I have typically are

726
00:27:15,180 --> 00:27:13,420
climbing on mountain biking or skiing

727
00:27:16,620 --> 00:27:15,190
and so you know that it was actually

728
00:27:18,840 --> 00:27:16,630
that you know being outdoors that

729
00:27:20,700 --> 00:27:18,850
attracted me to geology and you know

730
00:27:23,490 --> 00:27:20,710
still today my kind of happy place is in

731
00:27:24,960 --> 00:27:23,500
the field somewhere so I'm getting ready

732
00:27:26,840 --> 00:27:24,970
for another trip up to the Canadian

733
00:27:30,390 --> 00:27:26,850
Arctic this will be about the 20th year

734
00:27:33,720 --> 00:27:30,400
working up there so not going back to

735
00:27:36,630 --> 00:27:33,730
Horton this year but for kind of other

736
00:27:38,730 --> 00:27:36,640
non crater related field work but I've

737
00:27:41,520 --> 00:27:38,740
been kind of slowly chipping away at the

738
00:27:43,290 --> 00:27:41,530

Canadian impact record you know Canada

739
00:27:45,390 --> 00:27:43,300
probably next to Australia has the

740
00:27:47,430 --> 00:27:45,400
biggest concentration of impact craters

741
00:27:49,260 --> 00:27:47,440
in the world because it has a lot of you

742
00:27:51,330 --> 00:27:49,270
know the old ancient Canadian Shield

743
00:27:52,860 --> 00:27:51,340
rocks and so you know I've had the

744
00:27:54,920 --> 00:27:52,870
pleasure to do work in northern Labrador

745
00:27:57,360 --> 00:27:54,930
northern Quebec northern Saskatchewan

746
00:27:59,820 --> 00:27:57,370
looking at these you know incredibly

747
00:28:03,030 --> 00:27:59,830
remote craters you know I've been flown

748
00:28:04,890 --> 00:28:03,040
in by helicopter float plane you know

749
00:28:07,230 --> 00:28:04,900
twin otter and tons of tires up in the

750
00:28:08,970 --> 00:28:07,240
Arctic and you know usually get dropped

751
00:28:11,010 --> 00:28:08,980
off in the middle of nowhere and then

752
00:28:12,930 --> 00:28:11,020
it's you know see you in two weeks or a

753
00:28:15,420 --> 00:28:12,940
month kind of thing and they hope they

754
00:28:19,140 --> 00:28:15,430
come back and get yeah

755
00:28:21,810 --> 00:28:19,150
lots of stories I have my festive

756
00:28:23,220 --> 00:28:21,820
article about three years ago and did

757
00:28:25,530 --> 00:28:23,230
some field work at some of the

758
00:28:28,440 --> 00:28:25,540
Australian impact craters actually and

759
00:28:30,510 --> 00:28:28,450
that was great too and again similar

760
00:28:33,090 --> 00:28:30,520
grass even more isolated and teeny

761
00:28:34,500 --> 00:28:33,100
little to ca3 see at a helicopter and I

762
00:28:36,390 --> 00:28:34,510
actually have my son along with me then

763
00:28:38,730 --> 00:28:36,400

and dropped us out in the middle of the

764
00:28:41,640 --> 00:28:38,740
outback and yeah see you and we'll see

765
00:28:43,260 --> 00:28:41,650
you in a few days very cool okay yeah I

766
00:28:44,550 --> 00:28:43,270
mean being a geologist myself and having

767
00:28:46,860 --> 00:28:44,560
been quite a bit of field orchid this

768
00:28:48,300 --> 00:28:46,870
definitely adds to the motivation of

769
00:28:49,830 --> 00:28:48,310
being trapped in an office for most of

770
00:28:53,100 --> 00:28:49,840
the year writing proposals to get the

771
00:28:56,010 --> 00:28:53,110
secular the lights at the end of the

772
00:28:57,660 --> 00:28:56,020
tunnel yeah

773
00:28:59,070 --> 00:28:57,670
now it's time for that questions which

774
00:29:01,110 --> 00:28:59,080
is awesome and very excited to thank you

775
00:29:04,470 --> 00:29:01,120
all for your questions that you've been

776
00:29:06,750 --> 00:29:04,480
sending them so the first one Gordon is

777
00:29:08,850 --> 00:29:06,760
from Amanda Lau who is asking from

778
00:29:11,430 --> 00:29:08,860
Facebook you think that the idea of

779
00:29:14,610 --> 00:29:11,440
panspermia still makes sense can life

780
00:29:16,590 --> 00:29:14,620
survive an impact that's a great

781
00:29:18,540 --> 00:29:16,600
question and there's almost Isaac to

782
00:29:22,770 --> 00:29:18,550
there and once at the wasp it can life

783
00:29:24,750 --> 00:29:22,780
survive impact the answer is yes you

784
00:29:27,390 --> 00:29:24,760
know even for example at the Horton

785
00:29:29,420 --> 00:29:27,400
crater in the Arctic we did some I did

786
00:29:32,100 --> 00:29:29,430
some work and collaborations with a

787
00:29:33,900 --> 00:29:32,110
chemist John Parnell at the University

788
00:29:36,030 --> 00:29:33,910

of Aberdeen and he showed that you know

789
00:29:37,500 --> 00:29:36,040
a lot of the organic molecules in the

790
00:29:40,500 --> 00:29:37,510
rocks even the ones that are heated and

791
00:29:42,000 --> 00:29:40,510
shot to high pressures survived and what

792
00:29:43,350 --> 00:29:42,010
I think is most about I haven't done

793
00:29:46,830 --> 00:29:43,360
this myself but people have done

794
00:29:48,210 --> 00:29:46,840
experiments actually NASA Ames and at

795
00:29:50,430 --> 00:29:48,220
NASA Johnson they have these

796
00:29:52,680 --> 00:29:50,440
high-powered experimental guns that are

797
00:29:55,830 --> 00:29:52,690
literally you know creating on a small

798
00:29:58,230 --> 00:29:55,840
scale impact events and I know what they

799
00:30:01,920 --> 00:29:58,240
did they impregnated you know rocks with

800
00:30:03,810 --> 00:30:01,930
bacteria shadow projectile a super high

801
00:30:08,510 --> 00:30:03,820
velocity and you know a certain portion

802
00:30:11,990 --> 00:30:08,520
of that those organisms survive and so

803
00:30:14,580 --> 00:30:12,000
panspermia you know that end is possible

804
00:30:16,680 --> 00:30:14,590
people have put most of the pieces

805
00:30:20,850 --> 00:30:16,690
together now I think you know people

806
00:30:22,650 --> 00:30:20,860
have done experiments on re-entry a good

807
00:30:24,720 --> 00:30:22,660
friend of mine who actually got me has

808
00:30:25,080 --> 00:30:24,730
it probably into astrobiology Charles

809
00:30:26,820 --> 00:30:25,090
Cockell

810
00:30:29,460 --> 00:30:26,830
who's now at the University of Edinburgh

811
00:30:31,110 --> 00:30:29,470
I don't know how we got permission but

812
00:30:33,060 --> 00:30:31,120
he convinced the Russians to strap rocks

813
00:30:35,430 --> 00:30:33,070

to the outside of a Soyuz capsule and

814
00:30:38,910 --> 00:30:35,440
that re-entered the Earth's atmosphere

815
00:30:40,230 --> 00:30:38,920
and you know some of the organisms in

816
00:30:42,720 --> 00:30:40,240
those rocks survived in a

817
00:30:44,070 --> 00:30:42,730
high-temperature reentry and then we

818
