



EPISODE 50: JULY 1ST, 2022

DR. MEENAKSHI WADHWA



Astrobiology Program

1
00:00:33,030 --> 00:00:30,790

[Music]

2
00:00:34,950 --> 00:00:33,040

greetings friends fellow earthlings and

3
00:00:36,870 --> 00:00:34,960

if you're anything like me

4
00:00:38,709 --> 00:00:36,880

maybe those who are anxiously awaiting

5
00:00:39,590 --> 00:00:38,719

samples to be returned from mars to

6
00:00:41,910 --> 00:00:39,600

earth

7
00:00:44,150 --> 00:00:41,920

welcome to ask an astrobiologist the

8
00:00:46,069 --> 00:00:44,160

show that celebrates the science and

9
00:00:47,590 --> 00:00:46,079

celebrates the scientists involved in

10
00:00:48,470 --> 00:00:47,600

our quest to understand the nature of

11
00:00:50,790 --> 00:00:48,480

life

12
00:00:53,029 --> 00:00:50,800

i'm your host dr graham the cosmo

13
00:00:55,270 --> 00:00:53,039

biologist lao and we're brought to you

14

00:00:56,869 --> 00:00:55,280

by the nasa astrobiology program and

15

00:00:58,310 --> 00:00:56,879

saginet.org

16

00:00:59,990 --> 00:00:58,320

as always we want to thank all of you

17

00:01:01,830 --> 00:01:00,000

out there who watch our show both during

18

00:01:04,390 --> 00:01:01,840

the live stream asking questions in the

19

00:01:05,990 --> 00:01:04,400

chat on youtube who ask questions of our

20

00:01:07,510 --> 00:01:06,000

guests on twitter using the hashtag

21

00:01:08,870 --> 00:01:07,520

askastrobio

22

00:01:11,270 --> 00:01:08,880

as well as those of you who watch the

23

00:01:12,550 --> 00:01:11,280

show after it's aired i try my best to

24

00:01:14,310 --> 00:01:12,560

come in and answer questions when

25

00:01:15,910 --> 00:01:14,320

possible on youtube so if you're

26

00:01:17,190 --> 00:01:15,920

watching this after the live stream i

27

00:01:18,789 --> 00:01:17,200

will try to answer your questions there

28

00:01:20,390 --> 00:01:18,799

if i can as well

29

00:01:22,550 --> 00:01:20,400

today's episode is going to be

30

00:01:24,950 --> 00:01:22,560

incredible if you know me you know that

31

00:01:27,109 --> 00:01:24,960

i absolutely love rocks from space and

32

00:01:29,670 --> 00:01:27,119

what they can teach us about our place

33

00:01:31,749 --> 00:01:29,680

in the universe today we have an expert

34

00:01:33,910 --> 00:01:31,759

in planetary science isotope

35

00:01:37,270 --> 00:01:33,920

geochemistry meteoritics and sample

36

00:01:40,310 --> 00:01:37,280

return to earth joining us for the show

37

00:01:42,550 --> 00:01:40,320

dr menakshi mini wadwa is a professor

38

00:01:44,630 --> 00:01:42,560

and the director of the school of earth

39

00:01:47,510 --> 00:01:44,640

and space exploration at arizona state

40

00:01:49,109 --> 00:01:47,520

university she earned her bs and ms

41

00:01:51,030 --> 00:01:49,119

degrees in geology from punjab

42

00:01:53,350 --> 00:01:51,040

university and then continued her

43

00:01:55,910 --> 00:01:53,360

studies in earth and planetary sciences

44

00:01:58,709 --> 00:01:55,920

earning her phd in 1994 from washington

45

00:02:00,630 --> 00:01:58,719

university in st louis dr wadwa is a

46

00:02:03,109 --> 00:02:00,640

planetary scientist and isotope

47

00:02:04,789 --> 00:02:03,119

geochemist interested in time scales and

48

00:02:07,190 --> 00:02:04,799

processes involved in the formation and

49

00:02:09,270 --> 00:02:07,200

evolution of the solar system and our

50

00:02:11,110 --> 00:02:09,280

planets and she was also a recent

51
00:02:13,030 --> 00:02:11,120
keynote speaker at the astrobiology

52
00:02:14,309 --> 00:02:13,040
science conference which i heard her

53
00:02:16,390 --> 00:02:14,319
keynote talk and i thought it was

54
00:02:18,070 --> 00:02:16,400
incredible i knew i wanted to have her

55
00:02:20,229 --> 00:02:18,080
on the show to talk to all of us about

56
00:02:23,030 --> 00:02:20,239
her research beyond being an expert in

57
00:02:24,790 --> 00:02:23,040
planetary materials like meteorites mini

58
00:02:27,750 --> 00:02:24,800
is also the principal scientist for

59
00:02:29,190 --> 00:02:27,760
nasa's mars sample return program dr

60
00:02:31,430 --> 00:02:29,200
wadwa thank you for joining us and

61
00:02:33,110 --> 00:02:31,440
welcome to ask an astrobiologist oh

62
00:02:34,550 --> 00:02:33,120
thank you so much graeme this is a real

63
00:02:36,710 --> 00:02:34,560

pleasure to be here

64

00:02:38,390 --> 00:02:36,720

awesome and like i said also we did talk

65

00:02:39,509 --> 00:02:38,400

before the show i'm so excited for all

66

00:02:41,030 --> 00:02:39,519

the things you have to share with our

67

00:02:42,470 --> 00:02:41,040

audience uh there's already some

68

00:02:44,390 --> 00:02:42,480

questions coming in from the youtube

69

00:02:46,070 --> 00:02:44,400

chat um but i wanna i wanna speak with

70

00:02:48,390 --> 00:02:46,080

you first a little bit about your life

71

00:02:49,750 --> 00:02:48,400

your career your research and the one

72

00:02:51,750 --> 00:02:49,760

place i love to start off with all of

73

00:02:54,390 --> 00:02:51,760

our guests is hearing about your origin

74

00:02:55,910 --> 00:02:54,400

story what got you interested in

75

00:02:57,990 --> 00:02:55,920

pursuing the path and the sciences that

76
00:02:59,190 --> 00:02:58,000
you're on now

77
00:03:01,030 --> 00:02:59,200
well so

78
00:03:03,350 --> 00:03:01,040
i've always been kind of interested in

79
00:03:05,270 --> 00:03:03,360
the natural world around me and you know

80
00:03:07,430 --> 00:03:05,280
i think all kids are at some level you

81
00:03:09,110 --> 00:03:07,440
know fascinated by insects fascinated by

82
00:03:11,589 --> 00:03:09,120
rocks that kind of thing

83
00:03:13,750 --> 00:03:11,599
um and i was no different you know but i

84
00:03:17,030 --> 00:03:13,760
kind of remember sort of

85
00:03:19,350 --> 00:03:17,040
one moment though uh in growing up

86
00:03:21,430 --> 00:03:19,360
uh when i kind of realized that this was

87
00:03:23,430 --> 00:03:21,440
this is what i want you know i i wanted

88
00:03:24,949 --> 00:03:23,440

to be a scientist i'm not sure i knew

89

00:03:27,509 --> 00:03:24,959

the word scientist at the time but

90

00:03:29,190 --> 00:03:27,519

that's kind of what what what felt right

91

00:03:31,270 --> 00:03:29,200

um i remember

92

00:03:32,710 --> 00:03:31,280

probably it was seven or eight years old

93

00:03:35,430 --> 00:03:32,720

and uh

94

00:03:37,509 --> 00:03:35,440

in class my teachers

95

00:03:39,990 --> 00:03:37,519

was talking about you know

96

00:03:42,309 --> 00:03:40,000

respiration and how human human beings

97

00:03:44,070 --> 00:03:42,319

you know breathe in oxygen let out

98

00:03:46,869 --> 00:03:44,080

carbon dioxide

99

00:03:48,309 --> 00:03:46,879

and um yeah i know this is fascinating

100

00:03:49,830 --> 00:03:48,319

and then you know after a few minutes of

101
00:03:51,509 --> 00:03:49,840
thinking about this i was like oh my god

102
00:03:52,789 --> 00:03:51,519
you know there's there's all these human

103
00:03:54,550 --> 00:03:52,799
beings on earth and we're going to be

104
00:03:56,710 --> 00:03:54,560
breathing in oxygen letting out carbon

105
00:03:59,190 --> 00:03:56,720
dioxide and so we're going to be running

106
00:04:01,429 --> 00:03:59,200
out of oxygen pretty soon

107
00:04:04,149 --> 00:04:01,439
i was like super worried and

108
00:04:06,229 --> 00:04:04,159
and uh yeah i i talked to my mom that

109
00:04:07,750 --> 00:04:06,239
evening and she was like yeah what's

110
00:04:09,589 --> 00:04:07,760
wrong you're worried they're like well

111
00:04:12,789 --> 00:04:09,599
you know i think we're gonna be we're

112
00:04:14,630 --> 00:04:12,799
gonna be all all extinct soon

113
00:04:17,349 --> 00:04:14,640

and she's like oh no you know there's

114

00:04:19,909 --> 00:04:17,359

all these cycles in nature that you know

115

00:04:22,150 --> 00:04:19,919

keep things in balance and uh

116

00:04:24,710 --> 00:04:22,160

and yeah there's you know

117

00:04:26,710 --> 00:04:24,720

plants do the opposite to photosynthesis

118

00:04:28,230 --> 00:04:26,720

and so all of that

119

00:04:29,590 --> 00:04:28,240

wow you know there's so much that i

120

00:04:30,870 --> 00:04:29,600

don't know and understand that there's

121

00:04:32,629 --> 00:04:30,880

so much to learn

122

00:04:34,629 --> 00:04:32,639

and so i just kind of remember sort of

123

00:04:36,070 --> 00:04:34,639

being thinking you know i'd love to be

124

00:04:38,629 --> 00:04:36,080

able to figure out some of these things

125

00:04:40,710 --> 00:04:38,639

about unnatural world and uh

126

00:04:42,070 --> 00:04:40,720

and and of course i mean as it turns out

127

00:04:44,469 --> 00:04:42,080

of course i mean we are worried about

128

00:04:45,830 --> 00:04:44,479

the level of co2 in our atmosphere and

129

00:04:48,469 --> 00:04:45,840

so

130

00:04:50,230 --> 00:04:48,479

it wasn't that far off i guess

131

00:04:52,230 --> 00:04:50,240

i love it it's such a cool story too

132

00:04:53,830 --> 00:04:52,240

like this this early wondering of what's

133

00:04:55,909 --> 00:04:53,840

gonna happen to us you know breathing in

134

00:04:57,909 --> 00:04:55,919

oxygen breathing out co2 and then making

135

00:05:00,150 --> 00:04:57,919

those larger connections to our planet

136

00:05:02,070 --> 00:05:00,160

and how life is so connected you know we

137

00:05:03,670 --> 00:05:02,080

share this one beautiful biosphere and

138

00:05:05,749 --> 00:05:03,680

it's the only place we know so far that

139

00:05:07,510 --> 00:05:05,759

has life but many of us wonder in

140

00:05:09,749 --> 00:05:07,520

looking at planetary materials from

141

00:05:11,590 --> 00:05:09,759

other worlds meteorites and sample

142

00:05:13,830 --> 00:05:11,600

return if we can actually find signs of

143

00:05:15,270 --> 00:05:13,840

life out there so at what point in your

144

00:05:17,029 --> 00:05:15,280

career you know you started off studying

145

00:05:18,710 --> 00:05:17,039

geology as an undergraduate student and

146

00:05:20,790 --> 00:05:18,720

then went into earth and planetary

147

00:05:22,390 --> 00:05:20,800

sciences at what part in your career did

148

00:05:24,629 --> 00:05:22,400

you really decide that like studying

149

00:05:25,830 --> 00:05:24,639

planetary materials to understand the

150

00:05:28,550 --> 00:05:25,840

history of our solar system and the

151
00:05:30,469 --> 00:05:28,560
history of planets was really your thing

152
00:05:32,150 --> 00:05:30,479
yeah so you know i

153
00:05:34,310 --> 00:05:32,160
went into

154
00:05:36,150 --> 00:05:34,320
grad school

155
00:05:38,390 --> 00:05:36,160
and maybe a lot of some of the students

156
00:05:40,870 --> 00:05:38,400
can relate to this you know starting out

157
00:05:43,189 --> 00:05:40,880
grad school not really knowing exactly

158
00:05:45,029 --> 00:05:43,199
what what part of planetary science i

159
00:05:46,950 --> 00:05:45,039
wanted to really focus in

160
00:05:49,749 --> 00:05:46,960
you know i i had my undergraduate degree

161
00:05:52,310 --> 00:05:49,759
in geology and i kind of i loved rocks

162
00:05:53,909 --> 00:05:52,320
and and really you know i felt like if

163
00:05:56,230 --> 00:05:53,919

you could apply the same kinds of things

164

00:05:58,070 --> 00:05:56,240

that we apply to earth rocks to try to

165

00:06:00,390 --> 00:05:58,080

do the same kinds of things with you

166

00:06:01,909 --> 00:06:00,400

know samples from the moon or from mars

167

00:06:03,749 --> 00:06:01,919

and you know

168

00:06:05,749 --> 00:06:03,759

just the thought of being somewhat of i

169

00:06:07,909 --> 00:06:05,759

guess i'm vicariously a geologist on

170

00:06:09,350 --> 00:06:07,919

another planet you know geologists don't

171

00:06:11,189 --> 00:06:09,360

mind i mean that really that's really

172

00:06:13,029 --> 00:06:11,199

what fascinated me right

173

00:06:15,029 --> 00:06:13,039

and so but i didn't know how to make

174

00:06:17,110 --> 00:06:15,039

that happen i actually i mean i didn't

175

00:06:19,350 --> 00:06:17,120

even know that we had you know hundreds

176
00:06:20,790 --> 00:06:19,360
of pounds of you know lunar rocks from

177
00:06:22,070 --> 00:06:20,800
the apollo missions at the time when i

178
00:06:23,350 --> 00:06:22,080
started out

179
00:06:25,029 --> 00:06:23,360
and um

180
00:06:26,870 --> 00:06:25,039
so it was only you know when i got to

181
00:06:29,670 --> 00:06:26,880
washington university and i started

182
00:06:31,670 --> 00:06:29,680
talking to a number of the faculty and

183
00:06:33,029 --> 00:06:31,680
the good thing was of course you know

184
00:06:34,629 --> 00:06:33,039
there were a number of people that were

185
00:06:36,950 --> 00:06:34,639
doing all different kinds of things in

186
00:06:38,550 --> 00:06:36,960
planetary science and um

187
00:06:39,909 --> 00:06:38,560
and i was talking to them about you know

188
00:06:42,710 --> 00:06:39,919

what i wanted to do with more remote

189

00:06:44,469 --> 00:06:42,720

sensing of planets or what are you know

190

00:06:45,990 --> 00:06:44,479

different kinds of things and and then

191

00:06:48,230 --> 00:06:46,000

one of the professors

192

00:06:49,749 --> 00:06:48,240

her name is glenn crozas and she was

193

00:06:52,150 --> 00:06:49,759

actually one of the few

194

00:06:54,309 --> 00:06:52,160

women planetary scientists at the time

195

00:06:55,430 --> 00:06:54,319

not very many of them actually and and

196

00:06:56,710 --> 00:06:55,440

so she

197

00:06:59,670 --> 00:06:56,720

she asked me hey you know do you want to

198

00:07:01,189 --> 00:06:59,680

look at these meteorites from mars and

199

00:07:03,990 --> 00:07:01,199

i was like what

200

00:07:06,710 --> 00:07:04,000

there's meteorites from mars

201
00:07:08,309 --> 00:07:06,720
and that was like a mind-blowing kind of

202
00:07:09,990 --> 00:07:08,319
experience for me because you know i

203
00:07:10,950 --> 00:07:10,000
looked at a thin section of this rock

204
00:07:13,189 --> 00:07:10,960
and

205
00:07:15,589 --> 00:07:13,199
you know it just looks so familiar like

206
00:07:18,550 --> 00:07:15,599
earth rocks that i've seen before magma

207
00:07:20,950 --> 00:07:18,560
magmatic you know igneous rocks and but

208
00:07:23,189 --> 00:07:20,960
it formed on another planet and it could

209
00:07:24,870 --> 00:07:23,199
tell us something about the geology of

210
00:07:26,790 --> 00:07:24,880
another planet and so that was like you

211
00:07:29,909 --> 00:07:26,800
know that aha moment i was like gosh you

212
00:07:31,189 --> 00:07:29,919
know i i can be a geologist on mars in a

213
00:07:33,189 --> 00:07:31,199

way right

214

00:07:35,189 --> 00:07:33,199

and so that's kind of what got me hooked

215

00:07:37,670 --> 00:07:35,199

um into sort of studying planetary

