
AbSciCon
2019

1
00:00:00,790 --> 00:00:07,320
[Music]

2
00:00:11,850 --> 00:00:09,110
[Applause]

3
00:00:13,320 --> 00:00:11,860
Thank You Jen and thank you all for

4
00:00:16,140 --> 00:00:13,330
sticking around when you would probably

5
00:00:17,580 --> 00:00:16,150
rather be eating lunch by now so I'm not

6
00:00:19,260 --> 00:00:17,590
gonna pretend that I'm never enough to

7
00:00:21,359 --> 00:00:19,270
know which is the best ocean world to go

8
00:00:23,490 --> 00:00:21,369
and study to find life in our heat in

9
00:00:25,170 --> 00:00:23,500
the next human generation but if you can

10
00:00:26,550 --> 00:00:25,180
pair up my age to the demographic of

11
00:00:28,830 --> 00:00:26,560
most by presenters you realize I have

12
00:00:30,359 --> 00:00:28,840
less time to spare than most of you so

13
00:00:34,500 --> 00:00:30,369

I'm really getting quite antsy about it

14
00:00:36,330 --> 00:00:34,510
and so that's really the motivation for

15
00:00:38,100 --> 00:00:36,340
what I'm gonna talk about today is a new

16
00:00:39,210 --> 00:00:38,110
five-year program that we were having

17
00:00:41,040 --> 00:00:39,220
funded through the NASA Astrobiology

18
00:00:42,689 --> 00:00:41,050
program and it's gonna be a big

19
00:00:44,099 --> 00:00:42,699
collaboration I'm introducing and all

20
00:00:45,209 --> 00:00:44,109
these really clever people down the

21
00:00:46,799 --> 00:00:45,219
bottom here are all the people have

22
00:00:48,660 --> 00:00:46,809
tricked into playing along with me and

23
00:00:51,060 --> 00:00:48,670
standing next to them I'm hoping I'm

24
00:00:53,430 --> 00:00:51,070
gonna look really good so that's

25
00:00:55,319 --> 00:00:53,440
basically what we're about and it's

26
00:00:57,209 --> 00:00:55,329
really trying to come up with trying to

27
00:00:59,310 --> 00:00:57,219
be planetary agnostic so rather than

28
00:01:00,689 --> 00:00:59,320
consider one planet at a time and work

29
00:01:02,040 --> 00:01:00,699
out how would you actually fit the data

30
00:01:04,439 --> 00:01:02,050
to make it look like a really compelling

31
00:01:05,910 --> 00:01:04,449
target would be to start the other way

32
00:01:07,440 --> 00:01:05,920
around and say okay how about we just

33
00:01:09,660 --> 00:01:07,450
start with a blank slate and just say

34
00:01:11,340 --> 00:01:09,670
taking the kinds of stuff that we know

35
00:01:12,690 --> 00:01:11,350
about let's assume you're not going to

36
00:01:15,149 --> 00:01:12,700
defy the laws of physics chemistry

37
00:01:16,679 --> 00:01:15,159
geology and and what we know about

38
00:01:19,950 --> 00:01:16,689

biology and how it could potentially

39
00:01:21,749 --> 00:01:19,960
work elsewhere are there places we could

40
00:01:22,859 --> 00:01:21,759
actually go to or how would we come up

41
00:01:24,359 --> 00:01:22,869
with some value judgments on a

42
00:01:26,429 --> 00:01:24,369
like-for-like basis that would actually

43
00:01:29,190 --> 00:01:26,439
allow us to say well which ocean worlds

44
00:01:30,359 --> 00:01:29,200
and with which measurements would

45
00:01:32,100 --> 00:01:30,369
provide us with the highest probability

46
00:01:36,990 --> 00:01:32,110
to actually come up with a successful

47
00:01:38,039 --> 00:01:37,000
approach to go in search for life and so

48
00:01:39,300 --> 00:01:38,049
to actually get beyond that first

49
00:01:40,889 --> 00:01:39,310
question I think there's two really

50
00:01:42,480 --> 00:01:40,899
important concepts come up with this is

51
00:01:44,670 --> 00:01:42,490
thinking about not just about can it

52
00:01:46,529 --> 00:01:44,680
help kind of planet host life but it

53
00:01:48,359 --> 00:01:46,539
could a NASA mission or anybody else's

54
00:01:49,740 --> 00:01:48,369
mission for that matter go out and