00:30:45,900 --> 00:30:44,080
know you know they've done experiments

819
00:30:47,370 --> 00:30:45,910
on the stay state space station that

820
00:30:51,060 --> 00:30:47,380
things could survive high radiation

821
00:30:53,910 --> 00:30:51,070
environments so yeah we are not going to

822
00:30:57,330 --> 00:30:53,920
say I agree in my pants Permian but I

823
00:30:59,730 --> 00:30:57,340
think you know it's it's potentially you

824
00:31:03,300 --> 00:30:59,740
know bits of that hypothesis seem viable

825
00:31:05,550 --> 00:31:03,310
sure if you are watching are interested

826
00:31:07,200 --> 00:31:05,560
in this idea of strapping rocks to the

827
00:31:08,880 --> 00:31:07,210
side of the space station Charles kaile

828
00:31:09,840 --> 00:31:08,890
was actually our very first guest for

829
00:31:13,980 --> 00:31:09,850
asking us

830
00:31:17,070 --> 00:31:13,990
biologist one time ago now 22 episodes

831
00:31:18,779 --> 00:31:17,080
ago and if you can find those this

832
00:31:21,450 --> 00:31:18,789
episode on YouTube so to refresh your

833
00:31:24,710 --> 00:31:21,460
memory so very cool thank you the next

834
00:31:27,659 --> 00:31:24,720
question comes from Anthony Vinciguerra

835
00:31:28,950 --> 00:31:27,669
on Facebook and he's asking about the

836
00:31:31,100 --> 00:31:28,960
Drake Equation and what do you think of

837
00:31:34,200 --> 00:31:31,110
it and is it still relevant for life

838
00:31:38,520 --> 00:31:34,210

it's definitely kind of outside my area

839
00:31:40,620 --> 00:31:38,530
of expertise but I think it is still

840
00:31:42,960 --> 00:31:40,630
relevant but you know in our own solar

841
00:31:46,770 --> 00:31:42,970
system we're learning you know it as a

842
00:31:49,500 --> 00:31:46,780
gross estimate of you know potential for

843
00:31:51,810 --> 00:31:49,510
life out there I do think it works but

844
00:31:53,580 --> 00:31:51,820
you know I think actually impacts create

845
00:31:55,980 --> 00:31:53,590
a a bit of an issue for that equation

846
00:31:58,380 --> 00:31:55,990
and it doesn't account with the fact

847
00:32:00,060 --> 00:31:58,390
that you know on small bodies in

848
00:32:02,370 --> 00:32:00,070
different parts you know out of the

849
00:32:05,039 --> 00:32:02,380
Goldilocks zone out of where water is

850
00:32:07,710 --> 00:32:05,049
stable you could create habitats for

851
00:32:09,330 --> 00:32:07,720
life on you know in various different

852
00:32:12,330 --> 00:32:09,340
parts of the solar system without the

853
00:32:14,250 --> 00:32:12,340
need for you know long term stability of

854
00:32:16,080 --> 00:32:14,260
water too so yeah you know as a

855
00:32:17,490 --> 00:32:16,090
fundamental base level I think it's

856
00:32:19,110 --> 00:32:17,500
still a great thing and but was

857
00:32:22,020 --> 00:32:19,120
definitely I think probably more and

858
00:32:25,799 --> 00:32:23,760
so that's leads actually to the next

859
00:32:28,049 --> 00:32:25,809
question by Michael Cooney who on

860
00:32:29,970 --> 00:32:28,059
Twitter asks do you think habitable

861
00:32:31,860 --> 00:32:29,980
environments actually do exist elsewhere

862
00:32:34,200 --> 00:32:31,870
in the universe are there stronger

863
00:32:37,010 --> 00:32:34,210

locations is that Mars or Europa where

864
00:32:41,909 --> 00:32:37,020
you'd expect to find signs of life I

865
00:32:45,090 --> 00:32:41,919
mean yes I think I still think Mars is

866
00:32:47,640 --> 00:32:45,100
you know as a great place to go to and

867
00:32:50,070 --> 00:32:47,650
again we have discovered based on remote

868
00:32:51,570 --> 00:32:50,080
sensing data for example we think some

869
00:32:53,340 --> 00:32:51,580
of the impacts on Mars created a

870
00:32:55,140 --> 00:32:53,350
geothermal system so I do think the

871
00:32:56,669 --> 00:32:55,150
habitats were there we know the

872
00:32:58,380 --> 00:32:56,679
ingredients were there and then it's

873
00:33:01,380 --> 00:32:58,390
just a question you know did life

874
00:33:03,029 --> 00:33:01,390
originate there definitely you know some

875
00:33:05,700 --> 00:33:03,039
of the afternoons of our own solar

876
00:33:07,560 --> 00:33:05,710
system are high-priority astrobiological

877
00:33:10,260 --> 00:33:07,570
targets because we know that you know

878
00:33:12,720 --> 00:33:10,270
liquid water exists even today and again

879
00:33:15,720 --> 00:33:12,730
you know impacts could be part of that

880
00:33:18,090 --> 00:33:15,730
story and creating delivering nutrients

881
00:33:20,549 --> 00:33:18,100
and also creating hydrothermal systems

882
00:33:23,549 --> 00:33:20,559
and other habitats that creep create

883
00:33:25,499 --> 00:33:23,559
them and make them even habitable today

884
00:33:28,230 --> 00:33:25,509
and then again as I entered out earlier

885
00:33:30,389 --> 00:33:28,240
you know our knowledge basically unless

886
00:33:33,509 --> 00:33:30,399
we fundamentally misunderstood how solar

887
00:33:35,489 --> 00:33:33,519
systems form impact events you know so

888
00:33:37,799 --> 00:33:35,499

an object hitting another object is

889
00:33:39,989 --> 00:33:37,809
going to be pervasive throughout the

890
00:33:42,419 --> 00:33:39,999
entire universe and every solar system

891
00:33:44,909 --> 00:33:42,429
and so you know impacts is something

892
00:33:46,680 --> 00:33:44,919
that's ubiquitous enough that yeah you

893
00:33:48,119 --> 00:33:46,690
know you tie that with with other things

894
00:33:50,190 --> 00:33:48,129
and the number of stars out there I

895
00:33:51,989 --> 00:33:50,200
think that there must be some habitable

896
00:33:53,989 --> 00:33:51,999
environments and maybe one or two I

897
00:33:57,419 --> 00:33:53,999
created by impacts

898
00:34:00,480 --> 00:33:57,429
yeah and seeing as we've discussed today

899
00:34:02,489 --> 00:34:00,490
as how resilient life can be it seems

900
00:34:03,230 --> 00:34:02,499
crazy to think that life is limited to

901
00:34:06,960 --> 00:34:03,240
our own planet

902
00:34:08,879 --> 00:34:06,970
so Amanda Lau asks again on Facebook

903
00:34:10,859 --> 00:34:08,889
where we talk a lot about Chicxulub like

904
00:34:13,349 --> 00:34:10,869
we did today but where there are larger

905
00:34:16,919 --> 00:34:13,359
impacts that wiped out life earlier on

906
00:34:19,349 --> 00:34:16,929
earth oh that's a great question and so

907
00:34:21,329 --> 00:34:19,359
we there currently today we know of

908
00:34:23,460 --> 00:34:21,339
about a hundred and ninety or so impact

909
00:34:24,750 --> 00:34:23,470
craters on earth if you're actually

910
00:34:27,030 --> 00:34:24,760