216

00:07:39,430 --> 00:07:37,680

materials because it just seemed like

217

00:07:41,189 --> 00:07:39,440

the skills that i've learned

218

00:07:43,029 --> 00:07:41,199

for you know studying geology and the

219

00:07:44,629 --> 00:07:43,039

earth i could apply those same skills to

220

00:07:47,749 --> 00:07:44,639

understanding something about

221

00:07:49,270 --> 00:07:47,759

the geology of mars i love that so much

222

00:07:50,150 --> 00:07:49,280

and i want to step back for a moment

223

00:07:52,070 --> 00:07:50,160

because you mentioned something really

224

00:07:54,309 --> 00:07:52,080

important there there weren't many women

225

00:07:56,550 --> 00:07:54,319

at all in planetary science and so you

226

00:07:58,150 --> 00:07:56,560

had a woman as a mentor and someone who

227

00:07:59,670 --> 00:07:58,160

could guide you i wonder if you can

228

00:08:01,830 --> 00:07:59,680

speak to the value not just of

229

00:08:03,110 --> 00:08:01,840

representation but also mentorship in

230

00:08:05,189 --> 00:08:03,120

your career

231

00:08:07,510 --> 00:08:05,199

yeah i mean i you know

232

00:08:09,990 --> 00:08:07,520

galen what i mean she's somebody that i

233

00:08:11,990 --> 00:08:10,000

still am in you know contact with and

234

00:08:14,790 --> 00:08:12,000

she's been a you know lifelong mentor

235

00:08:16,869 --> 00:08:14,800

and friend for me and i i think it was

236

00:08:17,909 --> 00:08:16,879

just so important to be able to see

237

00:08:21,510 --> 00:08:17,919

somebody

238

00:08:24,469 --> 00:08:21,520

um in that role um so i could actually

239

00:08:25,350 --> 00:08:24,479

see a path for myself in this career

240

00:08:28,070 --> 00:08:25,360

um

241

00:08:30,869 --> 00:08:28,080

and but you know even before before i i

242

00:08:33,190 --> 00:08:30,879

joined washu though i remember uh you

243

00:08:35,430 --> 00:08:33,200

know contacting her and that at that

244

00:08:37,509 --> 00:08:35,440

time you had to write letters and i

245

00:08:40,469 --> 00:08:37,519

remember saying you know dear professor

246

00:08:42,070 --> 00:08:40,479

crozars and and uh assuming that it was

247

00:08:44,230 --> 00:08:42,080

a man you know

248

00:08:46,389 --> 00:08:44,240

because i i did not know any better in

249

00:08:48,070 --> 00:08:46,399

my undergraduate career there were not

250

00:08:49,990 --> 00:08:48,080

any women professors there were not

251
00:08:52,790 --> 00:08:50,000
actually even hardly any women students

252
00:08:54,470 --> 00:08:52,800
alongside me and so you know it's it

253
00:08:56,949 --> 00:08:54,480
changed everything for me i mean i i

254
00:08:57,670 --> 00:08:56,959
knew i knew it was possible for me to to

255
00:08:59,750 --> 00:08:57,680
be

256
00:09:02,550 --> 00:08:59,760
a scientist in this particular field

257
00:09:03,509 --> 00:09:02,560
because i saw i saw gulen doing it you

258
00:09:05,350 --> 00:09:03,519
know

259
00:09:06,949 --> 00:09:05,360
so yeah it's so important

260
00:09:08,790 --> 00:09:06,959
oh that's wonderful and that reminds me

261
00:09:10,710 --> 00:09:08,800
of a personal story a friend of mine

262
00:09:12,470 --> 00:09:10,720
she's a wonderful explorer and she's

263
00:09:14,230 --> 00:09:12,480

done education around the world and and

264

00:09:16,230 --> 00:09:14,240

she was going on a trip to teach astro

265

00:09:17,190 --> 00:09:16,240

biology and planetary science to a girls

266

00:09:18,949 --> 00:09:17,200

school

267

00:09:20,230 --> 00:09:18,959

in bangladesh and i had been talking

268

00:09:21,750 --> 00:09:20,240

with her about possibly going along and

269

00:09:23,350 --> 00:09:21,760

i remember she reached out and she said

270

00:09:25,350 --> 00:09:23,360

you know actually i don't think you

271

00:09:26,710 --> 00:09:25,360

should come because she had noticed in

272

00:09:28,070 --> 00:09:26,720

her previous visit that when she was

273

00:09:30,070 --> 00:09:28,080

talking with these young girls they were

274

00:09:31,750 --> 00:09:30,080

all so excited to share their knowledge

275

00:09:33,509 --> 00:09:31,760

and to ask questions and then the

276

00:09:35,030 --> 00:09:33,519

principal an older man walked into the

277

00:09:36,230 --> 00:09:35,040

room and all the girls like sat up

278

00:09:38,310 --> 00:09:36,240

straight and put their hands down and

279

00:09:39,829 --> 00:09:38,320

were very quiet after that and i think

280

00:09:41,590 --> 00:09:39,839

it's so important for for young women

281

00:09:43,110 --> 00:09:41,600

around the world to to experience

282

00:09:44,870 --> 00:09:43,120

representation to see women doing

283

00:09:46,710 --> 00:09:44,880

incredible things and to feel like they

284

00:09:49,350 --> 00:09:46,720

are part of this grand journey of being

285

00:09:50,470 --> 00:09:49,360

human with all of us exactly yeah so i'm

286

00:09:51,910 --> 00:09:50,480

so glad that you know that to hear that

287

00:09:54,150 --> 00:09:51,920

there's more representation now but we

288

00:09:55,829 --> 00:09:54,160

still have a lot more work to do

289

00:09:57,509 --> 00:09:55,839

and i'm so glad you were inspired to

290

00:09:59,430 --> 00:09:57,519

continue in your realm and do the work

291

00:10:00,790 --> 00:09:59,440

that you've done uh before we talk about

292

00:10:02,389 --> 00:10:00,800

meteorites which i'm kind of like

293

00:10:04,630 --> 00:10:02,399

bubbling right now i feel like my skin

294

00:10:06,310 --> 00:10:04,640

getting all excited to talk about

295

00:10:08,550 --> 00:10:06,320

meteorites because i love space rock so

296

00:10:11,030 --> 00:10:08,560

much now we did a poll through the nasa

297

00:10:13,110 --> 00:10:11,040

astro bio twitter account asking people

298

00:10:14,710 --> 00:10:13,120

we gave them four options of possible

299

00:10:15,750 --> 00:10:14,720

meteorites and asked which was our

300

00:10:19,190 --> 00:10:15,760

favorite

301
00:10:21,910 --> 00:10:19,200
we gave them alh 84001 the allen hills

302
00:10:23,750 --> 00:10:21,920
meteorite that famously in 1996 was a

303
00:10:26,310 --> 00:10:23,760
potential signs of life where it were

304
00:10:29,110 --> 00:10:26,320
announced um the black beauty or the

305
00:10:31,350 --> 00:10:29,120
other weird meteorite um

306
00:10:34,470 --> 00:10:31,360
the murchison meteorite which we've now

307
00:10:36,710 --> 00:10:34,480
found dozens of organics amino acids

308
00:10:38,630 --> 00:10:36,720
inside of the merchants and meteorite uh

309
00:10:40,870 --> 00:10:38,640
and the chelyabinsk meteorite i thought

310
00:10:41,990 --> 00:10:40,880
we'd throw one in just for fun to see if

311
00:10:43,350 --> 00:10:42,000
people were thinking more about like

312
00:10:46,069 --> 00:10:43,360
more recent things they've heard of

313
00:10:48,069 --> 00:10:46,079

because chelyabinsk 2013 was a fireball

314

00:10:50,870 --> 00:10:48,079

that exploded uh over chelyabinsk in

315

00:10:52,389 --> 00:10:50,880

russia uh and people actually

316

00:10:53,990 --> 00:10:52,399

they picked chelyabinsk as their

317

00:10:55,990 --> 00:10:54,000

favorite one

318

00:10:57,509 --> 00:10:56,000

wow justin actually got the least amount

319

00:10:59,750 --> 00:10:57,519

of love which kind of hurt my heart a

320

00:11:01,430 --> 00:10:59,760

little bit i love it so much

321

00:11:04,069 --> 00:11:01,440

and as an astrobiologist i think it's so

322

00:11:05,750 --> 00:11:04,079

important um of those four which do you

323

00:11:07,750 --> 00:11:05,760

think is the coolest

324

00:11:09,750 --> 00:11:07,760

oh my god

325

00:11:12,829 --> 00:11:09,760

that's like asking who's my favorite

326

00:11:18,790 --> 00:11:16,230

i gosh that's a tough one i love them

327

00:11:20,310 --> 00:11:18,800

all but i would say probably black

328

00:11:25,750 --> 00:11:20,320

beauty

329

00:11:26,710 --> 00:11:25,760

that's a really fascinating meteorite by

330

00:11:28,550 --> 00:11:26,720

the way the you know the martian

331

00:11:30,750 --> 00:11:28,560

meteorites that we have they're all

332

00:11:33,670 --> 00:11:30,760

different kinds we they're about

333

00:11:36,230 --> 00:11:33,680

130 or so uh that we know of and but

334

00:11:37,590 --> 00:11:36,240

this is like one of a kind unique mars

335

00:11:39,350 --> 00:11:37,600

meteorite because it's actually an

336

00:11:41,190 --> 00:11:39,360

agglomeration of all different kinds of

337

00:11:43,430 --> 00:11:41,200

rocks most of the other martian

338

00:11:45,110 --> 00:11:43,440

meteorites are igneous rocks coming from

339

00:11:46,870 --> 00:11:45,120

one single rock and this one's sort of

340

00:11:48,550 --> 00:11:46,880

like a mishmash and the other thing

341

00:11:50,069 --> 00:11:48,560

that's really a couple of things that

342

00:11:53,190 --> 00:11:50,079

are really fascinating about it it has

343

00:11:55,990 --> 00:11:53,200

the most amount of total water

344

00:11:58,069 --> 00:11:56,000

uh close to one percent almost which is

345

00:12:00,069 --> 00:11:58,079

a ton compared to what's in the other

346

00:12:01,750 --> 00:12:00,079

mars meteorites which are you know parts

347

00:12:03,990 --> 00:12:01,760

per million or something like that you

348

00:12:05,670 --> 00:12:04,000

know total abundance um and the other

349

00:12:07,509 --> 00:12:05,680

one is that it's bulk composition is

350

00:12:10,069 --> 00:12:07,519

actually very similar

351
00:12:12,310 --> 00:12:10,079
to the compositions that the mars rovers

352
00:12:14,550 --> 00:12:12,320
are measuring for the surface rocks on

353
00:12:16,470 --> 00:12:14,560
mars the other mars meteorites that we

354
00:12:18,150 --> 00:12:16,480
know of for some strange reason they're

355
00:12:20,310 --> 00:12:18,160
not exactly

356
00:12:21,910 --> 00:12:20,320
you know analogous or in composition to

357
00:12:24,470 --> 00:12:21,920
what we're seeing from the rovers but

358
00:12:26,550 --> 00:12:24,480
this particular rock it's bang on you

359
00:12:28,389 --> 00:12:26,560
know the same kind of composition

360
00:12:29,990 --> 00:12:28,399
uh range that you're seeing from the

361
00:12:31,750 --> 00:12:30,000
rovers and so

362
00:12:33,910 --> 00:12:31,760
in the sense it represents the average

363
00:12:36,470 --> 00:12:33,920

composition of the mars crust in a in a

364

00:12:38,550 --> 00:12:36,480

much sort of more representative way

365

00:12:41,750 --> 00:12:38,560

than the other mars meteorites do

366

00:12:43,269 --> 00:12:41,760

um yeah so i and it's it's you know i i

367

00:12:44,230 --> 00:12:43,279

think it's just a fascinating beautiful

368

00:12:46,230 --> 00:12:44,240

rock i don't know if you've seen

369

00:12:49,829 --> 00:12:46,240

pictures of it but it's kind of a

370

00:12:51,350 --> 00:12:49,839

gorgeous looking um rock as well

371

00:12:52,870 --> 00:12:51,360

yeah absolutely i've seen pictures i

372

00:12:54,069 --> 00:12:52,880

haven't haven't seen it but i've seen

373

00:12:55,509 --> 00:12:54,079

pictures

374

00:12:57,030 --> 00:12:55,519

and yeah it's very beautiful it's a very

375

00:12:58,470 --> 00:12:57,040

cool rock i have some meteorites of my

376

00:13:00,069 --> 00:12:58,480

own i love them all

377

00:13:01,750 --> 00:13:00,079

so i can understand your hesitancy to

378

00:13:03,269 --> 00:13:01,760

pick a favorite but black beauty is a

379

00:13:05,110 --> 00:13:03,279

very cool rock

380

00:13:06,790 --> 00:13:05,120

um so i'd love to hear a little bit

381

00:13:08,150 --> 00:13:06,800

about meteorites you know you've gone

382

00:13:09,670 --> 00:13:08,160

out to the field to collect meteorites

383

00:13:11,590 --> 00:13:09,680

you've gone to antarctica

384

00:13:13,030 --> 00:13:11,600

to collect meteorites i'd love to hear a

385

00:13:14,790 --> 00:13:13,040

bit about what it's like to go out and

386

00:13:16,230 --> 00:13:14,800

collect these rocks and then bring them

387

00:13:18,150 --> 00:13:16,240

back to the lab and then do you know

388

00:13:21,190 --> 00:13:18,160

isotope cosmochemistry on them to try to

389

00:13:23,350 --> 00:13:21,200

understand their history yeah i know

390

00:13:25,030 --> 00:13:23,360

i tell you i mean antarctica is one of

391

00:13:27,430 --> 00:13:25,040

those places where

392

00:13:29,750 --> 00:13:27,440

you cannot really describe it adequately

393

00:13:31,829 --> 00:13:29,760

nor can you actually photograph it and

394

00:13:33,110 --> 00:13:31,839

sort of convey the wonder of being in

395

00:13:34,790 --> 00:13:33,120

that place

396

00:13:36,870 --> 00:13:34,800

through photographs or even you know

397

00:13:38,389 --> 00:13:36,880

video footage just because when you're

398

00:13:40,629 --> 00:13:38,399

down there and you're

399

00:13:42,790 --> 00:13:40,639

out in the field and you're in this

400

00:13:44,710 --> 00:13:42,800

space and by the way you know the field

401
00:13:47,189 --> 00:13:44,720
trips that we went on you go there

402
00:13:48,710 --> 00:13:47,199
during the austral summer which is 24

403
00:13:50,310 --> 00:13:48,720
hours of daylight

404
00:13:52,150 --> 00:13:50,320
and it's just an incredible thing i mean

405
00:13:54,310 --> 00:13:52,160
it takes your body a while to get used

406
00:13:55,829 --> 00:13:54,320
to that 24 hours of daylight but then

407
00:13:57,750 --> 00:13:55,839
after a while you can actually just

408
00:13:59,350 --> 00:13:57,760
depending on you know where the sun is

409
00:14:01,350 --> 00:13:59,360
relative to the horizon you can tell

410
00:14:02,389 --> 00:14:01,360
kind of what time of day it is or night

411
00:14:03,670 --> 00:14:02,399
it is

412
00:14:05,350 --> 00:14:03,680
and uh

413
00:14:07,829 --> 00:14:05,360

and and just sort of

414

00:14:09,350 --> 00:14:07,839

the field the field camp where we count

415

00:14:10,470 --> 00:14:09,360

you know just the isolation of it

416

00:14:12,470 --> 00:14:10,480

there's only

417

00:14:15,990 --> 00:14:12,480

we're hundreds of miles from any kind of

418

00:14:17,670 --> 00:14:16,000

you know uh occupied areas from mcmurdo

419

00:14:18,949 --> 00:14:17,680

station or from palm station hundreds of

420

00:14:22,230 --> 00:14:18,959

miles from that

421

00:14:23,110 --> 00:14:22,240

um out on this kind of ice that's miles

422

00:14:24,470 --> 00:14:23,120

thick

423

00:14:28,310 --> 00:14:24,480

and there's no

424

00:14:30,470 --> 00:14:28,320

wildlife whatsoever really there um and

425

00:14:32,069 --> 00:14:30,480

and you're there with these you know

426

00:14:34,550 --> 00:14:32,079

five other people that you're really

427

00:14:36,310 --> 00:14:34,560

dependent on for your existence really

428

00:14:38,069 --> 00:14:36,320

or depend on each other

429

00:14:40,870 --> 00:14:38,079

and it's like the most it's the most