55
00:01:50,999 --> 00:01:49,750
actually search for that life and come

56
00:01:52,709 --> 00:01:51,009
back with the compelling evidence that

57
00:01:54,840 --> 00:01:52,719
we want so it's basically two components

58
00:01:57,120 --> 00:01:54,850
to this then there's the biological

59
00:01:59,279 --> 00:01:57,130
potential which is could Planet X

60
00:02:01,440 --> 00:01:59,289
actually host life in the first place or

61
00:02:03,209 --> 00:02:01,450
to what extent could it host that life

62
00:02:05,130 --> 00:02:03,219
because it isn't just an binary thing

63
00:02:06,330 --> 00:02:05,140

this isn't just a is it plausible is it

64
00:02:08,669 --> 00:02:06,340
credible we're trying to go beyond that

65
00:02:10,620 --> 00:02:08,679
binary thing of yeah okay maybe this one

66
00:02:11,700 --> 00:02:10,630
could have life or this one looks deaky

67
00:02:13,770 --> 00:02:11,710
I'm promising it would actually be

68
00:02:14,760 --> 00:02:13,780
what's the probability function the kind

69
00:02:16,320 --> 00:02:14,770
of stuff we were hearing about on the

70
00:02:18,750 --> 00:02:16,330
plenary this morning of the probability

71
00:02:19,929 --> 00:02:18,760
of finding life but then the second part

72
00:02:22,280 --> 00:02:19,939
is

73
00:02:23,809 --> 00:02:22,290
even then even if you've got an ocean

74
00:02:25,490 --> 00:02:23,819
world that's probably teeming with life

75
00:02:26,899 --> 00:02:25,500
if it's gonna hold it away and keep it

76
00:02:28,099 --> 00:02:26,909
secret and make it impossible for us to

77
00:02:30,110 --> 00:02:28,109
actually find it that's a whole other

78
00:02:31,699 --> 00:02:30,120
issue as well so that's the second part

79
00:02:33,740 --> 00:02:31,709
of how you'd make those value judgments

80
00:02:34,970 --> 00:02:33,750
is not just the the potential to

81
00:02:36,679 --> 00:02:34,980
actually host life but then the

82
00:02:38,360 --> 00:02:36,689
potential to reveal that evidence of

83
00:02:39,470 --> 00:02:38,370
life to the kinds of missions that we

84
00:02:44,240 --> 00:02:39,480
could imagine actually being able to

85
00:02:46,280 --> 00:02:44,250
field in the future and so the way we

86
00:02:47,839 --> 00:02:46,290
want to do that then is basically we've

87
00:02:50,929 --> 00:02:47,849
come up with a three-fold approach and

88
00:02:52,550 --> 00:02:50,939

the first part was actually going you

89
00:02:54,830 --> 00:02:52,560
know my background is more in the ocean

90
00:02:56,270 --> 00:02:54,840
sciences than in astrobiology so a first

91
00:02:58,429 --> 00:02:56,280
starting point that we could contribute

92
00:02:59,750 --> 00:02:58,439
was go and work out how do we harness as

93
00:03:01,039 --> 00:02:59,760
many of the smartest people that I've

94
00:03:03,500 --> 00:03:01,049
met over the last thirty years of my

95
00:03:04,670 --> 00:03:03,510
career in ocean sciences and make sure

96
00:03:07,849 --> 00:03:04,680
we're actually folding all that

97
00:03:09,740 --> 00:03:07,859
information into what we do next but

98
00:03:11,030 --> 00:03:09,750
then the second part is saying okay but

99
00:03:12,020 --> 00:03:11,040
a bunch of oceanographers wandering in

100
00:03:14,000 --> 00:03:12,030
and stumbling around the field of

101
00:03:15,259 --> 00:03:14,010
astrobiology uninformed could cause an

102
00:03:17,210 --> 00:03:15,269
awful lot of damage and not necessarily

103
00:03:18,710 --> 00:03:17,220
be very helpful so how do we actually

104
00:03:20,210 --> 00:03:18,720
make sure that we have these people at

105
00:03:21,740 --> 00:03:20,220
every stage of the way in lockstep with

106
00:03:23,539 --> 00:03:21,750
planetary scientists who actually can

107
00:03:25,759 --> 00:03:23,549
turn around and tell us well that can't