interested in knowing where they are

911
00:34:28,740 --> 00:34:27,040
I'll do a shout out to a new kind of

912
00:34:31,260 --> 00:34:28,750
educational initiative we've got going

913
00:34:32,760 --> 00:34:31,270

which is just impact earth calm and you

914
00:34:35,550 --> 00:34:32,770
can kind of zoom around to your heart's

915
00:34:37,889 --> 00:34:35,560
content and see well the craters are but

916
00:34:40,500 --> 00:34:37,899
we have Chicxulub Rita fought in South

917
00:34:42,899 --> 00:34:40,510
Africa and Sudbury here in Ontario that

918
00:34:46,349 --> 00:34:42,909
are all around the 200 ish kilometer

919
00:34:48,480 --> 00:34:46,359
mark you know when we look at the moon

920
00:34:50,490 --> 00:34:48,490
though and Mars and other planets you

921
00:34:52,710 --> 00:34:50,500
know there are what we call basins

922
00:34:55,710 --> 00:34:52,720
impact basins that are thousands of

923
00:34:57,720 --> 00:34:55,720
kilometers across those size of impacts

924
00:34:59,250 --> 00:34:57,730
must have occurred on earth but it's

925
00:35:02,010 --> 00:34:59,260
just the fact that Earth is so

926
00:35:04,170 --> 00:35:02,020
geologically active that we have hardly

927
00:35:06,450 --> 00:35:04,180
any record of in particular the first

928
00:35:08,099 --> 00:35:06,460
billion years of Earth's history and you

929
00:35:09,930 --> 00:35:08,109
know virtually nothing from the first

930
00:35:12,530 --> 00:35:09,940
half a billion years of Earth history

931
00:35:14,730 --> 00:35:12,540
when those larger impacts happened

932
00:35:17,059 --> 00:35:14,740
whether the word you know how their

933
00:35:19,829 --> 00:35:17,069
impact related mass extinction events

934
00:35:21,900 --> 00:35:19,839
you know I think in the past you know

935
00:35:23,700 --> 00:35:21,910
when it when we're talking single-celled

936
00:35:25,650 --> 00:35:23,710
organisms you know it's a lot more

937
00:35:28,380 --> 00:35:25,660
resilient form of life and so you know

938
00:35:30,740 --> 00:35:28,390

and very localized those impacts would

939
00:35:34,380 --> 00:35:30,750
have been destructive but right now

940
00:35:36,480 --> 00:35:34,390
Chicxulub is the only kind of event

941
00:35:36,820 --> 00:35:36,490
associated with a mass extinction event

942
00:35:39,250 --> 00:35:36,830
and

943
00:35:41,800 --> 00:35:39,260
in the last half a billion years so 400

944
00:35:43,360 --> 00:35:41,810
million years very cool

945
00:35:46,210 --> 00:35:43,370
yeah I did some fieldwork I think two

946
00:35:48,460 --> 00:35:46,220
years ago in Lake Superior in Canada and

947
00:35:50,440 --> 00:35:48,470
there's some evidence of life trapped in

948
00:35:52,690 --> 00:35:50,450
rocks so in in charts essentially

949
00:35:54,700 --> 00:35:52,700
stromatolites which are about in the

950
00:35:57,010 --> 00:35:54,710
show before kind of mounds of biological

951
00:36:01,030 --> 00:35:57,020
mats but then have been sliced kind of

952
00:36:02,980 --> 00:36:01,040
flats by by glacial processes and up

953
00:36:05,110 --> 00:36:02,990
there in in they contain exterior that

954
00:36:07,090 --> 00:36:05,120
age is roughly the same as the Sudbury

955
00:36:08,800 --> 00:36:07,100
impact so it's kind of it was cool to

956
00:36:10,270 --> 00:36:08,810
kind of sit down you know in this very

957
00:36:12,010 --> 00:36:10,280
beautiful quiet environment on these

958
00:36:13,990 --> 00:36:12,020
charts which have evidence of life on

959
00:36:15,400 --> 00:36:14,000
Earth and that at the same time period

960
00:36:18,310 --> 00:36:15,410
that you know just a few hundred miles

961
00:36:20,320 --> 00:36:18,320
that way like you know Sudbury arrives

962
00:36:26,380 --> 00:36:20,330
and just wipes everything you can see

963
00:36:33,190 --> 00:36:30,760

Baldr Vica on facebook asks is it

964
00:36:37,720 --> 00:36:33,200
expensive to study astrobiology compared

965
00:36:40,450 --> 00:36:37,730
to other careers I don't you can make it

966
00:36:43,390 --> 00:36:40,460
expensive but no I wouldn't say it so at

967
00:36:44,950 --> 00:36:43,400
all you know it's expensive for me to go

968
00:36:46,900 --> 00:36:44,960
out to the Arctic to do fieldwork at the

969
00:36:48,670 --> 00:36:46,910
Horton crater but it's you know just a

970
00:36:51,400 --> 00:36:48,680
five hour drive for me to go to Sudbury

971
00:36:53,380 --> 00:36:51,410
so and then you know in terms of the

972
00:36:56,080 --> 00:36:53,390
laboratory techniques and the kind of

973
00:36:58,210 --> 00:36:56,090
things we look at in the lab you can you

974
00:37:00,280 --> 00:36:58,220
know there's a varying scale from you

975
00:37:01,960 --> 00:37:00,290
know it's doing simple work on an

976
00:37:03,700 --> 00:37:01,970
inexpensive microscope to you know

977
00:37:06,220 --> 00:37:03,710
playing the cutting edge techniques so

978
00:37:08,170 --> 00:37:06,230
you know I definitely not more expensive

979
00:37:10,600 --> 00:37:08,180
than any other field of science I would

980
00:37:12,310 --> 00:37:10,610
say yeah I agree with that after all

981
00:37:13,900 --> 00:37:12,320
astrobiology is where you take the

982
00:37:15,880 --> 00:37:13,910
direction of your science you know you

983
00:37:17,200 --> 00:37:15,890
can be an oceanographer doing

984
00:37:18,910 --> 00:37:17,210
astrobiology you can be a geologist

985
00:37:21,070 --> 00:37:18,920
doing astrobiology you can be a

986
00:37:22,300 --> 00:37:21,080
microbiologist doing astrobiology you

987
00:37:23,860 --> 00:37:22,310
can be an astronomer doing

988
00:37:26,020 --> 00:37:23,870

astrobiologists you're an expert in this

989
00:37:27,850 --> 00:37:26,030
independent fields then you take your

990
00:37:30,040 --> 00:37:27,860
research to answer as for biological

991
00:37:31,720 --> 00:37:30,050
questions so yeah it's not really a

992
00:37:33,340 --> 00:37:31,730
discipline almost it's kind of I see it

993
00:37:35,500 --> 00:37:33,350
as a framework on which different

994
00:37:37,270 --> 00:37:35,510
disciplines come together to study those

995
00:37:40,870 --> 00:37:37,280
really big questions that astrobiology

996
00:37:43,930 --> 00:37:40,880
asks like interdisciplinary crossroads

997
00:37:46,660 --> 00:37:43,940
of have many many disciplines which is

998
00:37:47,740 --> 00:37:46,670
what has attracted to me to astrobiology

999
00:37:50,650 --> 00:37:47,750
in the first place and I thank you as

1000
00:37:52,870 --> 00:37:50,660
well yeah I mean absolutely so

1001
00:37:53,980 --> 00:37:52,880
Graham Lao asks and I'm glad mention

1002
00:37:56,530 --> 00:37:53,990
that Graham because I've been asked that