430

00:14:42,710 --> 00:14:40,880

beautiful place in the world i think but

431

00:14:44,710 --> 00:14:42,720

but then you know hunting for meteorites

432

00:14:46,550 --> 00:14:44,720

there's i mean that's just again a

433

00:14:48,310 --> 00:14:46,560

mind-blowing experience i mean for me i

434

00:14:50,389 --> 00:14:48,320

studied media rights now for all of my

435

00:14:52,790 --> 00:14:50,399

career but that first experience of

436

00:14:55,110 --> 00:14:52,800

actually finding a meteorite

437

00:14:56,790 --> 00:14:55,120

out in the field and just actually sort

438

00:14:58,310 --> 00:14:56,800

of recognizing that hey you know there's

439

00:15:00,150 --> 00:14:58,320

actually a mechanism that happens here

440

00:15:02,310 --> 00:15:00,160

in antarctica that actually concentrates

441

00:15:03,910 --> 00:15:02,320

these meteorites so that you can find

442

00:15:05,590 --> 00:15:03,920

sometimes hundreds of meteorites in an

443

00:15:07,509 --> 00:15:05,600

area maybe you know the size of a

444

00:15:09,750 --> 00:15:07,519

football field i mean it's just

445

00:15:12,230 --> 00:15:09,760

incredible and so even though you your

446

00:15:14,790 --> 00:15:12,240

mind understands that it's it's still

447

00:15:17,430 --> 00:15:14,800

like amazing to find these rocks sitting

448

00:15:19,030 --> 00:15:17,440

on the ice and collecting them and and

449

00:15:20,710 --> 00:15:19,040

bringing them back and so you know i had

450

00:15:21,670 --> 00:15:20,720

the fortune of a good fortune of

451
00:15:23,829 --> 00:15:21,680
actually

452
00:15:25,269 --> 00:15:23,839
going down a couple of times as part of

453
00:15:26,870 --> 00:15:25,279
the antarctic search for meteorites

454
00:15:28,550 --> 00:15:26,880
program

455
00:15:30,870 --> 00:15:28,560
i went once as a graduate student and

456
00:15:33,110 --> 00:15:30,880
then i went again um

457
00:15:35,430 --> 00:15:33,120
just about a decade ago now so it's been

458
00:15:37,829 --> 00:15:35,440
it's been a few years but

459
00:15:40,069 --> 00:15:37,839
what an amazing experience

460
00:15:41,670 --> 00:15:40,079
that's so cool i'm super jealous i have

461
00:15:44,069 --> 00:15:41,680
been to the arctic i've been to a place

462
00:15:46,389 --> 00:15:44,079
above the arctic circle where uh the sun

463
00:15:47,829 --> 00:15:46,399

never sets and it was indeed bizarre

464

00:15:49,910 --> 00:15:47,839

just to have the sun just do a big

465

00:15:51,030 --> 00:15:49,920

circle and never have a night i was only

466

00:15:53,030 --> 00:15:51,040

there for two weeks so i never really

467

00:15:55,749 --> 00:15:53,040

had a chance to get very acclimated to

468

00:15:57,269 --> 00:15:55,759

it but field work can be dangerous those

469

00:15:59,430 --> 00:15:57,279

who know me know that we also had a

470

00:16:01,910 --> 00:15:59,440

potential near-death experience when we

471

00:16:03,269 --> 00:16:01,920

were in the arctic doing our research

472

00:16:05,030 --> 00:16:03,279

on a glacier

473

00:16:06,710 --> 00:16:05,040

and as i understand it you also had a

474

00:16:09,110 --> 00:16:06,720

rather terrible experience doing some

475

00:16:10,550 --> 00:16:09,120

field work back in 2017 in iceland um

476
00:16:11,670 --> 00:16:10,560
would you mind sharing that story with

477
00:16:13,430 --> 00:16:11,680
our audience

478
00:16:15,910 --> 00:16:13,440
yeah that was

479
00:16:17,670 --> 00:16:15,920
that was that was an um

480
00:16:19,110 --> 00:16:17,680
a pretty scary experience about but i

481
00:16:21,590 --> 00:16:19,120
mean you know

482
00:16:23,749 --> 00:16:21,600
i i so iceland of course i mean the

483
00:16:26,470 --> 00:16:23,759
reason i was in iceland was to collect

484
00:16:29,590 --> 00:16:26,480
some mars analog samples

485
00:16:31,350 --> 00:16:29,600
um so we have i have a project uh which

486
00:16:34,230 --> 00:16:31,360
uh where we're trying to understand the

487
00:16:36,870 --> 00:16:34,240
role of water and and igneous rocks and

488
00:16:38,870 --> 00:16:36,880

so icelandic rocks are really kind of

489

00:16:40,550 --> 00:16:38,880

perfect for for looking at some of the

490

00:16:43,110 --> 00:16:40,560

comparisons and so

491

00:16:44,870 --> 00:16:43,120

we were out there um and i

492

00:16:46,150 --> 00:16:44,880

this was day three of the field trip and

493

00:16:48,550 --> 00:16:46,160

i had a colleague from the university of

494

00:16:50,069 --> 00:16:48,560

iceland who was a geologist who was

495

00:16:51,430 --> 00:16:50,079

sort of helping us collect some of these

496

00:16:53,829 --> 00:16:51,440

samples

497

00:16:55,749 --> 00:16:53,839

and um we

498

00:16:57,910 --> 00:16:55,759

we're in actually quite a remote part of

499

00:16:59,030 --> 00:16:57,920

iceland uh several hundred miles from

500

00:17:01,110 --> 00:16:59,040

reykjavik

501
00:17:02,949 --> 00:17:01,120
um and we

502
00:17:05,029 --> 00:17:02,959
had a lunch stop and we're just sort of

503
00:17:07,029 --> 00:17:05,039
getting going after that and normally i

504
00:17:08,470 --> 00:17:07,039
mean it's in this remote part of iceland

505
00:17:10,230 --> 00:17:08,480
where there's hardly you hardly ever see

506
00:17:11,429 --> 00:17:10,240
any cars at all but you know getting out

507
00:17:13,510 --> 00:17:11,439
of the one spot there were a number of

508
00:17:15,829 --> 00:17:13,520
other cars that were getting out and and

509
00:17:18,390 --> 00:17:15,839
my colleague who was driving the car

510
00:17:21,110 --> 00:17:18,400
he tried to sort of quickly overtake

511
00:17:23,590 --> 00:17:21,120
a series of cars and one of those cars

512
00:17:25,909 --> 00:17:23,600
just pulled out into our lane and and

513
00:17:29,029 --> 00:17:25,919

sideswiped us and it's you know

514

00:17:31,590 --> 00:17:29,039

our vehicle just went kind of uh and

515

00:17:34,070 --> 00:17:31,600

over and basically well rolled over

516

00:17:36,390 --> 00:17:34,080

um and uh i

517

00:17:38,230 --> 00:17:36,400

literally was tossed out from the

518

00:17:39,430 --> 00:17:38,240

vehicle something like 30 feet away from

519

00:17:40,789 --> 00:17:39,440

the vehicle

520

00:17:42,870 --> 00:17:40,799

um and

521

00:17:44,630 --> 00:17:42,880

it was i don't remember any of it

522

00:17:46,549 --> 00:17:44,640

actually it's completely gone from my

523

00:17:49,270 --> 00:17:46,559

memory banks but it was

524

00:17:51,110 --> 00:17:49,280

i woke up in the emergency room not

525

00:17:51,830 --> 00:17:51,120

knowing kind of what happened

526
00:17:54,070 --> 00:17:51,840
and

527
00:17:55,270 --> 00:17:54,080
had a series of really kind of traumatic

528
00:17:56,870 --> 00:17:55,280
injuries

529
00:17:59,750 --> 00:17:56,880
most of them on my left side you know

530
00:18:03,029 --> 00:17:59,760
broken pelvis and fractures you know my

531
00:18:05,190 --> 00:18:03,039
shoulder and arm and and all of that

532
00:18:07,029 --> 00:18:05,200
as a result of that i mean i you know

533
00:18:08,710 --> 00:18:07,039
i had about a year of recovery after

534
00:18:11,029 --> 00:18:08,720
that i was in a wheelchair for about

535
00:18:13,190 --> 00:18:11,039
four months and uh lots of physical

536
00:18:15,830 --> 00:18:13,200
therapy but it was

537
00:18:17,909 --> 00:18:15,840
you know what what it made clear to me i

538
00:18:19,190 --> 00:18:17,919

had a lot of time to think i had a lot

539

00:18:20,870 --> 00:18:19,200

of time to sort of think about you know

540

00:18:24,230 --> 00:18:20,880

what i wanted to do with my life you

541

00:18:26,470 --> 00:18:24,240

know and i i realized that hey you know

542

00:18:29,669 --> 00:18:26,480

i better you know do things that really

543

00:18:32,070 --> 00:18:29,679

kind of uh are gonna be meaningful and

544

00:18:34,630 --> 00:18:32,080

uh you know that i'm really passionate

545

00:18:36,390 --> 00:18:34,640

about and and really care about and so

546

00:18:38,150 --> 00:18:36,400

it's really kind of i think in some ways

547

00:18:39,990 --> 00:18:38,160

helped me to kind of

548

00:18:41,350 --> 00:18:40,000

redefine kind of my path and i i

549

00:18:42,549 --> 00:18:41,360

realized that hey you know i wanted to

550

00:18:46,470 --> 00:18:42,559

be

551
00:18:48,310 --> 00:18:46,480
i want to make education opportunities

552
00:18:51,110 --> 00:18:48,320
available to many more

553
00:18:53,430 --> 00:18:51,120
um you know students out there and

554
00:18:55,350 --> 00:18:53,440
and so that's part of why

555
00:18:57,510 --> 00:18:55,360
i actually you know i became director of

556
00:18:59,830 --> 00:18:57,520
the school uh where i am at arizona

557
00:19:01,270 --> 00:18:59,840
state after that because i i decided

558
00:19:02,950 --> 00:19:01,280
that's kind of the path that i wanted to

559
00:19:05,350 --> 00:19:02,960
take not just focusing just on my

560
00:19:06,950 --> 00:19:05,360
research but also trying to make

561
00:19:08,470 --> 00:19:06,960
opportunities in education more

562
00:19:09,990 --> 00:19:08,480
available

563
00:19:11,909 --> 00:19:10,000

well that's beautiful thank you for

564

00:19:13,430 --> 00:19:11,919

sharing that with us and and i'm glad

565

00:19:15,590 --> 00:19:13,440

that you know that you survived i mean

566

00:19:16,870 --> 00:19:15,600

obviously you're here with us um and to

567

00:19:18,470 --> 00:19:16,880

hear that you know it's so such a

568

00:19:19,830 --> 00:19:18,480

remarkable time for you in your life and

569

00:19:21,430 --> 00:19:19,840

it kind of gives you that pivot to think

570

00:19:23,350 --> 00:19:21,440

a bit more about your own impacts in the

571

00:19:25,270 --> 00:19:23,360

world uh one reason i wanted to bring

572

00:19:26,630 --> 00:19:25,280

that story out is because you know we

573

00:19:27,909 --> 00:19:26,640

all have our stories and i think a lot

574

00:19:29,510 --> 00:19:27,919

of people think scientists you know just

575

00:19:31,110 --> 00:19:29,520

wear lab coats all day and they're in

576

00:19:32,310 --> 00:19:31,120

the lab and they don't realize that

577

00:19:33,909 --> 00:19:32,320

we're out in the field we're on

578

00:19:35,590 --> 00:19:33,919

computers we're of all different

579

00:19:37,590 --> 00:19:35,600

backgrounds and we also have our own

580

00:19:39,750 --> 00:19:37,600

stories our own histories and and some

581

00:19:42,789 --> 00:19:39,760

of those histories have rocky starts and

582

00:19:44,789 --> 00:19:42,799

fits and jumps and changes along the way

583

00:19:46,630 --> 00:19:44,799

much like when we look at a meteorite or

584

00:19:48,710 --> 00:19:46,640

a rock from space it can tell us about

585

00:19:51,190 --> 00:19:48,720

the history of our solar system the

586

00:19:52,950 --> 00:19:51,200

history of planets uh and i know that

587

00:19:54,630 --> 00:19:52,960

you've been involved a lot in early

588

00:19:56,710 --> 00:19:54,640

solar system work in the history of the

589

00:19:57,909 --> 00:19:56,720

worlds of our solar system as well i

590

00:19:59,909 --> 00:19:57,919

wonder if you can make that connection

591

00:20:02,070 --> 00:19:59,919

for us then from the work you've done in

592

00:20:03,750 --> 00:20:02,080

meteorites and the early solar system

593

00:20:06,549 --> 00:20:03,760

and things like that to then getting

594

00:20:08,310 --> 00:20:06,559

involved in sample return missions yeah

595

00:20:10,549 --> 00:20:08,320

you know it's a it's a very natural

596

00:20:12,470 --> 00:20:10,559

connection actually because you know

597

00:20:14,710 --> 00:20:12,480

meteorites most of them actually

598

00:20:16,549 --> 00:20:14,720

represent pieces of asteroids

599

00:20:18,950 --> 00:20:16,559

and so in in a sense you know what

600

00:20:21,430 --> 00:20:18,960

you've got with meteorites are

601
00:20:24,390 --> 00:20:21,440
are a very cheap way of doing sample

602
00:20:26,310 --> 00:20:24,400
return because they actually come to us

603
00:20:28,470 --> 00:20:26,320
um and so you know the samples that we

604
00:20:30,710 --> 00:20:28,480
have of mars the martian meteorites you

605
00:20:32,789 --> 00:20:30,720
know we're spending billions of dollars

606
00:20:34,390 --> 00:20:32,799
to actually go to mars and get those

607
00:20:36,230 --> 00:20:34,400
samples back now

608
00:20:38,070 --> 00:20:36,240
because there is actually some value to

609
00:20:39,830 --> 00:20:38,080
doing that because meteorites of course

610
00:20:41,350 --> 00:20:39,840
i mean they're wonderful and and they

611
00:20:43,190 --> 00:20:41,360
come to us free

612
00:20:45,830 --> 00:20:43,200
but they're not um

613
00:20:47,430 --> 00:20:45,840

i would say a non-biased sample of mars

614

00:20:49,750 --> 00:20:47,440

and they've been through a lot you know

615

00:20:51,270 --> 00:20:49,760

they had this huge impact on mars that

616

00:20:52,950 --> 00:20:51,280

injected them they went through these

617

00:20:55,029 --> 00:20:52,960

shock processes

618

00:20:56,390 --> 00:20:55,039

um you know during that process and then

619

00:20:57,830 --> 00:20:56,400

they've been sitting around on the earth

620

00:20:59,830 --> 00:20:57,840

for a long time exchanging with the

621

00:21:01,750 --> 00:20:59,840

earth's environment and so things change

622

00:21:04,149 --> 00:21:01,760

as a result of that and so we want

623

00:21:04,950 --> 00:21:04,159

sample return because of those factors

624

00:21:06,710 --> 00:21:04,960

right

625

00:21:08,549 --> 00:21:06,720

but but in a sense you know that

626

00:21:11,029 --> 00:21:08,559

connection is very much there you know i

627

00:21:13,430 --> 00:21:11,039

want to be able to study materials from

628

00:21:15,510 --> 00:21:13,440

places in our solar system

629

00:21:17,510 --> 00:21:15,520

that you know hopefully we can go and

630

00:21:18,870 --> 00:21:17,520

actually get them with spacecraft but

631

00:21:20,710 --> 00:21:18,880

meteorites kind of extend that

632

00:21:22,870 --> 00:21:20,720

possibility to a lot of sort of to

633

00:21:24,630 --> 00:21:22,880

places and times that we otherwise

634

00:21:26,789 --> 00:21:24,640

you know can't have a very hard time

635

00:21:28,390 --> 00:21:26,799

sampling otherwise and so

636

00:21:29,669 --> 00:21:28,400

that connection was kind of you know

637

00:21:31,270 --> 00:21:29,679

obvious to me from the very beginning

638

00:21:33,270 --> 00:21:31,280

when i started studying these martian

639

00:21:36,070 --> 00:21:33,280

meteorites you know

640

00:21:37,270 --> 00:21:36,080

i really was at the at that time i was

641

00:21:39,029 --> 00:21:37,280

thinking hey you know wouldn't it be

642

00:21:40,950 --> 00:21:39,039

great if we could actually

643

00:21:43,110 --> 00:21:40,960

go to mars and pick up some samples that

644

00:21:44,950 --> 00:21:43,120