108
00:03:28,009 --> 00:03:25,769
possibly work on Planet X or Planet Z or

109
00:03:29,750 --> 00:03:28,019
Planet Alpha because there's these other

110
00:03:31,580 --> 00:03:29,760
things going on that we do know we don't

111
00:03:32,599 --> 00:03:31,590
know huge amounts about other planets

112
00:03:34,280 --> 00:03:32,609
compared to what we know about our own

113
00:03:36,050 --> 00:03:34,290

planet than the system and how it works

114
00:03:37,610 --> 00:03:36,060
as an integrated system but there are

115
00:03:39,110 --> 00:03:37,620
some basic things that we do know so

116
00:03:41,659 --> 00:03:39,120
there's some things we can't violate and

117
00:03:43,339 --> 00:03:41,669
so we have to have that right and then

118
00:03:45,500 --> 00:03:43,349
the third part is what we've recognized

119
00:03:48,619 --> 00:03:45,510
is the team we pull together to actually

120
00:03:50,059 --> 00:03:48,629
put this proposal together we have to

121
00:03:51,619 --> 00:03:50,069
love each other dearly and trust each

122
00:03:53,180 --> 00:03:51,629
other dearly because we're going to be

123
00:03:55,219 --> 00:03:53,190
hammering on each other intellectually

124
00:03:56,479 --> 00:03:55,229
non-stop for the next five years so

125
00:03:57,770 --> 00:03:56,489
we're going to be basically going out of

126
00:03:59,990 --> 00:03:57,780
our way to make album make ourselves

127
00:04:01,399 --> 00:04:00,000
uncomfortable and so as we've chosen

128
00:04:03,259 --> 00:04:01,409
that it's meant we've actually chosen

129
00:04:05,750 --> 00:04:03,269
quite a select tight-knit group of who

130
00:04:07,610 --> 00:04:05,760
the pis are gonna be and then the danger

131
00:04:09,050 --> 00:04:07,620
there is that you a leus everything you

132
00:04:10,580 --> 00:04:09,060
do because you've just got some people's

133
00:04:12,559 --> 00:04:10,590
locked-in prejudices they bring to the

134
00:04:13,939 --> 00:04:12,569
system so this is only gonna work if you

135
00:04:16,249 --> 00:04:13,949
guys work with us as well that this

136
00:04:19,129 --> 00:04:16,259
program is designed as well throughout

137
00:04:20,629 --> 00:04:19,139
to be community led as well or community

138
00:04:22,219 --> 00:04:20,639

influenced so we want to basically make

139
00:04:24,170 --> 00:04:22,229
sure that every step of the way

140
00:04:26,740 --> 00:04:24,180
we embrace as much as possible of the

141
00:04:32,300 --> 00:04:29,540
so let's get on to the the naive

142
00:04:33,680 --> 00:04:32,310
oversimplification part of things over

143
00:04:35,390 --> 00:04:33,690
about six months as we developed the

144
00:04:37,130 --> 00:04:35,400
proposal a dozen of us sat with a a

145
00:04:38,750 --> 00:04:37,140
virtual whiteboard and we hammered on

146
00:04:41,770 --> 00:04:38,760
what are all the processes that you

147
00:04:44,690 --> 00:04:41,780
could imagine happening generically on a

148
00:04:46,280 --> 00:04:44,700
template ocean world and what are all

149
00:04:47,900 --> 00:04:46,290
the issues you might have we came up

150
00:04:49,160 --> 00:04:47,910
with a cartoon impression of well this

151
00:04:50,780 --> 00:04:49,170
is what could be happening just for the

152
00:04:52,340 --> 00:04:50,790
physics of an ocean world and then on

153
00:04:53,360 --> 00:04:52,350
top of that we layered on what could

154
00:04:55,280 --> 00:04:53,370
then be happening in terms of the

155
00:04:57,380 --> 00:04:55,290
geochemistry that would be begat by

156
00:04:59,420 --> 00:04:57,390
those physical processes and then from

157
00:05:01,370 --> 00:04:59,430
that what are the kinds of potential

158
00:05:02,750 --> 00:05:01,380
metabolisms that might be available for

159
00:05:05,930 --> 00:05:02,760
microbial activity and where might all