1003
00:37:58,210 --> 00:37:56,540
too so go to a new work at the Center

1004
00:38:00,130 --> 00:37:58,220
for planetary science and exploration at

1005
00:38:03,160 --> 00:38:00,140
Western you tell us a little bit about

1006
00:38:04,960 --> 00:38:03,170
cps x and how does it play a role in the

1007
00:38:07,570 --> 00:38:04,970
broader exploration of Earth and for

1008
00:38:09,010 --> 00:38:07,580
Canada yeah I'd love to her wasn't

1009
00:38:10,330 --> 00:38:09,020
expected to be asked a question on that

1010
00:38:13,870 --> 00:38:10,340
but it's great to have the opportunity

1011
00:38:15,640 --> 00:38:13,880
so yeah so this is a cross-disciplinary

1012
00:38:17,980 --> 00:38:15,650
center you know like what we just talked

1013
00:38:19,420 --> 00:38:17,990

about with astrobiology so I'm in the

1014
00:38:20,860 --> 00:38:19,430
Department of Earth Sciences here at

1015
00:38:22,330 --> 00:38:20,870
Weston and you know like other

1016
00:38:25,930 --> 00:38:22,340
universities we have departments of

1017
00:38:27,850 --> 00:38:25,940
explains at and so Western is a culture

1018
00:38:29,440 --> 00:38:27,860
bringing together you know people from

1019
00:38:31,840 --> 00:38:29,450
various different backgrounds under

1020
00:38:33,820 --> 00:38:31,850
these centers and Institute's and so we

1021
00:38:35,470 --> 00:38:33,830
created this CPS X the Center for

1022
00:38:38,110 --> 00:38:35,480
planetary science an exploration about a

1023
00:38:40,510 --> 00:38:38,120
decade ago to bring together initially

1024
00:38:42,550 --> 00:38:40,520
engineers and scientists but it's really

1025
00:38:44,320 --> 00:38:42,560
exploded to become you know we got

1026
00:38:46,120 --> 00:38:44,330
Health Sciences and doctors and lawyers

1027
00:38:48,550 --> 00:38:46,130
you know as we're getting into space

1028
00:38:50,740 --> 00:38:48,560
policy and laws and you know space is

1029
00:38:53,410 --> 00:38:50,750
really one of those things that is you

1030
00:38:54,910 --> 00:38:53,420
know infinitely interdisciplinary the

1031
00:38:57,160 --> 00:38:54,920
income at space and there's a need for

1032
00:38:59,620 --> 00:38:57,170
you know understanding of space from

1033
00:39:01,000 --> 00:38:59,630
various different disciplines and you

1034
00:39:02,410 --> 00:39:01,010
know what's really driving and really

1035
00:39:04,630 --> 00:39:02,420
what attracted me to Western is the

1036
00:39:06,520 --> 00:39:04,640
center and we have Canada's only

1037
00:39:08,500 --> 00:39:06,530
graduate program in planetary science

1038
00:39:10,840 --> 00:39:08,510

and so we had a lot of students coming

1039
00:39:12,850 --> 00:39:10,850
here from across Canada but also the US

1040
00:39:14,130 --> 00:39:12,860
and you know overseas to to come come

1041
00:39:17,650 --> 00:39:14,140
and work in this really fun

1042
00:39:20,970 --> 00:39:17,660
interdisciplinary environment fantastic

1043
00:39:24,670 --> 00:39:20,980
so CPS X folks check it out online

1044
00:39:26,590 --> 00:39:24,680
perhaps the most violent impact crater

1045
00:39:29,050 --> 00:39:26,600
or rather impact because there's no

1046
00:39:31,480 --> 00:39:29,060
crater of it anymore is the one that

1047
00:39:33,340 --> 00:39:31,490
formed the earth and the moon so nothing

1048
00:39:35,650 --> 00:39:33,350
many people realize that the earth and

1049
00:39:38,500 --> 00:39:35,660
the moon emerged from a gigantic impact

1050
00:39:40,360 --> 00:39:38,510
I call the moon-forming impact perhaps

1051
00:39:42,910 --> 00:39:40,370
you can tell us about the the birth of

1052
00:39:44,410 --> 00:39:42,920
the earth and the moon yeah yeah you

1053
00:39:47,080 --> 00:39:44,420
know we've been talking about impact

1054
00:39:50,260 --> 00:39:47,090
craters as you say but you know there's

1055
00:39:52,150 --> 00:39:50,270
a complete scale from you know on you

1056
00:39:55,270 --> 00:39:52,160
know on spacecraft they formed teeny

1057
00:39:57,280 --> 00:39:55,280
teeny micron size what we call micro

1058
00:39:59,710 --> 00:39:57,290
meteorite impacts from the impact of

1059
00:40:01,780 --> 00:39:59,720
dust particles on a solar panel on the

1060
00:40:03,880 --> 00:40:01,790
space station and yeah the extreme other

1061
00:40:06,519 --> 00:40:03,890
end would be you know the moon

1062
00:40:08,500 --> 00:40:06,529
forming impact and you know we do think

1063
00:40:10,420 --> 00:40:08,510

that those kinds of giant impacts have

1064
00:40:13,569 --> 00:40:10,430
played a role potentially in the

1065
00:40:15,339 --> 00:40:13,579
formation of the Martian dichotomy and

1066
00:40:17,769 --> 00:40:15,349
other planets in the solar system so

1067
00:40:19,690 --> 00:40:17,779
basically the idea is that you know when

1068
00:40:22,750 --> 00:40:19,700
the solar system first formed we didn't

1069
00:40:25,029 --> 00:40:22,760
just have you know the eight Rebate we

1070
00:40:26,859 --> 00:40:25,039
eight planets as they exist now but

1071
00:40:29,200 --> 00:40:26,869
there were other proto plan is out there

1072
00:40:31,900 --> 00:40:29,210
the estimates you know a few you know

1073
00:40:34,480 --> 00:40:31,910
there's two or five who knows and

1074
00:40:36,370 --> 00:40:34,490
essentially I'm fairly soon after the

1075
00:40:39,339 --> 00:40:36,380
earth but earth is formed or was still

1076
00:40:42,279 --> 00:40:39,349
forming another object roughly the size

1077
00:40:44,650 --> 00:40:42,289
of Mars that we call FEA impacted the

1078
00:40:46,870 --> 00:40:44,660
earth and you know as a cataclysmic

1079
00:40:48,519 --> 00:40:46,880
event you know stripped off a large part

1080
00:40:50,019 --> 00:40:48,529
of the Earth's crust and then

1081
00:40:53,170 --> 00:40:50,029
essentially what was left of the

1082
00:40:55,509 --> 00:40:53,180
impactor and the earth basically formed

1083
00:40:58,029 --> 00:40:55,519
the earth-moon system that we see today

1084
00:41:00,630 --> 00:40:58,039
and it still still remains it stood the

1085
00:41:03,370 --> 00:41:00,640
test of time and still remains the best

1086
00:41:05,500 --> 00:41:03,380
hypothesis for the formation of our own

1087
00:41:08,529 --> 00:41:05,510
moon and for various things and in

1088
00:41:14,109 --> 00:41:08,539

various chemical evidences that we see

1089
00:41:16,870 --> 00:41:14,119
on the moon yeah just fascinating next

1090
00:41:18,730 --> 00:41:16,880
question is from Omar al and perhaps

1091
00:41:21,249 --> 00:41:18,740
another anonymous user who are asking

1092
00:41:23,499 --> 00:41:21,259
about do you think they are earth-like

1093
00:41:26,049 --> 00:41:23,509