we understand the geologic context of

645

00:21:46,789 --> 00:21:44,960

and and then you know bring them back

646

00:21:47,909 --> 00:21:46,799

and study them in their pristine

647

00:21:48,789 --> 00:21:47,919

condition

648

00:21:50,230 --> 00:21:48,799

and

649

00:21:52,950 --> 00:21:50,240

you know so i've dreamed of sample

650

00:21:54,789 --> 00:21:52,960

return you know since since that time

651
00:21:57,669 --> 00:21:54,799
and it's always been sometime in the

652
00:21:58,549 --> 00:21:57,679
future you know 10 15 years down in the

653
00:22:00,470 --> 00:21:58,559
future

654
00:22:02,950 --> 00:22:00,480
and that horizon kept moving back and

655
00:22:05,190 --> 00:22:02,960
moving back and then finally we're we're

656
00:22:07,110 --> 00:22:05,200
at this point today where

657
00:22:10,470 --> 00:22:07,120
it's all coming together and there's a

658
00:22:12,950 --> 00:22:10,480
timeline there's you know where in plans

659
00:22:14,789 --> 00:22:12,960
of you know basically making plans for

660
00:22:17,350 --> 00:22:14,799
getting those samples back

661
00:22:20,070 --> 00:22:17,360
and i can actually see it happening now

662
00:22:22,149 --> 00:22:20,080
and and it feels real so this is a

663
00:22:24,070 --> 00:22:22,159

really super exciting time

664

00:22:26,310 --> 00:22:24,080

that is so exciting

665

00:22:27,830 --> 00:22:26,320

and and and martial returns not the only

666

00:22:29,350 --> 00:22:27,840

one that i'm involved in of course i'm

667

00:22:30,950 --> 00:22:29,360

i'm actually part of the science team

668

00:22:33,669 --> 00:22:30,960

for the hayabusa 2

669

00:22:36,390 --> 00:22:33,679

japanese space uh space mission space

670

00:22:39,110 --> 00:22:36,400

agency's mission to an asteroid called

671

00:22:40,950 --> 00:22:39,120

rugu and we're analyzing actually pieces

672

00:22:43,190 --> 00:22:40,960

of that asteroid in my laboratory right

673

00:22:45,350 --> 00:22:43,200

now and uh you know learning things

674

00:22:46,310 --> 00:22:45,360

about our early solar system from that

675

00:22:48,789 --> 00:22:46,320

so

676

00:22:50,390 --> 00:22:48,799

um yeah wonderful i think you know this

677

00:22:53,190 --> 00:22:50,400

is really the golden age of sample

678

00:22:55,110 --> 00:22:53,200

return at this point and so exciting

679

00:22:57,029 --> 00:22:55,120

really really excited for actually

680

00:22:58,789 --> 00:22:57,039

students being just starting out now who

681

00:23:00,310 --> 00:22:58,799

will really be benefiting from all of

682

00:23:02,549 --> 00:23:00,320

what we're going to do in the future

683

00:23:05,270 --> 00:23:02,559

with this and they'll be engaged in

684

00:23:06,310 --> 00:23:05,280

analysis of these materials

685

00:23:08,070 --> 00:23:06,320

absolutely there could be a student

686

00:23:09,990 --> 00:23:08,080

watching right now who might end up

687

00:23:11,510 --> 00:23:10,000

analyzing mars sample return materials

688

00:23:13,350 --> 00:23:11,520

or even some materials

689

00:23:16,070 --> 00:23:13,360

or samples being brought right back

690

00:23:17,590 --> 00:23:16,080

right now from osiris-rex um you know

691

00:23:19,110 --> 00:23:17,600

we've done some sample returns we have

692

00:23:21,190 --> 00:23:19,120

some asteroidal materials we've brought

693

00:23:22,710 --> 00:23:21,200

some commentary dust back we have the

694

00:23:24,630 --> 00:23:22,720

apollo samples we brought back so

695

00:23:26,149 --> 00:23:24,640

there's already stuff that we have but

696

00:23:27,669 --> 00:23:26,159

of course we always want more and so

697

00:23:29,830 --> 00:23:27,679

this is the very first time we are going

698

00:23:31,990 --> 00:23:29,840

to do a mars sample return in this

699

00:23:33,430 --> 00:23:32,000

current architecture uh i wonder so

700

00:23:34,950 --> 00:23:33,440

maybe our audience doesn't really quite

701
00:23:36,870 --> 00:23:34,960
know the whole structure right now of

702
00:23:38,950 --> 00:23:36,880
msr i wonder if you could walk us

703
00:23:40,390 --> 00:23:38,960
through mars sample return and what

704
00:23:41,669 --> 00:23:40,400
that's going to look like in the coming

705
00:23:44,470 --> 00:23:41,679
decade or so

706
00:23:46,870 --> 00:23:44,480
yeah so you know we're we are in what we

707
00:23:48,310 --> 00:23:46,880
call phase a for mars sampler return

708
00:23:50,470 --> 00:23:48,320
mission and so

709
00:23:51,830 --> 00:23:50,480
the plans are still in formulation so

710
00:23:53,350 --> 00:23:51,840
you got to keep that in mind i think the

711
00:23:56,149 --> 00:23:53,360
architecture is not completely

712
00:23:58,710 --> 00:23:56,159
determined at this stage but as we uh

713
00:24:01,430 --> 00:23:58,720

are planning uh at the current time

714

00:24:04,470 --> 00:24:01,440

what the plans involve is are two

715

00:24:05,430 --> 00:24:04,480

components to the to the mission one

716

00:24:08,070 --> 00:24:05,440

uh

717

00:24:09,669 --> 00:24:08,080

is going to be an earth return orbiter

718

00:24:11,110 --> 00:24:09,679

which is going to be and actually this

719

00:24:13,190 --> 00:24:11,120

is a partnership i should say between

720

00:24:15,029 --> 00:24:13,200

nasa and the european space agency and

721

00:24:16,470 --> 00:24:15,039

so there's parts of it that isa is going

722

00:24:18,870 --> 00:24:16,480

to be doing parts of it that nasa is

723

00:24:20,390 --> 00:24:18,880

going to be doing and so there's

724

00:24:25,669 --> 00:24:20,400

one

725

00:24:27,909 --> 00:24:25,679

launch actually that's going to involve

726

00:24:29,909 --> 00:24:27,919

an earth return orbiter which is going

727

00:24:31,750 --> 00:24:29,919

to go to mars and it's going to orbit

728

00:24:33,669 --> 00:24:31,760

around mars and it'll become important

729

00:24:35,430 --> 00:24:33,679

as i just uh as i explained this a

730

00:24:38,230 --> 00:24:35,440

little better but the second launch is

731

00:24:40,549 --> 00:24:38,240

actually going to be a sample retrieval

732

00:24:41,909 --> 00:24:40,559

lander and it could be one or it could

733

00:24:43,990 --> 00:24:41,919

be two landers

734

00:24:46,950 --> 00:24:44,000

and they are going to take down to the

735

00:24:49,190 --> 00:24:46,960

surface of mars they're going to take

736

00:24:50,870 --> 00:24:49,200

a rocket that's going to then launch off

737

00:24:52,710 --> 00:24:50,880

the surface of mars and bring back the

738

00:24:54,789 --> 00:24:52,720

samples that are collected

739

00:24:56,149 --> 00:24:54,799

in a little canister

740

00:24:57,590 --> 00:24:56,159

and so

741

00:24:59,190 --> 00:24:57,600

this is going to be the first time ever

742

00:25:01,029 --> 00:24:59,200

that we're going to launch from another

743

00:25:02,310 --> 00:25:01,039

planet so it's historic from that

744

00:25:05,029 --> 00:25:02,320

perspective

745

00:25:06,549 --> 00:25:05,039

and then the launch is going to then

746

00:25:09,350 --> 00:25:06,559

take this you know sample canister from

747

00:25:10,870 --> 00:25:09,360

mars it's going to orbit uh mars and

748

00:25:12,470 --> 00:25:10,880

going to be captured by this earth

749

00:25:14,070 --> 00:25:12,480

return orbiter

750

00:25:15,750 --> 00:25:14,080

and then there's going to be an earth

751
00:25:18,230 --> 00:25:15,760
entry system that's going to basically

752
00:25:19,830 --> 00:25:18,240
bring back those samples back to earth

753
00:25:21,190 --> 00:25:19,840
and so this is a it's a really

754
00:25:23,269 --> 00:25:21,200
complicated

755
00:25:25,669 --> 00:25:23,279
um mission in the sense that there's

756
00:25:27,590 --> 00:25:25,679
multiple components to it there's

757
00:25:29,510 --> 00:25:27,600
obviously partnerships um you know

758
00:25:30,950 --> 00:25:29,520
between nasa and esa

759
00:25:32,950 --> 00:25:30,960
there's a number of different nasa

760
00:25:34,390 --> 00:25:32,960
centers that are contributing various

761
00:25:36,549 --> 00:25:34,400
parts to the

762
00:25:39,269 --> 00:25:36,559
uh to the different uh components of

763
00:25:40,310 --> 00:25:39,279

this of this mission and so

764

00:25:42,070 --> 00:25:40,320

um

765

00:25:44,149 --> 00:25:42,080

it's gonna be one of the most ambitious

766

00:25:47,269 --> 00:25:44,159

things that nasa has done in a long time

767

00:25:49,110 --> 00:25:47,279

and i'm just so excited to be part of it

768

00:25:50,470 --> 00:25:49,120

that's so groovy yeah i mean we've been

769

00:25:52,310 --> 00:25:50,480

doing doing all these cool things the

770

00:25:53,510 --> 00:25:52,320

engineers at jpl are doing so many cool

771

00:25:55,750 --> 00:25:53,520

things with how we land the rovers and

772

00:25:57,510 --> 00:25:55,760

all this stuff but this is a huge

773

00:25:59,190 --> 00:25:57,520

structure a huge architecture of how we

774

00:26:00,630 --> 00:25:59,200

have to do these different launches and

775

00:26:03,590 --> 00:26:00,640

and get these samples back and then

776

00:26:05,430 --> 00:26:03,600

start to analyze the samples as well but

777

00:26:07,430 --> 00:26:05,440

there is so much we can do with our high

778

00:26:09,350 --> 00:26:07,440

precision instruments here on earth and

779

00:26:10,549 --> 00:26:09,360

when we have those samples in hand i

780

00:26:11,990 --> 00:26:10,559

think it's always important for people

781

00:26:14,390 --> 00:26:12,000

out there to remember that that we can

782

00:26:15,990 --> 00:26:14,400

do so much more science with these

783

00:26:18,630 --> 00:26:16,000

samples we have them in hand than we can

784

00:26:20,470 --> 00:26:18,640

right now with our rovers um on mars

785

00:26:22,070 --> 00:26:20,480

exactly i mean you know you've got

786

00:26:24,149 --> 00:26:22,080

instruments like these synchrotrons that

787

00:26:26,149 --> 00:26:24,159

are about you know several city blocks

788

00:26:28,390 --> 00:26:26,159

across and you can never take those on

789

00:26:30,470 --> 00:26:28,400

spacecraft and use them to analyze

790

00:26:32,149 --> 00:26:30,480

materials so it'll be you know we'll be

791

00:26:33,909 --> 00:26:32,159

able to analyze these samples with the

792

00:26:35,750 --> 00:26:33,919

best most you know state-of-the-art

793

00:26:37,909 --> 00:26:35,760

technologies that are available here on

794

00:26:39,990 --> 00:26:37,919

earth and the wonderful thing about it

795

00:26:42,230 --> 00:26:40,000

is you know the advantage of time right

796

00:26:44,870 --> 00:26:42,240

and once you bring these things back you

797

00:26:46,870 --> 00:26:44,880

you can actually wait to develop some

798

00:26:48,710 --> 00:26:46,880

technologies that you know you may not

799

00:26:50,470 --> 00:26:48,720

have i mean and we are going to actually

800

00:26:53,029 --> 00:26:50,480

analyze these uh materials with

801
00:26:55,830 --> 00:26:53,039
technology that don't exist today but

802
00:26:57,430 --> 00:26:55,840
will in the future right and so and you

803
00:26:59,590 --> 00:26:57,440
know and there'll be questions that we

804
00:27:02,149 --> 00:26:59,600
lost that we can't even think of right

805
00:27:04,549 --> 00:27:02,159
now so i mean just the the powerful

806
00:27:06,070 --> 00:27:04,559
nature of sample return is just that you

807
00:27:09,350 --> 00:27:06,080
have these materials back and they'll be

808
00:27:10,789 --> 00:27:09,360
available for generations to come

809
00:27:12,710 --> 00:27:10,799
the apollo samples for example i mean

810
00:27:15,269 --> 00:27:12,720
you know they came back in the late 60s

811
00:27:17,669 --> 00:27:15,279
but even last year we opened up a sample

812
00:27:19,669 --> 00:27:17,679
tube that had been sealed for 50 years

813
00:27:21,269 --> 00:27:19,679

and there's new science being done on

814

00:27:24,230 --> 00:27:21,279

those materials and we're learning new

815

00:27:26,389 --> 00:27:24,240

things you know so that's yeah it's just

816

00:27:28,630 --> 00:27:26,399

it'll be an incredible gift

817

00:27:30,389 --> 00:27:28,640

to bring these materials back

818

00:27:31,909 --> 00:27:30,399

yeah definitely i've been fortunate i've

819

00:27:33,350 --> 00:27:31,919

done x-ray spectroscopy at three

820

00:27:35,190 --> 00:27:33,360

different synchrotrons in my own life

821

00:27:37,430 --> 00:27:35,200

and and you're right these are gigantic

822

00:27:39,190 --> 00:27:37,440

facilities you know mega facilities that

823

00:27:40,630 --> 00:27:39,200

you know we're speeding electrons close

824

00:27:43,029 --> 00:27:40,640

to the speed of light around these huge

825

00:27:45,350 --> 00:27:43,039

rings that it can take you 15 minutes or

826

00:27:46,710 --> 00:27:45,360

over an hour to walk around them some of

827

00:27:48,389 --> 00:27:46,720

them even have like tricycles and stuff

828

00:27:50,310 --> 00:27:48,399

for you to go around the rings with

829

00:27:51,990 --> 00:27:50,320

yeah and the amazing thing is of course

830

00:27:53,830 --> 00:27:52,000

i mean the power of that is that you can

831

00:27:55,909 --> 00:27:53,840

actually study these samples at the

832

00:27:58,630 --> 00:27:55,919

almost at the atomic scale right

833

00:28:01,110 --> 00:27:58,640

and uh you there's no hope of actually

834

00:28:02,549 --> 00:28:01,120

doing that remotely on on

835

00:28:04,310 --> 00:28:02,559

other planets we have to bring them back

836

00:28:05,990 --> 00:28:04,320

to be able to study that in that detail

837

00:28:07,830 --> 00:28:06,000

and you need that really you know to be

838

00:28:10,630 --> 00:28:07,840

able to really address that question of

839

00:28:12,870 --> 00:28:10,640

is there evidence of past life

840

00:28:15,909 --> 00:28:12,880

in these rocks you're going to need that

841

00:28:17,750 --> 00:28:15,919

uh you know level of precision level of

842

00:28:20,470 --> 00:28:17,760

spatial resolution to be able to address

843

00:28:22,389 --> 00:28:20,480

those types of important questions

844

00:28:24,789 --> 00:28:22,399

absolutely i do want to open it to our

845

00:28:26,389 --> 00:28:24,799

audience q a here very soon so i see a

846

00:28:27,669 --> 00:28:26,399

lot of questions rolling in right now

847

00:28:29,029 --> 00:28:27,679

from my team

848

00:28:30,789 --> 00:28:29,039

from those who are watching right now

849

00:28:32,149 --> 00:28:30,799

the live stream on youtube are asking

850

00:28:33,830 --> 00:28:32,159

questions in the chat so please keep

851
00:28:37,029 --> 00:28:33,840
asking questions we'll get to them very

852
00:28:39,590 --> 00:28:37,039
soon i promise but now we have our ftl

853
00:28:41,830 --> 00:28:39,600
segment our faster than light

854
00:28:43,269 --> 00:28:41,840
rapid fire segments so just you know

855
00:28:44,470 --> 00:28:43,279
rather short answers but if you don't