160
00:05:07,490 --> 00:05:05,940
those things be and then by a deft

161
00:05:09,020 --> 00:05:07,500
sleight of hand we worked out that we

162
00:05:10,909 --> 00:05:09,030
could actually reduce that back to this

163
00:05:13,070 --> 00:05:10,919

little Wi-Fi icon of here or at the key

164
00:05:15,680 --> 00:05:13,080
six different investigations and what

165
00:05:17,780 --> 00:05:15,690
their interconnections might be and so

166
00:05:19,370 --> 00:05:17,790
we have people with expertise at the

167
00:05:21,800 --> 00:05:19,380
center of each of these different

168
00:05:23,870 --> 00:05:21,810
investigations but really where the real

169
00:05:24,980 --> 00:05:23,880
juice and flavor is going to come from

170
00:05:26,060 --> 00:05:24,990
this meeting is probably gonna be more

171
00:05:27,290 --> 00:05:26,070
of those interconnections at the

172
00:05:29,630 --> 00:05:27,300
interfaces of where these things were

173
00:05:31,580 --> 00:05:29,640
all hive together but what I'm gonna do

174
00:05:32,990 --> 00:05:31,590
now is just run you through the core

175
00:05:35,719 --> 00:05:33,000
elements of what those different

176
00:05:37,370 --> 00:05:35,729
components are gonna be so the first

177
00:05:38,900 --> 00:05:37,380
part starting so this is I remember

178
00:05:41,810 --> 00:05:38,910
we're thinking about ocean worlds so

179
00:05:43,760 --> 00:05:41,820
this is where my version of habitability

180
00:05:45,200 --> 00:05:43,770
is not the same as haven't had liquid

181
00:05:47,690 --> 00:05:45,210
water on the surface of a planet

182
00:05:49,460 --> 00:05:47,700
so although that's that's one version of

183
00:05:50,780 --> 00:05:49,470
habitability mine includes

184
00:05:52,310 --> 00:05:50,790
chemosynthesis because I've spent the

185
00:05:55,159 --> 00:05:52,320
last 30 years studying that kind of

186
00:05:57,770 --> 00:05:55,169
stuff so I know it's a thing and I can't

187
00:05:59,270 --> 00:05:57,780
raise that part of my brain so so we're

188
00:06:01,100 --> 00:05:59,280

going to start from the bottom up and so

189
00:06:02,630 --> 00:06:01,110
the idea then is what might be happening

190
00:06:05,360 --> 00:06:02,640
to you physically what would it take for

191
00:06:08,030 --> 00:06:05,370
any given planet to either have or not

192
00:06:10,460 --> 00:06:08,040
have internal differentiation processes

193
00:06:11,630 --> 00:06:10,470
and if that resulted there are some

194
00:06:13,040 --> 00:06:11,640
important things that might come out of

195
00:06:14,659 --> 00:06:13,050
that one might be what's the thermal

196
00:06:16,250 --> 00:06:14,669
flux that's available to drive any kind

197
00:06:18,020 --> 00:06:16,260
of sea water circulation another one

198
00:06:20,000 --> 00:06:18,030
might be what are the processes that

199
00:06:22,400 --> 00:06:20,010
might actually produce topography on the

200
00:06:24,500 --> 00:06:22,410
sea floor our planets you know because

201
00:06:26,600 --> 00:06:24,510
we have lack data we tend to draw

202
00:06:28,230 --> 00:06:26,610
radially symmetric cross-sections of

203
00:06:30,210 --> 00:06:28,240
ocean worlds

204
00:06:32,100 --> 00:06:30,220
and it's vanishingly unlikely that

205
00:06:33,360 --> 00:06:32,110
that's true and it's really really

206
00:06:35,189 --> 00:06:33,370
important that we don't suppress that

207
00:06:36,719 --> 00:06:35,199
stuff which is actually true of our own

208
00:06:38,730 --> 00:06:36,729
ocean circulation models I'll come back

209
00:06:41,070 --> 00:06:38,740
to that later on so this is just one

210
00:06:42,300 --> 00:06:41,080
example of priests off so tans work some

211
00:06:44,760 --> 00:06:42,310
of the work he's been working on he's

212
00:06:46,409 --> 00:06:44,770