worlds out there in the galaxy

1094
00:41:27,579 --> 00:41:26,059
for us to find and if you had to guess

1095
00:41:29,349 --> 00:41:27,589
what are the chance of us finding

1096
00:41:30,940 --> 00:41:29,359
another earth sometime soon what it

1097
00:41:33,839 --> 00:41:30,950
would be Oh

1098
00:41:36,099 --> 00:41:33,849
again you know this is me talking as a

1099
00:41:39,249 --> 00:41:36,109
planetary scientist and speculating

1100
00:41:41,740 --> 00:41:39,259
probably as much as you do now or you

1101
00:41:44,079 --> 00:41:41,750
you you would do yeah I mean I think the

1102
00:41:45,880 --> 00:41:44,089
mote the we we think there are like

1103
00:41:48,370 --> 00:41:45,890
worlds out there you know statistically

1104
00:41:49,289 --> 00:41:48,380
given the number of stars in our own

1105
00:41:52,329 --> 00:41:49,299
galaxy

1106
00:41:54,400 --> 00:41:52,339
there must be earth-like planets out

1107
00:41:57,999 --> 00:41:54,410
there a lot of his life on them again

1108
00:42:00,370 --> 00:41:58,009
that's a different matter whether we'll

1109
00:42:02,799 --> 00:42:00,380
find and discover those I mean I think

1110
00:42:05,200 --> 00:42:02,809
you know in the past decade this whole

1111
00:42:07,210 --> 00:42:05,210
era of discovering planets outside our

1112
00:42:09,549 --> 00:42:07,220
own solar system so you know exoplanet

1113
00:42:11,920 --> 00:42:09,559

research has just exploded and I mean

1114
00:42:13,210 --> 00:42:11,930
I'm just fascinated is not my research

1115
00:42:15,099 --> 00:42:13,220
area and I find it absolutely

1116
00:42:17,650 --> 00:42:15,109
fascinating you know how we can be

1117
00:42:20,380 --> 00:42:17,660
discovering planets around stars

1118
00:42:21,789 --> 00:42:20,390
and thousands of light-years away but

1119
00:42:23,349 --> 00:42:21,799
you know with the next generation Space

1120
00:42:25,630 --> 00:42:23,359
Telescope's hopefully getting launched

1121
00:42:27,579 --> 00:42:25,640
in the next few years we're getting

1122
00:42:29,680 --> 00:42:27,589
close soon closer to be able to detect

1123
00:42:32,309 --> 00:42:29,690
those air flight planets and so yeah you

1124
00:42:36,010 --> 00:42:32,319
know kind of watch that space as it were

1125
00:42:38,109 --> 00:42:36,020
fascinating so Joshua the Borja on

1126
00:42:39,549 --> 00:42:38,119
Facebook also asked a question that I'm

1127
00:42:40,539 --> 00:42:39,559
gonna restate a little bit's because

1128
00:42:42,010 --> 00:42:40,549
it's a little bit outside our

1129
00:42:47,740 --> 00:42:42,020
conversation topic but he's interested

1130
00:42:50,289 --> 00:42:47,750
in organic molecules and our can those

1131
00:42:53,319 --> 00:42:50,299
be brought to a planetary system via an

1132
00:42:56,740 --> 00:42:53,329
impactor the short answer is yes

1133
00:42:58,690 --> 00:42:56,750
absolutely you know we do think that or

1134
00:43:01,079 --> 00:42:58,700
people have thought for a long time

1135
00:43:03,910 --> 00:43:01,089
actually that you know some of the

1136
00:43:06,339 --> 00:43:03,920
organic molecules were delivered to

1137
00:43:08,980 --> 00:43:06,349
early Earth either by comets that we

1138
00:43:10,809 --> 00:43:08,990

know and think carbon-rich or by a class

1139
00:43:12,700 --> 00:43:10,819
of meteorites we call carbonaceous

1140
00:43:15,490 --> 00:43:12,710
chondrites and they can be you know

1141
00:43:17,710 --> 00:43:15,500
several tens of percent formed of carbon

1142
00:43:19,450 --> 00:43:17,720
and so you know whether it's small

1143
00:43:22,809 --> 00:43:19,460
meteorites kind of raining down on the

1144
00:43:24,789 --> 00:43:22,819
early Earth that's one thing you know an

1145
00:43:27,609 --> 00:43:24,799
interesting area I'm just starting to

1146
00:43:30,069 --> 00:43:27,619
really think about myself is you know I

1147
00:43:31,900 --> 00:43:30,079
mentioned earlier that most of the

1148
00:43:34,210 --> 00:43:31,910
projectile gets vaporized during an

1149
00:43:36,539 --> 00:43:34,220
impact because of high temperatures and

1150
00:43:38,620 --> 00:43:36,549
pressures there are exceptions

1151
00:43:41,140 --> 00:43:38,630
particularly when the velocity of the

1152
00:43:43,420 --> 00:43:41,150
impact is low enough and one could

1153
00:43:45,670 --> 00:43:43,430
imagine you know a big carbonaceous

1154
00:43:47,589 --> 00:43:45,680
asteroid carbon-rich asteroid striking

1155
00:43:49,809 --> 00:43:47,599
early Earth when there was water around

1156
00:43:52,359 --> 00:43:49,819
you know perhaps that very same crater

1157
00:43:54,069 --> 00:43:52,369
generating a hydrothermal system and you

1158
00:43:56,140 --> 00:43:54,079
know so not only having the habitat for

1159
00:43:57,910 --> 00:43:56,150
life but potentially the ingredients for

1160
00:43:59,620 --> 00:43:57,920
life and putting the two and two

1161
00:44:01,599 --> 00:43:59,630
together so I know that's pure

1162
00:44:02,710 --> 00:44:01,609
speculation but we can do that on the

1163
00:44:05,339 --> 00:44:02,720

show I hope a little bit

1164
00:44:09,339 --> 00:44:05,349
oh absolutely this is what it's about

1165
00:44:12,519 --> 00:44:09,349
our next question is from anonymous he

1166
00:44:15,279 --> 00:44:12,529
so we talked about craters on Earth as

1167
00:44:17,650 --> 00:44:15,289
being good analogues to craters

1168
00:44:19,809 --> 00:44:17,660
elsewhere and this person is curious

1169
00:44:22,059 --> 00:44:19,819
about actually what makes an analogue a

1170
00:44:24,880 --> 00:44:22,069
good analog to a extraterrestrial

1171
00:44:27,039 --> 00:44:24,890
environment yeah another great question

1172
00:44:29,019 --> 00:44:27,049
and so you have to actually turn that

1173
00:44:30,800 --> 00:44:29,029
around a little bit and think about what

1174
00:44:32,480 --> 00:44:30,810
the analog is for you know it was

1175
00:44:36,740 --> 00:44:32,490
very there's various different reasons

1176
00:44:39,050 --> 00:44:36,750
for choosing an analog so you know is it

1177
00:44:40,340 --> 00:44:39,060
purely scientific and so in that case

1178
00:44:42,860 --> 00:44:40,350
you know if you're looking at for

1179
00:44:44,870 --> 00:44:42,870
example understanding what's going on on

1180
00:44:47,570 --> 00:44:44,880
present-day surface of Mars maybe it's

1181
00:44:49,340 --> 00:44:47,580
understanding gully formation you want

1182
00:44:51,890 --> 00:44:49,350
to go to some of the driest coldest

1183
00:44:53,600 --> 00:44:51,900
places on earth so you know Antarctic

1184
00:44:55,670 --> 00:44:53,610
Dry Valleys or the High Arctic would be

1185