856
00:28:46,630 --> 00:28:44,480
mind these are some just interesting

857
00:28:48,710 --> 00:28:46,640
things that might draw more out about

858
00:28:50,870 --> 00:28:48,720
your interest in your career

859
00:28:52,789 --> 00:28:50,880
first one comes from me specifically

860
00:28:54,389 --> 00:28:52,799
what stories

861
00:28:56,789 --> 00:28:54,399
what kinds of fiction stories

862
00:28:59,029 --> 00:28:56,799
non-fiction stories human stories have

863
00:29:01,669 --> 00:28:59,039

inspired you to want to explore more

864

00:29:04,389 --> 00:29:01,679

about the universe

865

00:29:05,350 --> 00:29:04,399

gosh so i can think of maybe two so what

866

00:29:07,909 --> 00:29:05,360

one

867

00:29:09,909 --> 00:29:07,919

human story that really inspired me is

868

00:29:13,029 --> 00:29:09,919

the shackleton story yeah and the

869

00:29:15,029 --> 00:29:13,039

anarchic you know exploration uh and and

870

00:29:18,789 --> 00:29:15,039

shackleton just you know one of my

871

00:29:20,310 --> 00:29:18,799

big-time heroes i think just his um

872

00:29:22,549 --> 00:29:20,320

leadership style and just his

873

00:29:25,190 --> 00:29:22,559

exploration of the antarctic and how he

874

00:29:27,029 --> 00:29:25,200

kind of kept his team together

875

00:29:29,190 --> 00:29:27,039

under really hardship conditions you

876
00:29:30,630 --> 00:29:29,200
know the book endurance i think actually

877
00:29:31,830 --> 00:29:30,640
really captures that so well and i was

878
00:29:34,149 --> 00:29:31,840
just yeah it's one of the most

879
00:29:34,950 --> 00:29:34,159
inspirational things to me personally i

880
00:29:37,990 --> 00:29:34,960
think

881
00:29:40,230 --> 00:29:38,000
um you know he he's a real hero in many

882
00:29:41,909 --> 00:29:40,240
ways for leadership and exploration and

883
00:29:43,669 --> 00:29:41,919
then the other thing i think that really

884
00:29:46,230 --> 00:29:43,679
affected me as a child actually was

885
00:29:48,870 --> 00:29:46,240
watching you know jacques cousteau's uh

886
00:29:51,669 --> 00:29:48,880
documentaries and exploring

887
00:29:53,590 --> 00:29:51,679
um the undersea world and and that just

888
00:29:55,990 --> 00:29:53,600

was incredibly sort of

889

00:29:58,310 --> 00:29:56,000

fascinating for me and yeah

890

00:30:00,310 --> 00:29:58,320

absolutely that's so cool um if you

891

00:30:01,830 --> 00:30:00,320

could go back in time to the beginning

892

00:30:05,510 --> 00:30:01,840

of your career and give yourself some

893

00:30:10,310 --> 00:30:07,510

uh so i

894

00:30:12,149 --> 00:30:10,320

i would i would tell my sort of younger

895

00:30:13,830 --> 00:30:12,159

self that

896

00:30:16,630 --> 00:30:13,840

you should

897

00:30:19,590 --> 00:30:16,640

really appreciate the moment live in the

898

00:30:21,669 --> 00:30:19,600

moment more instead of always focusing

899

00:30:24,149 --> 00:30:21,679

forward and planning for the future and

900

00:30:26,789 --> 00:30:24,159

what you might do i think just

901
00:30:28,630 --> 00:30:26,799
enjoying your time where you are

902
00:30:30,230 --> 00:30:28,640
what you're doing i think that's so

903
00:30:31,750 --> 00:30:30,240
important and and that's something

904
00:30:34,070 --> 00:30:31,760
actually that i think

905
00:30:36,470 --> 00:30:34,080
i could benefit from even today not a

906
00:30:37,590 --> 00:30:36,480
piece of advice um and then the other i

907
00:30:39,830 --> 00:30:37,600
think the other thing i would say is

908
00:30:42,230 --> 00:30:39,840
take take more risks you know

909
00:30:43,990 --> 00:30:42,240
take more chances ex you know put

910
00:30:45,269 --> 00:30:44,000
yourself outside your comfort zone every

911
00:30:46,950 --> 00:30:45,279
once in a while i think that's when we

912
00:30:48,870 --> 00:30:46,960
actually learn the most

913
00:30:51,430 --> 00:30:48,880

is when we do that

914

00:30:52,870 --> 00:30:51,440

absolutely um what's something that

915

00:30:54,310 --> 00:30:52,880

really excites you right now about the

916

00:30:56,630 --> 00:30:54,320

future of planetary science and

917

00:30:58,230 --> 00:30:56,640

astrobiology

918

00:31:00,230 --> 00:30:58,240

gosh i mean i think like i said the

919

00:31:01,669 --> 00:31:00,240

golden age of sample return right i mean

920

00:31:02,950 --> 00:31:01,679

we're looking forward to all these

921

00:31:04,149 --> 00:31:02,960

materials that are gonna be coming back

922

00:31:05,990 --> 00:31:04,159

we're going to have the osiris-rex

923

00:31:07,430 --> 00:31:06,000

materials coming back next year we're

924

00:31:08,549 --> 00:31:07,440

planning for you know these artemis

925

00:31:11,269 --> 00:31:08,559

missions that are going to bring back

926

00:31:12,710 --> 00:31:11,279

all these samples of of the moon uh in

927

00:31:14,070 --> 00:31:12,720

the near future and then of course mars

928

00:31:16,389 --> 00:31:14,080

have the return so i mean i'm super

929

00:31:18,149 --> 00:31:16,399

excited about that for the next you know

930

00:31:20,549 --> 00:31:18,159

decade or two we're gonna have some

931

00:31:22,470 --> 00:31:20,559

fantastic materials coming back

932

00:31:24,870 --> 00:31:22,480

absolutely um so we mentioned earlier

933

00:31:26,870 --> 00:31:24,880

you're a professor and the director of

934

00:31:28,470 --> 00:31:26,880

cc uh you informed me earlier before the

935

00:31:30,470 --> 00:31:28,480

show i was pronouncing it wrong for

936

00:31:33,430 --> 00:31:30,480

years uh the school of earth and space

937

00:31:35,909 --> 00:31:33,440

exploration at asu uh what is your

938

00:31:37,830 --> 00:31:35,919

favorite part of your job

939

00:31:39,590 --> 00:31:37,840

gosh you know what i love about my job

940

00:31:41,269 --> 00:31:39,600

is that no single day is this you know

941

00:31:43,029 --> 00:31:41,279

it's not the same as any other day

942

00:31:44,470 --> 00:31:43,039

everything you know

943

00:31:46,310 --> 00:31:44,480

every day is different and there's

944

00:31:47,909 --> 00:31:46,320

different challenges there's there's

945

00:31:49,830 --> 00:31:47,919

always something that's new and

946

00:31:52,070 --> 00:31:49,840

different to do and and of course i mean

947

00:31:54,789 --> 00:31:52,080

science is part of that and i love the

948

00:31:56,950 --> 00:31:54,799

mentoring part of it as well uh that's

949

00:32:00,070 --> 00:31:56,960

that's such an important part i think

950

00:32:01,909 --> 00:32:00,080

for all of us is to sort of give back

951
00:32:03,909 --> 00:32:01,919
to sort of the growth of our of our

952
00:32:05,029 --> 00:32:03,919
community and our field and really i

953
00:32:07,190 --> 00:32:05,039
want to be able to provide the

954
00:32:09,990 --> 00:32:07,200
opportunities that i've had

955
00:32:12,630 --> 00:32:10,000
to others so yeah

956
00:32:15,190 --> 00:32:12,640
very cool and this is a fun question

957
00:32:19,509 --> 00:32:15,200
what is an unbelievable science fact

958
00:32:23,830 --> 00:32:21,669
so an unbelievable science fact for

959
00:32:25,509 --> 00:32:23,840
myself actually and i

960
00:32:27,750 --> 00:32:25,519
i can't believe i you know actually

961
00:32:30,070 --> 00:32:27,760
participated in some of the

962
00:32:33,029 --> 00:32:30,080
findings for that is just you know just

963
00:32:36,230 --> 00:32:33,039

the age of our solar system right

964

00:32:38,310 --> 00:32:36,240

uh four point five six seven

965

00:32:41,269 --> 00:32:38,320

eight

966

00:32:43,509 --> 00:32:41,279

a billion years we know that to an

967

00:32:44,950 --> 00:32:43,519

incredible level of precision

968

00:32:47,190 --> 00:32:44,960

and just to think about that you know

969

00:32:48,950 --> 00:32:47,200

this the context of that you know if you

970

00:32:51,029 --> 00:32:48,960

if you think about

971

00:32:53,669 --> 00:32:51,039

to wrap your mind around

972

00:32:55,110 --> 00:32:53,679

that big a number it's hard even if for

973

00:32:57,190 --> 00:32:55,120

somebody who studies it you know on

974

00:32:58,470 --> 00:32:57,200

day-to-day basis to even do that

975

00:33:01,350 --> 00:32:58,480

so if you're thinking about the length

976
00:33:03,909 --> 00:33:01,360
of your arm you know that's about the

977
00:33:05,350 --> 00:33:03,919
whole of human you know earth history or

978
00:33:07,110 --> 00:33:05,360
the solar system history and you were

979
00:33:09,110 --> 00:33:07,120
basically if you were to take a nail

980
00:33:11,269 --> 00:33:09,120
file and rub it against your nail you

981
00:33:12,870 --> 00:33:11,279
would remove all of human history right

982
00:33:14,549 --> 00:33:12,880
so that's the kind of scale that you're

983
00:33:15,909 --> 00:33:14,559
talking about just blows my mind just

984
00:33:18,389 --> 00:33:15,919
thinking about you know

985
00:33:20,470 --> 00:33:18,399
what the age of our solar system is

986
00:33:22,470 --> 00:33:20,480
and and when life originated actually is

987
00:33:23,590 --> 00:33:22,480
a very small fraction of that time so i

988
00:33:26,070 --> 00:33:23,600

mean i think

989

00:33:28,230 --> 00:33:26,080

just geologic time skills and

990

00:33:30,389 --> 00:33:28,240

that's kind of the most incredible thing

991

00:33:32,230 --> 00:33:30,399

to me i love it it's so mind-blowing

992

00:33:34,470 --> 00:33:32,240

right like you evolved to think on

993

00:33:36,950 --> 00:33:34,480

scales of seconds and minutes and and

994

00:33:39,110 --> 00:33:36,960

and you know length scales of a meter to

995

00:33:41,430 --> 00:33:39,120

three meters you know or a centimeter to

996

00:33:43,350 --> 00:33:41,440

think of things in such huge scales both

997

00:33:45,029 --> 00:33:43,360

really long periods of time in super

998

00:33:47,590 --> 00:33:45,039

short periods of time just it is very

999

00:33:49,269 --> 00:33:47,600

staggering so i love that a lot um i do

1000

00:33:50,789 --> 00:33:49,279

want to jump now to our audience q a

1001

00:33:53,190 --> 00:33:50,799

since i i see we have a bunch of

1002

00:33:55,110 --> 00:33:53,200

questions to get to um the first

1003

00:33:57,430 --> 00:33:55,120

question actually came into us via

1004

00:33:59,350 --> 00:33:57,440

twitter a couple of days ago

1005

00:34:02,630 --> 00:33:59,360

and at first i misunderstood the person

1006

00:34:05,110 --> 00:34:02,640

who was asking this is user j van evert

1007

00:34:07,110 --> 00:34:05,120

jan underscore one on twitter they

1008

00:34:09,589 --> 00:34:07,120

wanted to know why only rock samples are

1009

00:34:11,270 --> 00:34:09,599

being collected so far and why for mars

1010

00:34:13,430 --> 00:34:11,280

some scientists say radiation will kill

1011

00:34:15,909 --> 00:34:13,440

all life to a depth of three meters now

1012

00:34:17,270 --> 00:34:15,919

to be fair i responded i thought they

1013

00:34:18,950 --> 00:34:17,280

meant you know like why are we only

1014

00:34:21,109 --> 00:34:18,960

collecting rock and not like water or

1015

00:34:23,430 --> 00:34:21,119

ice and obviously if we can get to

1016

00:34:24,790 --> 00:34:23,440

europa or enceladus and fly through the

1017

00:34:26,389 --> 00:34:24,800

plumes and collect some material and

1018

00:34:29,430 --> 00:34:26,399

bring it back that'd be that'd be

1019

00:34:31,510 --> 00:34:29,440

fantastic um but their real question um

1020

00:34:34,069 --> 00:34:31,520

about the collection was why aren't we

1021

00:34:35,909 --> 00:34:34,079

collecting regolith from mars like why

1022

00:34:38,149 --> 00:34:35,919

are we looking for solid rock samples in

1023

00:34:40,550 --> 00:34:38,159

those cache tubes and not like scooping

1024

00:34:42,869 --> 00:34:40,560

up some of the surface material i think

1025

00:34:45,669 --> 00:34:42,879

actually the plan is to collect some of

1026

00:34:47,589 --> 00:34:45,679

that regolith material so yeah i mean

1027

00:34:49,109 --> 00:34:47,599

there is interest in collecting regolith

1028

00:34:51,030 --> 00:34:49,119

as well and there's lots that you can

1029

00:34:53,589 --> 00:34:51,040

learn from from studying that type of

1030

00:34:55,990 --> 00:34:53,599

material versus the rock chords as well

1031

00:34:57,510 --> 00:34:56,000

so yeah absolutely i think you know what

1032

00:34:59,030 --> 00:34:57,520

we're trying to do

1033

00:35:00,710 --> 00:34:59,040

what we're going to bring back is going

1034

00:35:02,230 --> 00:35:00,720

to be rocks it's going to be regolith

1035

00:35:04,710 --> 00:35:02,240

there's also going to be mars atmosphere

1036

00:35:06,550 --> 00:35:04,720

that we're going to bring back so yeah

1037

00:35:08,150 --> 00:35:06,560

all different kinds of stuff

1038

00:35:09,990 --> 00:35:08,160

yeah and so another good question so the

1039

00:35:11,990 --> 00:35:10,000

second part of their question then was

1040

00:35:13,990 --> 00:35:12,000

about depth uh so the surface of mars we

1041

00:35:15,430 --> 00:35:14,000

know is a you know a lot of radiation

1042

00:35:17,030 --> 00:35:15,440

coming in compared to the surface of the

1043

00:35:18,870 --> 00:35:17,040

earth and it's a highly oxidizing

1044

00:35:19,990 --> 00:35:18,880

environment and so a lot of people have

1045

00:35:23,349 --> 00:35:20,000

said if we're going to find

1046

00:35:25,030 --> 00:35:23,359

biosignatures we need to dig deep now

1047

00:35:26,550 --> 00:35:25,040

obviously these samples from percy are

1048

00:35:28,630 --> 00:35:26,560

from perseverance aren't going to be

1049

00:35:30,630 --> 00:35:28,640

very deep samples

1050

00:35:33,030 --> 00:35:30,640

so do we have an issue then with the

1051

00:35:36,390 --> 00:35:33,040

quality or potential for biosignatures

1052

00:35:38,710 --> 00:35:36,400

in the samples from perseverance so

1053

00:35:41,270 --> 00:35:38,720

i think there's uh what i want to

1054

00:35:44,310 --> 00:35:41,280

clarify here is that the goal for

1055

00:35:46,550 --> 00:35:44,320

perseverance and the goal of you know

1056

00:35:49,190 --> 00:35:46,560

investigating this particular region

1057

00:35:52,230 --> 00:35:49,200

that we that perseverance is in you know

1058

00:35:54,950 --> 00:35:52,240

this delta region of jezreel crater

1059

00:35:57,430 --> 00:35:54,960

is not to look for extant life so much

1060

00:35:59,829 --> 00:35:57,440

as evidence of past life

1061

00:36:02,310 --> 00:35:59,839

the probability of extant life is very

1062

00:36:03,750 --> 00:36:02,320

very very very low in this particular

1063

00:36:05,750 --> 00:36:03,760

reason you know

1064

00:36:07,910 --> 00:36:05,760

um so what we're hoping to do is but you

1065

00:36:09,829 --> 00:36:07,920

know in the past this we think that this

1066

00:36:11,430 --> 00:36:09,839

was an environment that was habitable in