one of the PI's on on our project and so

213
00:06:47,999 --> 00:06:46,419

this is some of these most recent work

214
00:06:49,980 --> 00:06:48,009
thinking about Enceladus is just an

215
00:06:51,510 --> 00:06:49,990
example of the fact of this is this

216
00:06:52,710 --> 00:06:51,520
isn't to say Enceladus is definitely one

217
00:06:56,219 --> 00:06:52,720
of the things that's going to be really

218
00:06:57,749 --> 00:06:56,229
compelling but it embraces like the the

219
00:06:59,189 --> 00:06:57,759
philosophy of the diversity of

220
00:07:00,360 --> 00:06:59,199
geophysical process that might be

221
00:07:02,219 --> 00:07:00,370
happening on the planetary interior

222
00:07:05,460 --> 00:07:02,229
which we need to accommodate before we

223
00:07:06,960 --> 00:07:05,470
go any further a second thing is we've

224
00:07:08,100 --> 00:07:06,970
talked about hydrothermal activity and

225
00:07:09,659 --> 00:07:08,110
there's the stuff that I've worked on in

226
00:07:10,800 --> 00:07:09,669
all of my career is actually exploring

227
00:07:11,999 --> 00:07:10,810
for different kinds of deep sea

228
00:07:13,320 --> 00:07:12,009
hydrothermal activity and trying to

229
00:07:15,300 --> 00:07:13,330
prove that there isn't anywhere you can

230
00:07:17,760 --> 00:07:15,310
go and if you search correctly you can't

231
00:07:20,760 --> 00:07:17,770
find it I think I was a triple negative

232
00:07:21,960 --> 00:07:20,770
sorry but anyway if you're thinking our

233
00:07:23,730 --> 00:07:21,970
hydrothermal activity and you're

234
00:07:25,439 --> 00:07:23,740
thinking of a black smokers stop please

235
00:07:27,059 --> 00:07:25,449
and if you're thinking of hydrothermal

236
00:07:29,159 --> 00:07:27,069
activity you think the lost city stomp

237
00:07:31,170 --> 00:07:29,169
please there's probably the kinds of

238
00:07:32,580 --> 00:07:31,180

diffuse flow or the kinds of important

239
00:07:33,899 --> 00:07:32,590
fluid flow that our planet present on

240
00:07:35,390 --> 00:07:33,909
other planets may be completely

241
00:07:37,620 --> 00:07:35,400
different from anything we've seen and

242
00:07:39,209 --> 00:07:37,630
the majority of fluid flow on our own

243
00:07:40,080 --> 00:07:39,219
planet is probably completely different

244
00:07:42,209 --> 00:07:40,090
from anything you've ever seen on

245
00:07:43,950 --> 00:07:42,219
National Geographic television either so

246
00:07:46,050 --> 00:07:43,960
for example here's a cross-section from

247
00:07:48,080 --> 00:07:46,060
a cartoon of Andy Fisher's he's another

248
00:07:50,610 --> 00:07:48,090
one of our Co eyes from UC Santa Cruz

249
00:07:52,290 --> 00:07:50,620
who works on where most of the fluid

250
00:07:54,149 --> 00:07:52,300
flow happens on our planet and it's at

251
00:07:56,430 --> 00:07:54,159
very low temperatures its massive

252
00:07:58,680 --> 00:07:56,440
integration in terms of physics and heat

253
00:08:00,120 --> 00:07:58,690
of volume but it's not the most

254
00:08:02,189 --> 00:08:00,130
spectacular stuff that makes for good

255
00:08:03,209 --> 00:08:02,199
television videos so that's probably not

256
00:08:05,670 --> 00:08:03,219
the stuff you should be thinking about

257
00:08:07,529 --> 00:08:05,680
and an example of how unpromising a

258
00:08:09,719 --> 00:08:07,539
planet can be and it might still host

259
00:08:10,740 --> 00:08:09,729
seafloor fluid flow is one of the things

260
00:08:12,749 --> 00:08:10,750
we've actually realized as our

261
00:08:13,920 --> 00:08:12,759
discussions was if you took the moon and

262
00:08:16,050 --> 00:08:13,930
nobody really thinks of the moon has

263
00:08:17,730 --> 00:08:16,060

been geologically active our Moon if you

264
00:08:19,860 --> 00:08:17,740
put two miles of water on top of it