00:44:57,710 --> 00:44:55,680
great analogs if you're clearly

1186
00:44:59,720 --> 00:44:57,720
interested in you know understanding

1187
00:45:01,040 --> 00:44:59,730
cratering on the moon and you know any

1188
00:45:04,160 --> 00:45:01,050

crater on earth would make a good

1189
00:45:06,410 --> 00:45:04,170
analogue the other aspect of analogs we

1190
00:45:07,580 --> 00:45:06,420
talked about earlier is and you know and

1191
00:45:09,890 --> 00:45:07,590
using them to test and develop

1192
00:45:11,810 --> 00:45:09,900
technologies and also for actually the

1193
00:45:13,460 --> 00:45:11,820
Mission Operations you know with

1194
00:45:16,010 --> 00:45:13,470
training and developing the Mission

1195
00:45:18,620 --> 00:45:16,020
Operations architecture and there it

1196
00:45:21,710 --> 00:45:18,630
really does help to have very valid

1197
00:45:24,200 --> 00:45:21,720
scientific analogs in you know as close

1198
00:45:25,520 --> 00:45:24,210
as you can get desert environments you

1199
00:45:27,260 --> 00:45:25,530
know there's something about you know if

1200
00:45:29,000 --> 00:45:27,270
you were driving through a forest trying

1201
00:45:31,460 --> 00:45:29,010
to simulate a mission to the moon

1202
00:45:33,560 --> 00:45:31,470
you know the adipic your mindset will be

1203
00:45:35,660 --> 00:45:33,570
there so you know that's also what makes

1204
00:45:38,210 --> 00:45:35,670
Horton so unique we've got this

1205
00:45:41,090 --> 00:45:38,220
meteorite impact crater 23 kilometers

1206
00:45:42,710 --> 00:45:41,100
across and it's big and it's in a poet

1207
00:45:45,530 --> 00:45:42,720
as an environment where you're lucky if

1208
00:45:50,600 --> 00:45:45,540
we see any life-form other than you and

1209
00:45:53,090 --> 00:45:50,610
a day up there cool so I guess that

1210
00:45:56,090 --> 00:45:53,100
brings us to the next question by Marian

1211
00:45:58,400 --> 00:45:56,100
Denton on Facebook who's asks what's

1212
00:46:01,420 --> 00:45:58,410
been the most memorable field experience

1213
00:46:03,560 --> 00:46:01,430

or discovery that you've experienced

1214
00:46:05,620 --> 00:46:03,570
experience in discoveries you know

1215
00:46:07,820 --> 00:46:05,630
perhaps to two separate answers but

1216
00:46:11,060 --> 00:46:07,830
probably we both have occurred up on

1217
00:46:13,580 --> 00:46:11,070
Devon island in the Canadian Arctic one

1218
00:46:15,800 --> 00:46:13,590
was the most I think still most the

1219
00:46:17,810 --> 00:46:15,810
exciting discovery for me which really

1220
00:46:20,600 --> 00:46:17,820
started me on this whole no

1221
00:46:23,390 --> 00:46:20,610
astrobiological track was as often

1222
00:46:25,670 --> 00:46:23,400
happens on the second-to-last day of my

1223
00:46:27,920 --> 00:46:25,680
first field season at the Horton crater

1224
00:46:32,090 --> 00:46:27,930
was when I discovered that you know

1225
00:46:34,700 --> 00:46:32,100
really concrete conclusive evidence for

1226
00:46:36,950 --> 00:46:34,710
hydrothermal system in that crater and

1227
00:46:39,230 --> 00:46:36,960
it was this beautiful big you know about

1228
00:46:41,360 --> 00:46:39,240
the size of my office this big kind of

1229
00:46:43,160 --> 00:46:41,370
geode essentially just kind of sparkling

1230
00:46:44,450 --> 00:46:43,170
and I was like wow there's you know this

1231
00:46:47,270 --> 00:46:44,460
is just fantastic

1232
00:46:49,730 --> 00:46:47,280
and it was in the branches generated by

1233
00:46:52,100 --> 00:46:49,740
the impact so had to come after the

1234
00:46:54,380 --> 00:46:52,110
impact and so you know that was one of

1235
00:46:57,290 --> 00:46:54,390
the most amazing discoveries and then

1236
00:46:59,180 --> 00:46:57,300
you know experiences still and I still

1237
00:47:01,460 --> 00:46:59,190
keep getting asked questions about this

1238
00:47:04,160 --> 00:47:01,470

I was on Devon island last summer on the

1239
00:47:05,900 --> 00:47:04,170
south coast and woke up first first

1240
00:47:08,180 --> 00:47:05,910
morning account woke up at 6:00 a.m. and

1241
00:47:11,030 --> 00:47:08,190
there's a polar bear trashing a tent and

1242
00:47:13,730 --> 00:47:11,040
three other white fuzzy things on the

1243
00:47:15,860 --> 00:47:13,740
sea ice right by camp and so that was

1244
00:47:17,750 --> 00:47:15,870
yeah you know quite an experience for

1245
00:47:19,730 --> 00:47:17,760
other reasons but kind of brings a home

1246
00:47:21,770 --> 00:47:19,740
that were working in a pretty remote

1247
00:47:23,150 --> 00:47:21,780
part of the world that was literally on

1248
00:47:26,930 --> 00:47:23,160
the shore of the Northwest Passage

1249
00:47:29,270 --> 00:47:26,940
and so yeah you know that was I've had

1250
00:47:30,410 --> 00:47:29,280
many experiences in the field and you

1251
00:47:32,210 --> 00:47:30,420
know dealing with adverse weather

1252
00:47:34,940 --> 00:47:32,220
conditions and other things but that was

1253
00:47:38,870 --> 00:47:34,950
my first very up close contact with

1254
00:47:40,100 --> 00:47:38,880
polar bears from the north wow this

1255
00:47:41,300 --> 00:47:40,110
makes me think of another question you

1256
00:47:44,030 --> 00:47:41,310
mentioned that you've been working in a

1257
00:47:45,260 --> 00:47:44,040
High Arctic for for twenty years or so

1258
00:47:46,790 --> 00:47:45,270
have you been seeing some of the

1259
00:47:49,550 --> 00:47:46,800
environmental change caused by global

1260
00:47:51,050 --> 00:47:49,560
warming up there yeah absolutely you

1261
00:47:53,120 --> 00:47:51,060
know and you wouldn't think on a 20 year

1262
00:47:55,040 --> 00:47:53,130
time scale you would but this coming

1263
00:47:57,170 --> 00:47:55,050

summer I actually came to Canada 20

1264
00:47:59,210 --> 00:47:57,180
years ago this June and so yeah this

1265
00:48:01,430 --> 00:47:59,220
summer we'll be kind of 20 years from my

1266
00:48:05,870 --> 00:48:01,440
first field season to another field

1267
00:48:07,730 --> 00:48:05,880
season and yeah more extreme weather you

1268
00:48:09,380 --> 00:48:07,740
know it rains a lot more in these polar

1269
00:48:12,260 --> 00:48:09,390
desert environments than it used to

1270
00:48:13,130 --> 00:48:12,270
I do see you know pretty drastic changes

1271
00:48:15,200 --> 00:48:13,140
in the sea ice

1272
00:48:17,480 --> 00:48:15,210
you know you fly are not really working

1273
00:48:19,670 --> 00:48:17,490
around sea ice but on the flights you

1274
00:48:22,070 --> 00:48:19,680
know up to the Arctic and things you

1275
00:48:24,740 --> 00:48:22,080
know I go up a very similar time each

1276