1067

00:36:13,829 --> 00:36:11,440

the in the ancient

1068

00:36:15,430 --> 00:36:13,839

history of mars and so

1069

00:36:17,349 --> 00:36:15,440

the environment then was very different

1070

00:36:19,190 --> 00:36:17,359

there was possibly liquid water on the

1071

00:36:21,349 --> 00:36:19,200

surface there was a thicker atmosphere

1072

00:36:23,430 --> 00:36:21,359

perhaps it was warmer wetter

1073

00:36:25,430 --> 00:36:23,440

um and that's when you know some of

1074

00:36:26,870 --> 00:36:25,440

these rocks were likely deposited and so

1075

00:36:28,630 --> 00:36:26,880

what we're looking for really is not

1076

00:36:29,990 --> 00:36:28,640

evidence of extent life and sure yeah

1077

00:36:31,349 --> 00:36:30,000

absolutely i mean the current

1078

00:36:32,710 --> 00:36:31,359

environment there is completely

1079

00:36:34,790 --> 00:36:32,720

inhospitable

1080

00:36:36,710 --> 00:36:34,800

uh but what we're hoping to find is bias

1081

00:36:39,430 --> 00:36:36,720

signatures that points to evidence of

1082

00:36:41,270 --> 00:36:39,440

ancient life and and yeah i mean i think

1083

00:36:42,790 --> 00:36:41,280

we're going to the right places there to

1084

00:36:44,790 --> 00:36:42,800

look for that and

1085

00:36:46,710 --> 00:36:44,800

uh we hope to find it yeah i don't think

1086

00:36:50,150 --> 00:36:46,720

we need to you know necessarily go down

1087

00:36:51,190 --> 00:36:50,160

very deep to look for ancient evidence

1088

00:36:53,750 --> 00:36:51,200

very cool

1089

00:36:55,750 --> 00:36:53,760

um i agree entirely um there's still so

1090

00:36:57,270 --> 00:36:55,760

much value in those samples

1091

00:36:59,589 --> 00:36:57,280

our next question comes from to us from

1092

00:37:02,150 --> 00:36:59,599

dr jim pass who leads the astro

1093

00:37:03,750 --> 00:37:02,160

sociology research institute he always

1094

00:37:06,630 --> 00:37:03,760

wants to ask questions that are related

1095

00:37:07,670 --> 00:37:06,640

to sociology and human behavior in our

1096

00:37:09,109 --> 00:37:07,680

research

1097

00:37:10,630 --> 00:37:09,119

and so jim has said the mars sample

1098

00:37:12,470 --> 00:37:10,640

return program represents a highly

1099

00:37:14,150 --> 00:37:12,480

anticipated next step in the search for

1100

00:37:15,829 --> 00:37:14,160

extraterrestrial life

1101
00:37:18,630 --> 00:37:15,839
uh he would like to know your thoughts

1102
00:37:21,030 --> 00:37:18,640
on how social scientists and maybe even

1103
00:37:22,630 --> 00:37:21,040
others in the humanities can participate

1104
00:37:25,510 --> 00:37:22,640
including putting these findings into

1105
00:37:28,069 --> 00:37:25,520
the proper context for human life

1106
00:37:31,030 --> 00:37:28,079
yeah no i i completely agree and this is

1107
00:37:32,950 --> 00:37:31,040
you know one of the one of humanity's

1108
00:37:35,510 --> 00:37:32,960
biggest questions i think is you know

1109
00:37:37,109 --> 00:37:35,520
are we alone in the universe

1110
00:37:40,470 --> 00:37:37,119
did you know did life originate

1111
00:37:41,910 --> 00:37:40,480
elsewhere in our solar system uh did it

1112
00:37:43,349 --> 00:37:41,920
you know originate elsewhere in the

1113
00:37:45,190 --> 00:37:43,359

universe and

1114

00:37:46,790 --> 00:37:45,200

these are big questions that i think not

1115

00:37:48,310 --> 00:37:46,800

it's not just scientists that grapple

1116

00:37:49,910 --> 00:37:48,320

with that it's all of humanity and

1117

00:37:51,430 --> 00:37:49,920

certainly the social sciences and i

1118

00:37:53,190 --> 00:37:51,440

think we're going to need the

1119

00:37:55,589 --> 00:37:53,200

participation and the perspectives from

1120

00:37:58,310 --> 00:37:55,599

social science to really help us

1121

00:37:59,190 --> 00:37:58,320

frame you know whatever that we find you

1122

00:38:01,030 --> 00:37:59,200

know

1123

00:38:03,829 --> 00:38:01,040

uh for us human beings to really kind of

1124

00:38:05,510 --> 00:38:03,839

frame what it means to be alive on this

1125

00:38:07,349 --> 00:38:05,520

planet you know

1126

00:38:10,230 --> 00:38:07,359

uh as humans we need to sort of

1127

00:38:11,750 --> 00:38:10,240

understand that and and to put that in

1128

00:38:13,190 --> 00:38:11,760

in the right framework and and you know

1129

00:38:14,870 --> 00:38:13,200

from that perspective i think you know

1130

00:38:17,430 --> 00:38:14,880

whatever the answer that we get whether

1131

00:38:20,069 --> 00:38:17,440

it's yes or no i think it's gonna be

1132

00:38:22,310 --> 00:38:20,079

it's going to have a huge impact on what

1133

00:38:24,150 --> 00:38:22,320

you know be human beings how we perceive

1134

00:38:24,950 --> 00:38:24,160

ourselves and our place in the universe

1135

00:38:27,109 --> 00:38:24,960

right

1136

00:38:29,589 --> 00:38:27,119

and so i think there is a huge role for

1137

00:38:31,349 --> 00:38:29,599

social sciences to play in in fact for

1138

00:38:32,870 --> 00:38:31,359

everyone you know all of humanity to

1139

00:38:34,310 --> 00:38:32,880

really sort of

1140

00:38:35,829 --> 00:38:34,320

be able to participate in that

1141

00:38:37,670 --> 00:38:35,839

exploration

1142

00:38:39,990 --> 00:38:37,680

and and that and that sort of answering

1143

00:38:41,270 --> 00:38:40,000

that question so yeah i think it's a

1144

00:38:42,069 --> 00:38:41,280

great question

1145

00:38:43,510 --> 00:38:42,079

yeah

1146

00:38:45,109 --> 00:38:43,520

reminds me of a star trek next

1147

00:38:47,589 --> 00:38:45,119

generation episode called samaritan

1148

00:38:49,589 --> 00:38:47,599

snare where captain picard is basically

1149

00:38:51,190 --> 00:38:49,599

explaining that you know anyone can

1150

00:38:53,430 --> 00:38:51,200

learn you know celestial mechanics and

1151

00:38:56,390 --> 00:38:53,440

how to pile a starship but if you study

1152

00:38:59,030 --> 00:38:56,400

history and philosophy theater art then

1153

00:39:00,790 --> 00:38:59,040

it makes everything else makes sense

1154

00:39:02,710 --> 00:39:00,800

yeah exactly

1155

00:39:05,510 --> 00:39:02,720

we have a couple of clarification

1156

00:39:07,990 --> 00:39:05,520

questions here about your work um one of

1157

00:39:09,910 --> 00:39:08,000

them from sibsonker palette on youtube

1158

00:39:11,829 --> 00:39:09,920

uh wants to know uh if you can clarify

1159

00:39:15,510 --> 00:39:11,839

the difference between astrochemistry

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00:39:20,790 --> 00:39:19,030

so you know it's a fine fine line there

1161

00:39:22,790 --> 00:39:20,800

i think astro chemistry cosmetic

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00:39:23,670 --> 00:39:22,800

chemistry probably gets to the same sort

1163

00:39:24,950 --> 00:39:23,680

of thing

1164

00:39:27,589 --> 00:39:24,960

as i look at it you know i've always

1165

00:39:28,950 --> 00:39:27,599

called myself a cosmetic chemist

1166

00:39:32,550 --> 00:39:28,960

and

1167

00:39:35,109 --> 00:39:32,560

something about the chemistry of the

1168

00:39:36,870 --> 00:39:35,119

cosmos and and so astrochemistry is

1169

00:39:38,390 --> 00:39:36,880

about you know similar i would say in

1170

00:39:39,750 --> 00:39:38,400

the sense that it's also getting to the

1171

00:39:40,950 --> 00:39:39,760

chemistry of

1172

00:39:43,829 --> 00:39:40,960

of

1173

00:39:47,510 --> 00:39:43,839

this universe and stars and and and all

1174

00:39:49,750 --> 00:39:47,520

of that so um yeah i think it's it's

1175

00:39:52,950 --> 00:39:49,760

it's a fine line there and i i wouldn't

1176

00:39:55,750 --> 00:39:52,960

put too fine a point on it

1177

00:39:58,630 --> 00:39:55,760

awesome uh nikki the science teacher at

1178

00:40:00,390 --> 00:39:58,640

teach astrobio wants to know what is the

1179

00:40:02,710 --> 00:40:00,400

mechanism that concentrates meteorites

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00:40:05,430 --> 00:40:02,720

in antarctica

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00:40:08,309 --> 00:40:05,440

that's a great question actually um

1182

00:40:10,390 --> 00:40:08,319

it's it's a fascinating process that we

1183

00:40:12,790 --> 00:40:10,400

actually don't understand

1184

00:40:14,870 --> 00:40:12,800

super well i think we understand

1185

00:40:16,790 --> 00:40:14,880

kind of broadly what happens so as we

1186

00:40:18,790 --> 00:40:16,800

understand it there's almost like a

1187

00:40:20,870 --> 00:40:18,800

conveyor belt like mechanism that

1188

00:40:22,710 --> 00:40:20,880

happens in antarctica and we actually

1189

00:40:24,470 --> 00:40:22,720

mean it should happen operate in similar

1190

00:40:25,990 --> 00:40:24,480

ways in other places on earth like

1191

00:40:27,670 --> 00:40:26,000

greenland but we haven't actually seen

1192

00:40:29,030 --> 00:40:27,680

meteorites there or found meteorites

1193

00:40:30,950 --> 00:40:29,040

there in the same kind of abundance or

1194

00:40:32,790 --> 00:40:30,960

concentrations in antarctica but what

1195

00:40:34,309 --> 00:40:32,800

happens we think in antarctica is you

1196

00:40:35,510 --> 00:40:34,319

know you've got these big ice sheets

1197

00:40:37,510 --> 00:40:35,520

that are

1198

00:40:40,390 --> 00:40:37,520

miles thick in some places and they're

1199

00:40:42,870 --> 00:40:40,400

actually moving along you know basically

1200

00:40:44,390 --> 00:40:42,880

from the from the uh center of the

1201

00:40:46,550 --> 00:40:44,400

continent out towards the coastlines

1202

00:40:48,950 --> 00:40:46,560

they're flowing gradually these these

1203

00:40:51,109 --> 00:40:48,960

ice sheets and when they come up against

1204

00:40:53,670 --> 00:40:51,119

some kind of mountain range or some even

1205

00:40:55,109 --> 00:40:53,680

sometimes subsurface obstruction the ice

1206

00:40:57,030 --> 00:40:55,119

tends to move up

1207

00:40:58,390 --> 00:40:57,040

and it's also actually at the surface

1208

00:40:59,670 --> 00:40:58,400

it's sublimating because you've got

1209

00:41:01,270 --> 00:40:59,680

these catabolic winds these

1210

00:41:02,790 --> 00:41:01,280

gravitationally driven

1211

00:41:04,470 --> 00:41:02,800

really you know and i've experienced

1212

00:41:06,870 --> 00:41:04,480

those winds by the way they're not

1213

00:41:08,870 --> 00:41:06,880

they're not fun um they have like the

1214

00:41:11,349 --> 00:41:08,880

surface of the ice and so when

1215

00:41:13,270 --> 00:41:11,359

meteorites fall over time

1216

00:41:14,790 --> 00:41:13,280

they get carried along with these ice

1217

00:41:17,109 --> 00:41:14,800

sheets until they come up against you

1218

00:41:18,710 --> 00:41:17,119

know basically this these areas where

1219

00:41:22,230 --> 00:41:18,720

the ice is being

1220

00:41:23,030 --> 00:41:22,240

ablated and it's being assumed basically

1221

00:41:29,190 --> 00:41:23,040

and

1222

00:41:31,670 --> 00:41:29,200

concentrate on some of these uh areas

1223

00:41:33,589 --> 00:41:31,680

that are called stranding surfaces

1224

00:41:36,069 --> 00:41:33,599

and so they're typically blue ice fields

1225

00:41:38,550 --> 00:41:36,079

because of the nature of you know the

1226

00:41:39,510 --> 00:41:38,560

way that the ice is moving and it's very

1227

00:41:42,069 --> 00:41:39,520

kind of

1228

00:41:43,190 --> 00:41:42,079

um you know being ablated away in these

1229

00:41:44,150 --> 00:41:43,200

zones

1230

00:41:47,270 --> 00:41:44,160

so

1231

00:41:49,910 --> 00:41:47,280

uh basically that's that's the mechanism

1232

00:41:52,150 --> 00:41:49,920

um and you know i when when when i

1233

00:41:54,309 --> 00:41:52,160

actually saw it without my own eyes you

1234

00:41:55,750 --> 00:41:54,319

know standing in a place where i could

1235

00:41:57,829 --> 00:41:55,760

actually see number of different

1236

00:41:59,430 --> 00:41:57,839

meteorites within a small area i mean

1237

00:42:01,190 --> 00:41:59,440

it's just how incredible is that you

1238

00:42:02,550 --> 00:42:01,200

know and they're not related they're not

1239

00:42:03,829 --> 00:42:02,560

part of the same strewn field or

1240

00:42:06,230 --> 00:42:03,839

anything like that they're all different

1241

00:42:07,670 --> 00:42:06,240

meteorites that have sort of accumulated

1242

00:42:09,510 --> 00:42:07,680

there over time over hundreds of

1243

00:42:11,670 --> 00:42:09,520

thousands of years you know

1244

00:42:13,750 --> 00:42:11,680

and uh it's incredible i think it's such

1245

00:42:15,910 --> 00:42:13,760

a gift to be able to go and collect

1246

00:42:17,430 --> 00:42:15,920

these meteorites every year and find new

1247

00:42:19,270 --> 00:42:17,440

samples every year and they've

1248

00:42:21,109 --> 00:42:19,280

contributed so much to our understanding

1249

00:42:22,870 --> 00:42:21,119

of the solar system and

1250

00:42:24,230 --> 00:42:22,880

the universe actually

1251

00:42:25,670 --> 00:42:24,240

absolutely and part of that

1252

00:42:28,470 --> 00:42:25,680

understanding feeds into our next

1253

00:42:30,870 --> 00:42:28,480

question then it's a pretty big question

1254

00:42:34,069 --> 00:42:30,880

from rendering reality 3d animations uh

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00:42:35,510 --> 00:42:34,079

led by tom caruso on youtube tom wants

1256

00:42:38,069 --> 00:42:35,520

to know if we can if you can explain the

1257

00:42:39,670 --> 00:42:38,079

differences of water distribution

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00:42:41,349 --> 00:42:39,680

early in the formation of the solar

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00:42:42,829 --> 00:42:41,359

system and how those differences impact

1260

00:42:46,230 --> 00:42:42,839

what we see

1261

00:42:48,790 --> 00:42:46,240

now yeah that is a really big question

1262

00:42:50,390 --> 00:42:48,800

so you know

1263

00:42:52,150 --> 00:42:50,400

water of course i mean we're interested

1264

00:42:53,829 --> 00:42:52,160

in because of the habitability aspect of

1265

00:42:55,990 --> 00:42:53,839

that right but i mean

1266

00:42:57,750 --> 00:42:56,000

it's sort of one of those molecules that

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00:42:58,870 --> 00:42:57,760

also just like any other kind of

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00:43:00,309 --> 00:42:58,880

chemical

1269

00:43:01,430 --> 00:43:00,319

um

1270

00:43:03,670 --> 00:43:01,440

uh

1271

00:43:07,190 --> 00:43:03,680

sort of molecules that are condensing

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00:43:09,829 --> 00:43:07,200

from a cloud of gas and dust you know

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00:43:12,470 --> 00:43:09,839