265
00:08:21,600 --> 00:08:19,870
right now you would not be able to stop

266
00:08:24,510 --> 00:08:21,610
fluid flow happening because of the

267
00:08:26,120 --> 00:08:24,520
pre-existing topography so basically if

268
00:08:28,080 --> 00:08:26,130
the moon can have seafloor fluid flow

269
00:08:29,520 --> 00:08:28,090
then it suddenly makes you realize

270
00:08:30,839 --> 00:08:29,530
hopefully that philosophically just

271
00:08:32,940 --> 00:08:30,849
about any planet no matter how boring

272
00:08:34,889 --> 00:08:32,950
you think it might be might still be

273
00:08:36,959 --> 00:08:34,899
able to host reactions that could

274
00:08:39,090 --> 00:08:36,969
produce water rock interactions and

275
00:08:40,980 --> 00:08:39,100
geochemical results

276
00:08:42,300 --> 00:08:40,990
another one of the prejudices I want you

277
00:08:43,440 --> 00:08:42,310
to leave at the door is that you

278
00:08:44,730 --> 00:08:43,450
actually think you know where the best

279
00:08:46,860 --> 00:08:44,740
geochemical reactions are going to come

280
00:08:48,330 --> 00:08:46,870
from that yield the most energy this is

281
00:08:52,440 --> 00:08:48,340
some very recent work from Everett

282
00:08:54,840 --> 00:08:52,450
shocks imminent graduate student Tucker

283
00:08:56,340 --> 00:08:54,850
Ellie's about to graduate and so these

284
00:08:57,840 --> 00:08:56,350
two plots on the left-hand side is

285
00:08:59,460 --> 00:08:57,850
showing you what happens if you take all

286
00:09:01,620 --> 00:08:59,470
the world's mid-ocean ridge resorts and

287
00:09:03,990 --> 00:09:01,630
so this is a very earth-based study he's

288
00:09:06,210 --> 00:09:04,000

been doing and showing you how exciting

289
00:09:07,620 --> 00:09:06,220
or how unexpected the results can be it

290
00:09:09,240 --> 00:09:07,630
turns out if you want the maximum energy

291
00:09:13,920 --> 00:09:09,250
yield for this reaction up at the top

292
00:09:15,090 --> 00:09:13,930
here from oh sorry let me go back that

293
00:09:16,470 --> 00:09:15,100
isn't the laser pointer that's the

294
00:09:18,180 --> 00:09:16,480
pointer so if you want the maximum

295
00:09:20,400 --> 00:09:18,190
energy you can get from that it turns

296
00:09:22,020 --> 00:09:20,410
out the most important thing in a redox

297
00:09:24,870 --> 00:09:22,030
active bit of rock is actually the

298
00:09:28,010 --> 00:09:24,880
aluminum concentration who knew that

299
00:09:30,600 --> 00:09:28,020
hands up if you already knew that okay

300
00:09:33,120 --> 00:09:30,610
Julie said the same talk before first

301
00:09:34,740 --> 00:09:33,130
hand from Everett and then the right

302
00:09:36,540 --> 00:09:34,750
hand side is then saying okay well then

303
00:09:38,760 --> 00:09:36,550
if you take that what's theoretically

304
00:09:40,890 --> 00:09:38,770
available geologically in terms of an

305
00:09:43,050 --> 00:09:40,900
abiotic organic reaction and how could

306
00:09:44,370 --> 00:09:43,060
that be harnessed into microbiology then

307
00:09:46,080 --> 00:09:44,380
the second part that comes into this is

308
00:09:47,070 --> 00:09:46,090
you can't just think about what the rock

309
00:09:48,450 --> 00:09:47,080
is you have to think about what the

310
00:09:49,680 --> 00:09:48,460
seawater concentrations are going to be

311
00:09:50,820 --> 00:09:49,690
and what the Seaboard of composition is

312
00:09:52,860 --> 00:09:50,830
going to be that you're interacting with

313
00:09:55,590 --> 00:09:52,870

and so that's the second half there that

314
00:09:57,150 --> 00:09:55,600
then the gray shaded field show you that

315
00:09:58,320 --> 00:09:57,160
even if you had all the best rocks in

316
00:10:01,140 --> 00:09:58,330
the world and you wanted to be able to

317