00:48:27,800 --> 00:48:24,750
year and you know this is fluctuations

1277
00:48:29,810 --> 00:48:27,810
but year on year it's progressively kind

1278
00:48:32,060 --> 00:48:29,820
of you know less sea ice when I get up

1279
00:48:34,340 --> 00:48:32,070
there and you know it's breaking up it's

1280
00:48:38,030 --> 00:48:34,350
breaking up earlier and informing a lot

1281
00:48:41,300 --> 00:48:38,040
later and less aerial extent I studied

1282
00:48:43,160 --> 00:48:41,310
in quite a bit of work on not crater

1283
00:48:46,070 --> 00:48:43,170
related now and which is taking me up to

1284
00:48:49,150 --> 00:48:46,080
the Arctic this summer on comparative

1285
00:48:51,800 --> 00:48:49,160
Mars planetology looking at glacial and

1286
00:48:54,500 --> 00:48:51,810
periglacial geomorphology so looking at

1287
00:48:55,820 --> 00:48:54,510
kind of ground ice too and so starting

1288
00:48:57,830 --> 00:48:55,830

to look actually had an undergrad

1289
00:49:00,109 --> 00:48:57,840
student do a project on

1290
00:49:01,910 --> 00:49:00,119
mapping changes and recession of

1291
00:49:04,190 --> 00:49:01,920
glaciers up in the Canadian Arctic and

1292
00:49:06,620 --> 00:49:04,200
the numbers are pretty staggering mister

1293
00:49:09,140 --> 00:49:06,630
how many of these cases are receded or

1294
00:49:10,970 --> 00:49:09,150
even disagree in you know the time we

1295
00:49:14,599 --> 00:49:10,980
had the first air photographs in the 50s

1296
00:49:18,609 --> 00:49:14,609
to the present day which could grab a

1297
00:49:23,359 --> 00:49:21,020
come back for another time on a lighter

1298
00:49:25,250 --> 00:49:23,369
note though you probably remember about

1299
00:49:27,880 --> 00:49:25,260
15 years ago maybe more now there are

1300
00:49:30,950 --> 00:49:27,890
these movies deep impacts and Armageddon

1301
00:49:34,730 --> 00:49:30,960
yeah Armageddon what did you think of

1302
00:49:38,540 --> 00:49:34,740
those it's funny you know I still use

1303
00:49:40,730 --> 00:49:38,550
those in talks that I give but if I

1304
00:49:43,790 --> 00:49:40,740
remember rightly it's early 90s you know

1305
00:49:45,380 --> 00:49:43,800
maybe even 1992 or something so you know

1306
00:49:46,910 --> 00:49:45,390
we're maybe showing our age of it here

1307
00:49:50,030 --> 00:49:46,920
Sanjoy because I'm sure a lot of

1308
00:49:53,990 --> 00:49:50,040
listeners were not born in the early 90s

1309
00:49:56,210 --> 00:49:54,000
I was in yeah I was in high school I

1310
00:49:59,540 --> 00:49:56,220
guess do you remember them coming out

1311
00:50:01,339 --> 00:49:59,550
and you know it kind of it brought I

1312
00:50:03,890 --> 00:50:01,349
think to the you know into the Hollywood

1313
00:50:07,040 --> 00:50:03,900

and a public the idea that things can

1314
00:50:08,240 --> 00:50:07,050
and do hit the earth maybe off why I

1315
00:50:11,900 --> 00:50:08,250
know tell me about what I actually think

1316
00:50:13,099 --> 00:50:11,910
of those movies I was hoping the camera

1317
00:50:15,290 --> 00:50:13,109
would hide the gray hairs that

1318
00:50:17,470 --> 00:50:15,300
absolutely appear but can't escape age

1319
00:50:21,920 --> 00:50:17,480
but I'm gonna own it

1320
00:50:24,260 --> 00:50:21,930
so the PD process is never a linear path

1321
00:50:26,270 --> 00:50:24,270
and it can be difficult and you know ups

1322
00:50:27,950 --> 00:50:26,280
and downs emotionally to get this degree

1323
00:50:29,900 --> 00:50:27,960
perhaps you can talk about your

1324
00:50:33,680 --> 00:50:29,910
experiences and if you had any mentors

1325
00:50:34,910 --> 00:50:33,690
that helped you along the way just a lot

1326
00:50:36,440 --> 00:50:34,920
of people who are starting graduate

1327
00:50:39,740 --> 00:50:36,450
school can get intimidated by a

1328
00:50:41,089 --> 00:50:39,750
derivative PhD obtaining process and but

1329
00:50:43,910 --> 00:50:41,099
I just want emphasize that it's not a

1330
00:50:45,349 --> 00:50:43,920
it's not a lonely process and perhaps

1331
00:50:47,710 --> 00:50:45,359
you can share your experience as well in

1332
00:50:52,970 --> 00:50:47,720
what you went through to to get a degree

1333
00:50:55,310 --> 00:50:52,980
yeah yeah you know what's one could talk

1334
00:50:58,130 --> 00:50:55,320
about I just kind of thinking before the

1335
00:50:59,990 --> 00:50:58,140
show - you know I see never applied to

1336
00:51:01,910 --> 00:51:00,000
University during high school because it

1337
00:51:03,170 --> 00:51:01,920
wasn't you know on my radar I wasn't

1338
00:51:05,810 --> 00:51:03,180

what I thought I'd be doing as a

1339
00:51:07,339 --> 00:51:05,820
teenager and I think that's something I

1340
00:51:09,740 --> 00:51:07,349
try and tell my grad students and my

1341
00:51:10,850 --> 00:51:09,750
current PhD students who are you know

1342
00:51:12,230 --> 00:51:10,860
worried

1343
00:51:14,300 --> 00:51:12,240
a lot about the future I'm you know

1344
00:51:16,310 --> 00:51:14,310
what's always worrying about what's next

1345
00:51:18,020 --> 00:51:16,320
what's after PhD you know I think

1346
00:51:19,520 --> 00:51:18,030
there's a lot of just kind of enjoying

1347
00:51:23,380 --> 00:51:19,530
the moment enjoying what you're doing

1348
00:51:26,120 --> 00:51:23,390
and not worry too much about the future

1349
00:51:29,810 --> 00:51:26,130
you know so as an undergraduate I had no

1350
00:51:32,270 --> 00:51:29,820
idea I'd be doing a PhD you know if you

1351
00:51:34,820 --> 00:51:32,280
asked me back as a I was an undergrad or

1352
00:51:36,800 --> 00:51:34,830
even a PhD student if I'd be on this

1353
00:51:40,340 --> 00:51:36,810
show and a professor at Western I

1354
00:51:44,690 --> 00:51:40,350
probably would have laughed at you and

1355
00:51:46,280 --> 00:51:44,700
so yeah you know we I tried a lot of you

1356
00:51:49,250 --> 00:51:46,290
know getting a lot of different

1357
00:51:51,020 --> 00:51:49,260
experiences during PhD you know getting

1358
00:51:53,600 --> 00:51:51,030
some teaching experience I found very

1359
00:51:55,730 --> 00:51:53,610
rewarding and I enjoyed that as a PhD

1360
00:51:57,530 --> 00:51:55,740
student you know helping undergrad kind

1361
00:51:59,060 --> 00:51:57,540
of learn geology and I found that

1362
00:52:01,070 --> 00:51:59,070
rewarding and you know that's what made

1363
00:52:02,600 --> 00:52:01,080

me start to think about you know

1364
00:52:07,430 --> 00:52:02,610
potentially becoming a prophet in

1365
00:52:10,010 --> 00:52:07,440
academia you know I took time out got

1366
00:52:11,780 --> 00:52:10,020
him after PhD with him in government