it's going to behave in a way that is

1274

00:43:14,230 --> 00:43:12,480

geochemically you know makes sense um in

1275

00:43:16,470 --> 00:43:14,240

terms of its kind of geochemical

1276

00:43:17,430 --> 00:43:16,480

behavior it's volatility

1277

00:43:19,910 --> 00:43:17,440

um

1278

00:43:21,589 --> 00:43:19,920

and so a condensation temperature all of

1279

00:43:24,309 --> 00:43:21,599

that sort of factors into sort of the

1280

00:43:25,910 --> 00:43:24,319

initial distribution of water and things

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00:43:27,510 --> 00:43:25,920

that were condensing from that cloud of

1282

00:43:29,829 --> 00:43:27,520

gas and dust which which is where we

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00:43:32,309 --> 00:43:29,839

started out as you know our solar system

1284

00:43:33,910 --> 00:43:32,319

started out as a parcel of gas and dust

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00:43:35,030 --> 00:43:33,920

that collapsed and then in the center

1286

00:43:35,990 --> 00:43:35,040

was the sun

1287

00:43:37,430 --> 00:43:36,000

and

1288

00:43:40,150 --> 00:43:37,440

you know you had an evolution of

1289

00:43:41,750 --> 00:43:40,160

temperature and density

1290

00:43:43,589 --> 00:43:41,760

in the early history of the solar system

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00:43:44,870 --> 00:43:43,599

and so there was actually what we call a

1292

00:43:47,589 --> 00:43:44,880

snow line

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00:43:49,910 --> 00:43:47,599

which is the parts of the solar system

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00:43:52,230 --> 00:43:49,920

that and it's not sort of a

1295

00:43:53,349 --> 00:43:52,240

sort of a hard and fast line right

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00:43:56,150 --> 00:43:53,359

because

1297

00:43:57,910 --> 00:43:56,160

it's actually evolving with time as the

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00:44:00,630 --> 00:43:57,920

solar system is forming

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00:44:02,069 --> 00:44:00,640

uh where that line is but that's the the

1300

00:44:05,670 --> 00:44:02,079

the place where

1301

00:44:07,510 --> 00:44:05,680

liquid water is stable um actually it's

1302

00:44:11,589 --> 00:44:07,520

it's not played it's basically the place

1303

00:44:13,430 --> 00:44:11,599

where uh ice condenses from uh from the

1304

00:44:15,270 --> 00:44:13,440

cloud of gas and dust and so that's that

1305

00:44:17,270 --> 00:44:15,280

will be the snow line and so and that

1306

00:44:19,349 --> 00:44:17,280

evolves with time as the sun's sun is

1307

00:44:20,550 --> 00:44:19,359

forming and um

1308

00:44:22,309 --> 00:44:20,560

and so

1309

00:44:24,150 --> 00:44:22,319

what we think is that you know the inner

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00:44:26,309 --> 00:44:24,160

parts of our solar system

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00:44:29,109 --> 00:44:26,319

were typically hotter at the very

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00:44:30,790 --> 00:44:29,119

beginning and there was you know love

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00:44:32,309 --> 00:44:30,800

the volatiles were

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00:44:34,309 --> 00:44:32,319

like water were

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00:44:35,829 --> 00:44:34,319

much more depleted in the inner parts

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00:44:37,670 --> 00:44:35,839

and then the outer parts of the solar

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00:44:40,230 --> 00:44:37,680

system which were cooler

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00:44:42,470 --> 00:44:40,240

and but there was a lot else going on

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00:44:45,109 --> 00:44:42,480

this early solar system there's all of

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00:44:47,270 --> 00:44:45,119

these dynamics of things that you know

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00:44:49,510 --> 00:44:47,280

uh transported materials from the inner

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00:44:52,309 --> 00:44:49,520

to the outer solar system in jets

1323

00:44:54,790 --> 00:44:52,319

perhaps or just through you know

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00:44:56,790 --> 00:44:54,800

turbulence in the disk

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00:44:58,550 --> 00:44:56,800

uh and all these factors actually kind

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00:45:01,349 --> 00:44:58,560

of affect how these things get

1327

00:45:03,430 --> 00:45:01,359

distributed and it's rather complicated

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00:45:05,510 --> 00:45:03,440

but the bottom line is you know we found

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00:45:07,030 --> 00:45:05,520

for example from the stardust samples

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00:45:08,309 --> 00:45:07,040

you know the comet materials that were

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00:45:09,109 --> 00:45:08,319

returned

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00:45:11,109 --> 00:45:09,119

that

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00:45:12,710 --> 00:45:11,119

there is actually what we'd expected to

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00:45:15,270 --> 00:45:12,720

find there was that maybe it was just an

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00:45:16,710 --> 00:45:15,280

agglomeration of very sort of primitive

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00:45:19,270 --> 00:45:16,720

materials but what we found is that

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00:45:21,270 --> 00:45:19,280

there's actually stuff in the stardust

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00:45:23,270 --> 00:45:21,280

samples that came from the inner parts

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00:45:25,270 --> 00:45:23,280

of the solar system meaning that there

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00:45:26,470 --> 00:45:25,280

was this huge large scale transport of

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00:45:27,750 --> 00:45:26,480

materials

1342

00:45:30,069 --> 00:45:27,760

and so

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00:45:32,470 --> 00:45:30,079

the distribution of water you know in

1344

00:45:34,150 --> 00:45:32,480

the solar system was

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00:45:36,470 --> 00:45:34,160

you know generally speaking i would say

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00:45:38,230 --> 00:45:36,480

that there was like there's likely more

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00:45:40,069 --> 00:45:38,240

water in the outer

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00:45:42,630 --> 00:45:40,079

portions of the solar system as it was

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00:45:44,150 --> 00:45:42,640

forming where ice condensed but then

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00:45:46,710 --> 00:45:44,160

things were kind of

1351
00:45:49,589 --> 00:45:46,720
mixed around and you know water

1352
00:45:51,910 --> 00:45:49,599
evaporated there was you know lots going

1353
00:45:53,910 --> 00:45:51,920
on at the time you know rocky worlds

1354
00:45:56,150 --> 00:45:53,920
were forming you had comets crashing

1355
00:45:58,390 --> 00:45:56,160
into them maybe bringing in more water

1356
00:46:00,230 --> 00:45:58,400
from the outer parts to the inner parts

1357
00:46:02,870 --> 00:46:00,240
so it's a complex dance really that we

1358
00:46:04,230 --> 00:46:02,880
have to try to understand

1359
00:46:05,990 --> 00:46:04,240
and that's part of the fun of really

1360
00:46:07,270 --> 00:46:06,000
doing that you know studying these

1361
00:46:08,710 --> 00:46:07,280
objects

1362
00:46:10,870 --> 00:46:08,720
absolutely there's still so much to

1363
00:46:12,309 --> 00:46:10,880

learn and so much to piece together

1364

00:46:14,470 --> 00:46:12,319

about the processes that have occurred

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00:46:16,550 --> 00:46:14,480

through our solar system through time

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00:46:17,910 --> 00:46:16,560

um we're gonna shift gears really hard

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00:46:18,950 --> 00:46:17,920

right now i might i might start

1368

00:46:21,109 --> 00:46:18,960

answering this question i'll see if

1369

00:46:23,589 --> 00:46:21,119

you'd like to answer it as well uh david

1370

00:46:24,950 --> 00:46:23,599

r bunting at d.a bunting

1371

00:46:27,190 --> 00:46:24,960

has asked if it's probable that the

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00:46:29,109 --> 00:46:27,200

first extraterrestrial life we encounter

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00:46:30,790 --> 00:46:29,119