1367
00:52:15,290 --> 00:52:11,790
working at the Canadian Space Agency

1368
00:52:18,350 --> 00:52:15,300
before coming back to academia you know

1369
00:52:21,140 --> 00:52:18,360
increasingly now I so you know he said

1370
00:52:23,060 --> 00:52:21,150
lonely exist so I was actually at the

1371
00:52:25,190 --> 00:52:23,070
University where I was there was a few

1372
00:52:26,840 --> 00:52:25,200
it was working on impact craters but it

1373
00:52:29,360 --> 00:52:26,850
was really the only one doing kind of

1374
00:52:31,040 --> 00:52:29,370
planetary science pretty research so you

1375
00:52:34,160 --> 00:52:31,050
know I did struggle with that at times

1376
00:52:36,680 --> 00:52:34,170
and that's why conferences were so

1377
00:52:38,210 --> 00:52:36,690
important to me and I I made a point of

1378
00:52:41,090 --> 00:52:38,220
you know either either convincing my

1379
00:52:44,690 --> 00:52:41,100
supervisor to get me to a conference or

1380
00:52:47,000 --> 00:52:44,700
you know just you know make making your

1381
00:52:48,620 --> 00:52:47,010
own way and you know apply for all the

1382
00:52:49,970 --> 00:52:48,630
scholarships and things that I could to

1383
00:52:51,260 --> 00:52:49,980
get me travel funding to attend

1384
00:52:53,420 --> 00:52:51,270
conferences like the lunar and planetary

1385
00:52:56,060 --> 00:52:53,430
science conference that you know I

1386
00:52:59,060 --> 00:52:56,070
attended that my first six months into

1387
00:53:00,530 --> 00:52:59,070
my PhD down in Houston and you know that

1388
00:53:02,480 --> 00:53:00,540

was fantastic because Here I am now

1389
00:53:06,740 --> 00:53:02,490
surrounded by you know thousands of

1390
00:53:09,800 --> 00:53:06,750
people like-minded people and you know

1391
00:53:12,620 --> 00:53:09,810
back then there was email but you know

1392
00:53:16,730 --> 00:53:12,630
now I I'm on social media run on Twitter

1393
00:53:20,090 --> 00:53:16,740
and you know I do think it's easier to

1394
00:53:21,620 --> 00:53:20,100
you know keep in touch and reach out you

1395
00:53:25,099 --> 00:53:21,630
know just this morning actually I had a

1396
00:53:27,349 --> 00:53:25,109
Skype chat with you know this was

1397
00:53:29,630 --> 00:53:27,359
PhD to some University I'm not gonna

1398
00:53:30,710 --> 00:53:29,640
name them or the university we just sent

1399
00:53:32,839 --> 00:53:30,720
out on Twitter you know I'm interested

1400
00:53:35,510 --> 00:53:32,849
in doing field work in field analog

1401
00:53:37,400 --> 00:53:35,520
studies someone tagged me on that post

1402
00:53:39,890 --> 00:53:37,410
and I said you know sure happy to chat

1403
00:53:42,620 --> 00:53:39,900
and you know and we had a Skype chat

1404
00:53:46,130 --> 00:53:42,630
this morning and so yeah you know don't

1405
00:53:47,990 --> 00:53:46,140
be shy of reaching out and and you know

1406
00:53:53,210 --> 00:53:48,000
especially on things like Twitter now I

1407
00:53:54,859 --> 00:53:53,220
think it's a lot easier to do beautiful

1408
00:53:56,539 --> 00:53:54,869
words to anyway of the Gordon again

1409
00:53:58,730 --> 00:53:56,549
those of you are watching interested in

1410
00:54:00,380 --> 00:53:58,740
a graduate work in science don't feel

1411
00:54:03,170 --> 00:54:00,390
shy to send out an email to people you

1412
00:54:04,430 --> 00:54:03,180
know like knock on doors and experience

1413
00:54:06,109 --> 00:54:04,440

of graduate school is one where the

1414
00:54:07,339 --> 00:54:06,119
community matters to your own mental

1415
00:54:10,309 --> 00:54:07,349
health on to your own success in

1416
00:54:11,839 --> 00:54:10,319
graduate school so Gordon it's been an

1417
00:54:13,940 --> 00:54:11,849
absolute pleasure chatting with you

1418
00:54:15,440 --> 00:54:13,950
today thank you so much for taking us

1419
00:54:17,500 --> 00:54:15,450
the time to chat I know you're extremely

1420
00:54:20,029 --> 00:54:17,510
busy as particularly as chair of CBS X

1421
00:54:23,510 --> 00:54:20,039
so perhaps if you have some final words

1422
00:54:25,279 --> 00:54:23,520
of wisdom but if that thank you

1423
00:54:27,200 --> 00:54:25,289
what can I say thank you this is amazing

1424
00:54:28,910 --> 00:54:27,210
totally welcome so enjoy I can't believe

1425
00:54:30,230 --> 00:54:28,920
an hour has passed already and so it's

1426
00:54:32,240 --> 00:54:30,240
been fun and I could definitely talk

1427
00:54:35,599 --> 00:54:32,250
about these things and keep on answering

1428
00:54:37,880 --> 00:54:35,609
questions for many more hours and yeah I

1429
00:54:39,680 --> 00:54:37,890
mean I think we're in exciting times you

1430
00:54:41,960 --> 00:54:39,690
know we're going going back to the moon

1431
00:54:43,609 --> 00:54:41,970
and getting a bit closer to having you

1432
00:54:45,980 --> 00:54:43,619
know samples coming back from Mars and

1433
00:54:47,029 --> 00:54:45,990
then getting humans to Mars and so you

1434
00:54:49,549 --> 00:54:47,039
know the young students out there

1435
00:54:52,190 --> 00:54:49,559
listening you know this is I think your

1436
00:54:55,279 --> 00:54:52,200
generation an exciting time to be in

1437
00:54:57,019 --> 00:54:55,289
science and yeah you know I'll do a plug

1438
00:54:59,720 --> 00:54:57,029

for impacts in Canada is a really

1439
00:55:01,880 --> 00:54:59,730
important process to understand and to

1440
00:55:04,339 --> 00:55:01,890
learn about and to be honest it's a

1441
00:55:05,930 --> 00:55:04,349
field where we do need more more people

1442
00:55:07,970 --> 00:55:05,940
studying the impacts not just on the

1443
00:55:09,680 --> 00:55:07,980
earth but other planets too still room

1444
00:55:12,170 --> 00:55:09,690
for discovery which you know I really

1445
00:55:15,140 --> 00:55:12,180
find exciting and that hopefully you

1446
00:55:18,620 --> 00:55:15,150
will too thank you again and you tweet

1447
00:55:20,720 --> 00:55:18,630
us at dr. crater on Twitter and those of

1448
00:55:22,099 --> 00:55:20,730
you who are watching live and who will

1449
00:55:23,599 --> 00:55:22,109
probably hopefully see the recording as

1450
00:55:24,829 --> 00:55:23,609
well what do you all think about impact

1451
00:55:27,620 --> 00:55:24,839
craters how do you think that hasn't

1452
00:55:29,690 --> 00:55:27,630
impacted the well pun intended the

1453
00:55:32,420 --> 00:55:29,700
origin and evolution of life on Earth

1454
00:55:33,980 --> 00:55:32,430
and please join us next month for ask

1455
00:55:35,599 --> 00:55:33,990
and astrobiologists and until then

1456
00:55:36,440 --> 00:55:35,609
please stay curious