will be non-biological rather than

1374

00:46:32,870 --> 00:46:30,800

biological

1375

00:46:34,390 --> 00:46:32,880

i'll start by answering that one so you

1376

00:46:36,550 --> 00:46:34,400

might have seen a previous episode of

1377

00:46:39,589 --> 00:46:36,560

the show david where i had dr susan

1378

00:46:42,309 --> 00:46:39,599

schneider on the show dr schneider is an

1379

00:46:43,910 --> 00:46:42,319

expert in the future of the human mind

1380

00:46:46,550 --> 00:46:43,920

and artificial intelligence and we

1381

00:46:48,630 --> 00:46:46,560

talked a lot about post biological life

1382

00:46:50,950 --> 00:46:48,640

so not necessarily non-biological we use

1383

00:46:53,750 --> 00:46:50,960

the word post biological such that we

1384

00:46:55,990 --> 00:46:53,760

have an evolution from chemistry through

1385

00:46:58,150 --> 00:46:56,000

biology as we know it organic

1386

00:47:00,150 --> 00:46:58,160

chemistry becoming life but then we have

1387

00:47:02,550 --> 00:47:00,160

this transition phase into post

1388

00:47:03,990 --> 00:47:02,560

biological life artificial intelligence

1389

00:47:05,589 --> 00:47:04,000

this idea of humans merging with

1390

00:47:07,829 --> 00:47:05,599

machines and those kinds of things we

1391

00:47:09,030 --> 00:47:07,839

don't know what our own future holds but

1392

00:47:11,910 --> 00:47:09,040

when it comes to whether or not that's

1393

00:47:13,430 --> 00:47:11,920

probable the truth is we don't know we

1394

00:47:15,990 --> 00:47:13,440

don't know yet even if there's other

1395

00:47:17,750 --> 00:47:16,000

life out there at all we could be alone

1396

00:47:19,190 --> 00:47:17,760

it's kind of sad to say that but it's

1397

00:47:21,910 --> 00:47:19,200

it's possible based on our current

1398

00:47:22,950 --> 00:47:21,920

knowledge it does feel though that we

1399

00:47:25,030 --> 00:47:22,960

start looking out there into the

1400

00:47:27,109 --> 00:47:25,040

universe we see all these other worlds

1401

00:47:28,710 --> 00:47:27,119

we think of all the potential it starts

1402

00:47:30,710 --> 00:47:28,720

to feel like there must be something

1403

00:47:32,790 --> 00:47:30,720

else and if there is something else that

1404

00:47:35,349 --> 00:47:32,800

makes a lot of us wonder are post

1405

00:47:37,270 --> 00:47:35,359

biological civilizations likely and it's

1406

00:47:38,790 --> 00:47:37,280

a very big question many i don't know if

1407

00:47:40,390 --> 00:47:38,800

you want to add on to that or not that's

1408

00:47:42,309 --> 00:47:40,400

entirely up to you

1409

00:47:43,589 --> 00:47:42,319

no i think you said it very well i don't

1410

00:47:44,870 --> 00:47:43,599

think i have anything more to add to

1411

00:47:46,870 --> 00:47:44,880

that

1412

00:47:48,950 --> 00:47:46,880

all right thank you uh yeah so our next

1413

00:47:51,430 --> 00:47:48,960

question uh from ruchira powell on

1414

00:47:52,870 --> 00:47:51,440

youtube rachira wants to know um first

1415

00:47:54,069 --> 00:47:52,880

they say it's really inspiring to hear

1416

00:47:57,270 --> 00:47:54,079

from you today

1417

00:47:59,190 --> 00:47:57,280

um great richard wants to know uh

1418

00:48:00,710 --> 00:47:59,200

would love to learn if there's been any

1419

00:48:03,190 --> 00:48:00,720

instance that has been particularly

1420

00:48:06,870 --> 00:48:03,200

challenging for you yet exciting with

1421

00:48:08,390 --> 00:48:06,880

respect to your studies

1422

00:48:11,589 --> 00:48:08,400

yeah i mean you know that's part of what

1423

00:48:13,670 --> 00:48:11,599

i really enjoy about what i do is that

1424

00:48:16,230 --> 00:48:13,680

there are lots of challenges there's

1425

00:48:17,510 --> 00:48:16,240

analytical challenges there's you know

1426

00:48:19,589 --> 00:48:17,520

in terms of

1427

00:48:21,750 --> 00:48:19,599

you know every once in a while there's

1428

00:48:23,349 --> 00:48:21,760

you know some really hard hard problems

1429

00:48:24,150 --> 00:48:23,359

to try to solve

1430

00:48:26,390 --> 00:48:24,160

uh

1431

00:48:28,630 --> 00:48:26,400

with with grappling with the kinds of

1432

00:48:31,430 --> 00:48:28,640

questions you know so some of them

1433

00:48:33,510 --> 00:48:31,440

i think the the the most fun

1434

00:48:35,030 --> 00:48:33,520

things are ones that you sort of really

1435

00:48:37,670 --> 00:48:35,040

have to work towards

1436

00:48:39,349 --> 00:48:37,680

to get get to and so

1437

00:48:41,190 --> 00:48:39,359

i don't know if there's any particular

1438

00:48:42,630 --> 00:48:41,200

specific things she had in mind about

1439

00:48:44,390 --> 00:48:42,640

what kind of challenges but yeah i mean

1440

00:48:46,069 --> 00:48:44,400

i think

1441

00:48:47,670 --> 00:48:46,079

the reason why i love what i do is

1442

00:48:50,150 --> 00:48:47,680

because there's challenge involved it's

1443

00:48:52,870 --> 00:48:50,160

not an easy easy thing to just get from

1444

00:48:54,710 --> 00:48:52,880

one day to the next i think you know

1445

00:48:56,470 --> 00:48:54,720

we get to analyze these materials that

1446

00:48:58,309 --> 00:48:56,480

are really you know we have to make the

1447

00:48:59,990 --> 00:48:58,319

most out of small amounts and there's

1448

00:49:01,829 --> 00:49:00,000

limited amounts and so we have to be

1449

00:49:03,430 --> 00:49:01,839

very very careful about how we utilize

1450

00:49:04,950 --> 00:49:03,440

those samples and

1451
00:49:06,630 --> 00:49:04,960
and uh

1452
00:49:08,790 --> 00:49:06,640
and that's part of really what draws me

1453
00:49:10,950 --> 00:49:08,800
to to what i do is

1454
00:49:11,910 --> 00:49:10,960
is the challenge

1455
00:49:13,670 --> 00:49:11,920
awesome

1456
00:49:16,069 --> 00:49:13,680
um our next question is actually a

1457
00:49:18,470 --> 00:49:16,079
merged question from two of our our

1458
00:49:20,549 --> 00:49:18,480
current viewers uh marina ripan and

1459
00:49:22,390 --> 00:49:20,559
sonakshi srivastava

1460
00:49:23,910 --> 00:49:22,400
asked rather similar questions and so

1461
00:49:25,829 --> 00:49:23,920
i'm going to ask both together and let

1462
00:49:27,750 --> 00:49:25,839
you choose how to answer

1463
00:49:31,349 --> 00:49:27,760

first off is how do we actually know

1464

00:49:33,190 --> 00:49:31,359

that mars meteorites came from mars um

1465

00:49:34,630 --> 00:49:33,200

and then following on from that is what

1466

00:49:36,390 --> 00:49:34,640

are the geological and chemical

1467

00:49:38,230 --> 00:49:36,400

differences between rocks from earth and

1468

00:49:40,069 --> 00:49:38,240

mars

1469

00:49:43,430 --> 00:49:40,079

that's those are great questions by the

1470

00:49:45,750 --> 00:49:43,440

way um so it's kind of a fun detective

1471

00:49:47,829 --> 00:49:45,760

story really you know how we know these

1472

00:49:48,790 --> 00:49:47,839

meteorites came from mars

1473

00:49:50,470 --> 00:49:48,800

um

1474

00:49:53,190 --> 00:49:50,480

we actually

1475

00:49:55,750 --> 00:49:53,200

and it took actually the viking lander

1476
00:49:57,510 --> 00:49:55,760
to be there before these rocks were

1477
00:50:00,030 --> 00:49:57,520
actually

1478
00:50:01,990 --> 00:50:00,040
definitively or most of sort of as as

1479
00:50:03,430 --> 00:50:02,000
definitively as we can tell without

1480
00:50:05,030 --> 00:50:03,440
actually having sample returns back

1481
00:50:07,270 --> 00:50:05,040
right um

1482
00:50:09,430 --> 00:50:07,280
the viking landers was with these

1483
00:50:11,589 --> 00:50:09,440
landers that uh a couple of them that

1484
00:50:12,950 --> 00:50:11,599
landed on mars in the 1970s and they

1485
00:50:14,790 --> 00:50:12,960
measured the

1486
00:50:16,790 --> 00:50:14,800
atmosphere of

1487
00:50:19,270 --> 00:50:16,800
mars very well so we know what the

1488
00:50:21,109 --> 00:50:19,280

composition is in terms of how much

1489

00:50:22,390 --> 00:50:21,119

nitrogen carbon dioxide some of the

1490

00:50:23,750 --> 00:50:22,400

noble gases

1491

00:50:26,470 --> 00:50:23,760

and so

1492

00:50:28,309 --> 00:50:26,480

for a long time there was actually

1493

00:50:30,309 --> 00:50:28,319

some suggestions by some some of the

1494

00:50:32,870 --> 00:50:30,319

people that were studying these rocks

1495

00:50:35,589 --> 00:50:32,880

these martian meteorites as we call them

1496

00:50:37,030 --> 00:50:35,599

um and they found some unusual things in

1497

00:50:39,270 --> 00:50:37,040

them you know they found some minerals

1498

00:50:40,630 --> 00:50:39,280

that had some water which you know a lot

1499

00:50:42,790 --> 00:50:40,640

of the other types of meteorites that we

1500

00:50:44,870 --> 00:50:42,800

were studying were incredibly dry

1501
00:50:46,390 --> 00:50:44,880
and then they also found that the ages

1502
00:50:48,549 --> 00:50:46,400
of some of these meteorites were

1503
00:50:50,549 --> 00:50:48,559
actually a lot younger than many of the

1504
00:50:51,990 --> 00:50:50,559
other types of asteroidal meteorites

1505
00:50:53,430 --> 00:50:52,000
that we were studying which are closer

1506
00:50:54,870 --> 00:50:53,440
to the age of the solar system four and

1507
00:50:56,950 --> 00:50:54,880
a half billion years but these mars

1508
00:50:58,030 --> 00:50:56,960
meteorites some of them were as young as

1509
00:51:00,870 --> 00:50:58,040
something like

1510
00:51:02,870 --> 00:51:00,880
160 million years you know that's when

1511
00:51:05,349 --> 00:51:02,880
the earth had dinosaurs walking around

1512
00:51:08,069 --> 00:51:05,359
the surface geologically speaking that's

1513
00:51:09,589 --> 00:51:08,079

young right and so unusual features like

1514

00:51:11,670 --> 00:51:09,599

that and people are wondering you know

1515

00:51:12,790 --> 00:51:11,680

how come these rocks are so unusual

1516

00:51:15,030 --> 00:51:12,800

compared to uh some of the other

1517

00:51:17,589 --> 00:51:15,040

meteorites and some some of the brave

1518

00:51:19,270 --> 00:51:17,599

geologists among them actually uh

1519

00:51:20,790 --> 00:51:19,280

somebody known as ha you know his name

1520

00:51:23,270 --> 00:51:20,800

is half mcsween

1521

00:51:24,790 --> 00:51:23,280

and he he and ed stopper

1522

00:51:26,790 --> 00:51:24,800

at harvard they were graduate students

1523

00:51:28,150 --> 00:51:26,800

at the time they suggested this was in

1524

00:51:29,510 --> 00:51:28,160

the late 70s

1525

00:51:31,829 --> 00:51:29,520

that these things may have come from

1526
00:51:33,349 --> 00:51:31,839
mars but we had no definitive evidence

1527
00:51:35,190 --> 00:51:33,359
they really stuck their necks out by the

1528
00:51:37,510 --> 00:51:35,200
way to do that

1529
00:51:38,870 --> 00:51:37,520
um but what happened was that in the

1530
00:51:39,750 --> 00:51:38,880
early 80s

1531
00:51:40,790 --> 00:51:39,760
um

1532
00:51:42,710 --> 00:51:40,800
some of the

1533
00:51:44,470 --> 00:51:42,720
labs actually studied pieces of these

1534
00:51:46,150 --> 00:51:44,480
mars meteorites actually one particular

1535
00:51:47,430 --> 00:51:46,160
meteorite that was found in antarctica

1536
00:51:49,670 --> 00:51:47,440
by the way

1537
00:51:55,109 --> 00:51:49,680
and

1538
00:51:56,950 --> 00:51:55,119

the composition of the gas

1539

00:51:58,870 --> 00:51:56,960

and that gas matched very well the

1540

00:52:00,230 --> 00:51:58,880

composition that we knew of the mars

1541

00:52:02,069 --> 00:52:00,240

atmosphere

1542

00:52:03,589 --> 00:52:02,079

and it's almost like a fingerprint i

1543

00:52:05,349 --> 00:52:03,599

mean that composition is very different

1544

00:52:07,910 --> 00:52:05,359

actually than anything that we know

1545

00:52:10,069 --> 00:52:07,920

about um but it's very

1546

00:52:11,829 --> 00:52:10,079

similar to the mars atmosphere and

1547

00:52:13,190 --> 00:52:11,839

that's that was like a smoking gun

1548

00:52:15,349 --> 00:52:13,200

basically that told us that these

1549

00:52:19,109 --> 00:52:15,359

meteorites actually came from mars

1550

00:52:21,829 --> 00:52:19,119

um and uh so so that's how we know

1551

00:52:24,309 --> 00:52:21,839

um and you know as i said there's about

1552

00:52:25,990 --> 00:52:24,319

130 or so meteorites that we think that

1553

00:52:27,589 --> 00:52:26,000

you know are from mars we haven't done

1554

00:52:29,829 --> 00:52:27,599

this kind of

1555

00:52:31,910 --> 00:52:29,839

gas analysis for all of them but there

1556

00:52:34,390 --> 00:52:31,920

are other geochemical

1557

00:52:36,230 --> 00:52:34,400

signatures that we can match for all of

1558

00:52:39,109 --> 00:52:36,240

them all of them that basically tell us

1559

00:52:41,109 --> 00:52:39,119

that they came from the same place

1560

00:52:42,710 --> 00:52:41,119

and so that's why we think these are

1561

00:52:45,510 --> 00:52:42,720

from mars and i think you know obviously

1562

00:52:47,829 --> 00:52:45,520

when we bring back mars samples from the

1563

00:52:50,309 --> 00:52:47,839

sample return we'll be able to

1564

00:52:52,390 --> 00:52:50,319

definitively confirm that uh when we

1565

00:52:54,549 --> 00:52:52,400

look compared to geochemistry more uh

1566

00:52:56,309 --> 00:52:54,559

more so but that's that's basically the

1567

00:52:58,710 --> 00:52:56,319

essence of why we you know why we think

1568

00:53:01,109 --> 00:52:58,720

these meteorites came from mars

1569

00:53:02,630 --> 00:53:01,119

awesome uh yeah and i i've always had

1570

00:53:04,549 --> 00:53:02,640

the question do we have venusian

1571

00:53:06,309 --> 00:53:04,559

meteorites but we just don't have the

1572

00:53:07,589 --> 00:53:06,319

past knowledge of venus to know what do

1573

00:53:09,030 --> 00:53:07,599

you think of that

1574

00:53:11,190 --> 00:53:09,040

you know that's that's a great question

1575

00:53:13,990 --> 00:53:11,200

i think you know it's much tougher to

1576

00:53:16,309 --> 00:53:14,000

get things off of the surface of venus

1577

00:53:19,750 --> 00:53:16,319

uh it's a much bigger planet than mars

1578

00:53:21,349 --> 00:53:19,760

and so gravity well is much much more to

1579

00:53:24,230 --> 00:53:21,359

you know to overcome to get pieces of

1580

00:53:26,150 --> 00:53:24,240

meteorites the probability is not zero

1581

00:53:27,829 --> 00:53:26,160

but it's much much smaller than getting

1582

00:53:29,910 --> 00:53:27,839

mars meteorites in and of course you

1583

00:53:31,670 --> 00:53:29,920

know you have to also fight the gravity

1584

00:53:34,069 --> 00:53:31,680

well for the sun you know to bring

1585

00:53:36,069 --> 00:53:34,079

disciples from venus out from venus to

1586

00:53:39,270 --> 00:53:36,079

towards the earth rather than from mars

1587

00:53:40,790 --> 00:53:39,280

falling back in towards the uh towards

1588

00:53:43,589 --> 00:53:40,800

the sun i guess i mean so you actually

1589

00:53:45,270 --> 00:53:43,599

have a number of factors and also you

1590

00:53:47,190 --> 00:53:45,280

know venus has a much

1591

00:53:48,230 --> 00:53:47,200

thicker atmosphere than mars does as

1592

00:53:50,230 --> 00:53:48,240

well so

1593

00:53:52,870 --> 00:53:50,240

just the probability of having venus

1594

00:53:54,230 --> 00:53:52,880

samples is very much lower and same same

1595

00:53:55,910 --> 00:53:54,240

thing actually for mercury there's

1596

00:53:57,990 --> 00:53:55,920

actually been suggestions that maybe we

1597

00:53:59,190 --> 00:53:58,000

have mercury and meteorites it's

1598

00:54:01,589 --> 00:53:59,200

possible

1599

00:54:03,910 --> 00:54:01,599

but i think just getting uh getting

1600

00:54:06,309 --> 00:54:03,920

samples from you know so close into the

1601
00:54:07,990 --> 00:54:06,319
sun's gravity well out to where you know

1602
00:54:10,309 --> 00:54:08,000
where the earth is is a lot less

1603
00:54:12,230 --> 00:54:10,319
probable than getting more samples into

1604
00:54:14,069 --> 00:54:12,240
earth so

1605
00:54:15,829 --> 00:54:14,079
absolutely i think we have time for

1606
00:54:18,150 --> 00:54:15,839
maybe one or two more questions let's

1607
00:54:20,069 --> 00:54:18,160
see uh so first we have a question from

1608
00:54:21,750 --> 00:54:20,079
sunakshi srivastava

1609
00:54:24,710 --> 00:54:21,760
who wants to know what you were studying

1610
00:54:26,790 --> 00:54:24,720
as an undergraduate in punjab university

1611
00:54:28,549 --> 00:54:26,800
uh and then how that got you into

1612
00:54:31,190 --> 00:54:28,559
planetary science and being connected to

1613
00:54:33,670 --> 00:54:31,200

this realm of astrobiology

1614

00:54:36,549 --> 00:54:33,680

yeah so you know i

1615

00:54:38,630 --> 00:54:36,559

i i would say i'm a classically trained

1616

00:54:40,870 --> 00:54:38,640

geologist but you know i had my training

1617

00:54:42,789 --> 00:54:40,880

in india whether but the system of

1618

00:54:43,589 --> 00:54:42,799

education is a little bit different it's

1619

00:54:45,349 --> 00:54:43,599

um

1620

00:54:47,349 --> 00:54:45,359

so i you know i had

1621

00:54:49,589 --> 00:54:47,359

major i majored in geology and had

1622

00:54:50,950 --> 00:54:49,599

minors in physics and chemistry

1623

00:54:52,549 --> 00:54:50,960

um and

1624

00:54:54,870 --> 00:54:52,559

those were sort of the areas that i

1625

00:54:57,030 --> 00:54:54,880

really focused in on i you know studied

1626
00:54:59,270 --> 00:54:57,040
a lot sedimentology paleontology

1627
00:55:01,030 --> 00:54:59,280
structural geology we had lots of field

1628
00:55:03,190 --> 00:55:01,040
work that we did in all different parts

1629
00:55:05,109 --> 00:55:03,200
of the country you know all the way from

1630
00:55:07,270 --> 00:55:05,119
the himalayas down to

1631
00:55:08,150 --> 00:55:07,280
south india places in south india and

1632
00:55:10,789 --> 00:55:08,160
and

1633
00:55:13,670 --> 00:55:10,799
um so it was a very sort of classical

1634
00:55:16,150 --> 00:55:13,680
geology training i would say but with a

1635
00:55:17,109 --> 00:55:16,160
lot of physics and chemistry mixed in

1636
00:55:19,349 --> 00:55:17,119
and

1637
00:55:21,589 --> 00:55:19,359
what i found actually i was offered a

1638
00:55:24,150 --> 00:55:21,599

job at the oil and natural gas

1639

00:55:25,109 --> 00:55:24,160

commission in india after i finished my

1640

00:55:26,309 --> 00:55:25,119

degree

1641

00:55:27,750 --> 00:55:26,319

and

1642

00:55:29,510 --> 00:55:27,760

the other option when i was thinking

1643

00:55:32,150 --> 00:55:29,520

about you know graduate school and just

1644

00:55:35,109 --> 00:55:32,160

that dream of wanting to be

1645

00:55:37,109 --> 00:55:35,119

really you know geologist but geologist

1646

00:55:39,190 --> 00:55:37,119

who studies rocks from other places in

1647

00:55:41,829 --> 00:55:39,200

the solar system geologists on the on

1648

00:55:43,829 --> 00:55:41,839

mars in a sense that's that's the dream

1649

00:55:45,990 --> 00:55:43,839

that actually brought me to

1650

00:55:49,270 --> 00:55:46,000

to graduate school in the us right and

1651
00:55:50,710 --> 00:55:49,280
so i i kind of wanted to apply the tools

1652
00:55:52,549 --> 00:55:50,720
and skills that i learned as part of

1653
00:55:55,109 --> 00:55:52,559
that geology training to other places of

1654
00:55:56,950 --> 00:55:55,119
the solar system and uh

1655
00:55:58,309 --> 00:55:56,960
that's how i got going in planetary

1656
00:55:59,829 --> 00:55:58,319
science

1657
00:56:01,510 --> 00:55:59,839
that's awesome well i'm so glad you got

1658
00:56:02,950 --> 00:56:01,520
going in planetary science and that

1659
00:56:05,270 --> 00:56:02,960
we've had this opportunity to connect

1660
00:56:07,349 --> 00:56:05,280
today uh to chat to hear about your

1661
00:56:09,109 --> 00:56:07,359
research and your experiences to talk a

1662
00:56:10,549 --> 00:56:09,119
little bit about meteorites and rocks

1663
00:56:12,789 --> 00:56:10,559

from space which is one of my favorite

1664

00:56:14,829 --> 00:56:12,799

things um thank you so much for joining

1665

00:56:17,109 --> 00:56:14,839

us for sharing your time with our

1666

00:56:19,030 --> 00:56:17,119

audience well i'm so so pleased to have

1667

00:56:20,870 --> 00:56:19,040

been able to join here and uh loved

1668

00:56:22,309 --> 00:56:20,880

having you know the

1669

00:56:23,589 --> 00:56:22,319

opportunity to answer these great

1670

00:56:25,829 --> 00:56:23,599

questions

1671

00:56:27,270 --> 00:56:25,839

yeah and you had some awesome answers uh

1672

00:56:28,630 --> 00:56:27,280

we'll have a recorded version of this

1673

00:56:31,349 --> 00:56:28,640

episode as well that will go up online

1674

00:56:32,789 --> 00:56:31,359

so others can watch later on if you'd

1675

00:56:35,430 --> 00:56:32,799

like to learn more about the school of

1676
00:56:37,510 --> 00:56:35,440
earth and space exploration cc at

1677
00:56:40,150 --> 00:56:37,520
arizona state university and dr wadwa's

1678
00:56:41,990 --> 00:56:40,160
work you can find that online as well

1679
00:56:43,990 --> 00:56:42,000
i do want to give a plug real quick for

1680
00:56:46,710 --> 00:56:44,000
the most recent version of the

1681
00:56:48,630 --> 00:56:46,720
astrobiology graphic histories was just

1682
00:56:50,710 --> 00:56:48,640
released this summer at the astrobiology

1683
00:56:52,309 --> 00:56:50,720
science conference and i just recently

1684
00:56:55,030 --> 00:56:52,319
learned that we now have not only the

1685
00:56:57,750 --> 00:56:55,040
pdf version of this available online for

1686
00:56:59,030 --> 00:56:57,760
free but now we have an epub version as

1687
00:57:01,349 --> 00:56:59,040
well who'd let for those who'd like to

1688
00:57:03,510 --> 00:57:01,359

read the nasa astrobiology graphic

1689

00:57:04,710 --> 00:57:03,520

histories on their e-reader

1690

00:57:07,190 --> 00:57:04,720

so for those of you who want to stay in

1691

00:57:08,710 --> 00:57:07,200

the loop about nasa astrobiology and the

1692

00:57:10,069 --> 00:57:08,720

things that we're doing you can sign up

1693

00:57:12,549 --> 00:57:10,079

for the newsletter you'll get the link

1694

00:57:15,910 --> 00:57:12,559

right now uh you can also follow nasa

1695

00:57:18,870 --> 00:57:15,920

astrobiology on twitter at nasa astrobio

1696

00:57:20,630 --> 00:57:18,880

you can follow me at cosmobiologist uh

1697

00:57:22,309 --> 00:57:20,640

and as always we're so appreciative of

1698

00:57:24,549 --> 00:57:22,319

all of you joining us and for learning

1699

00:57:26,950 --> 00:57:24,559

more about astrobiology for tuning in

1700

00:57:31,180 --> 00:57:26,960

for asking your questions so as always