00:10:02,610 --> 00:10:01,150
generate what the this the fluid might

318
00:10:04,350 --> 00:10:02,620
be of the water rock reaction happening

319
00:10:05,970 --> 00:10:04,360
beneath the sea floor that the actual

320
00:10:08,160 --> 00:10:05,980
energy yield that's available as you

321
00:10:09,330 --> 00:10:08,170
then become going to the redox reactions

322
00:10:11,460 --> 00:10:09,340
that come up when you let that stuff

323
00:10:13,470 --> 00:10:11,470
then erupt back into the ocean that's

324
00:10:15,180 --> 00:10:13,480
out of equilibrium with is also going to

325
00:10:20,430 --> 00:10:15,190
be regulated by the composition of the

326
00:10:22,110 --> 00:10:20,440
ocean that it emerges into modeling is

327
00:10:23,550 --> 00:10:22,120
cheap so that's the idea is the Thira

328
00:10:25,410 --> 00:10:23,560
core modeling we can run millions of

329
00:10:27,330 --> 00:10:25,420
these calculations over the first phases

330
00:10:28,650 --> 00:10:27,340
of this program but we're also planning

331
00:10:30,210 --> 00:10:28,660
to back it up with a bunch of

332
00:10:32,550 --> 00:10:30,220
experimental work in the laboratory this

333
00:10:34,440 --> 00:10:32,560
can be both testing the the water rock

334
00:10:35,790 --> 00:10:34,450
reaction stuff under geochemical

335
00:10:37,800 --> 00:10:35,800
laboratories but then also actually

336
00:10:39,750 --> 00:10:37,810
testing with model organisms what the

337
00:10:41,400 --> 00:10:39,760
microbial yields might be of at

338
00:10:43,110 --> 00:10:41,410

different metabolisms as we identify

339
00:10:44,370 --> 00:10:43,120
what chemicals might be available on

340
00:10:45,690 --> 00:10:44,380
what's on the menu for lunch

341
00:10:47,130 --> 00:10:45,700
then we can actually turn around and

342
00:10:49,440 --> 00:10:47,140
three different microbes and actually do

343
00:10:51,150 --> 00:10:49,450
microbial experiments as well to see to

344
00:10:52,410 --> 00:10:51,160
what extent those different metabolisms

345
00:10:54,450 --> 00:10:52,420
get exploited

346
00:10:56,270 --> 00:10:54,460
so we have a parallel program of the

347
00:10:58,350 --> 00:10:56,280
experiments we're gonna be doing there

348
00:10:59,910 --> 00:10:58,360
that all gets us about as far as

349
00:11:01,920 --> 00:10:59,920
understanding the biological potential

350
00:11:03,780 --> 00:11:01,930
we then have to go on to the bio

351
00:11:05,940 --> 00:11:03,790
signature potential for the same system

352
00:11:07,740 --> 00:11:05,950
and part of that becomes worth how would

353
00:11:10,350 --> 00:11:07,750
the ocean circulate on an ocean world

354
00:11:11,460 --> 00:11:10,360
and here again we're trying to actually

355
00:11:15,180 --> 00:11:11,470
bring together two different length

356
00:11:17,370 --> 00:11:15,190
scales of basically this is a bun as a

357
00:11:19,860 --> 00:11:17,380
line of weakness in how we understand

358
00:11:21,630 --> 00:11:19,870
our own ocean circulation that most

359
00:11:23,310 --> 00:11:21,640
global circulation models for our own

360
00:11:25,140 --> 00:11:23,320
planet and this is the we're using

361
00:11:27,060 --> 00:11:25,150
working with John Marshall from MIT who

362
00:11:28,590 --> 00:11:27,070
runs the the three dimensional global

363
00:11:30,210 --> 00:11:28,600

circulation model for Earth one of the

364
00:11:33,030 --> 00:11:30,220
top-of-the-range model to get used for

365
00:11:34,710 --> 00:11:33,040
that it's completely devoid of seafloor

366
00:11:36,060 --> 00:11:34,720
topography even though we know seafloor

367
00:11:38,850 --> 00:11:36,070
topography is really important for

368
00:11:40,260 --> 00:11:38,860
mixing so it turns out John's actually

369
00:11:41,490 --> 00:11:40,270
made a bit of a start on this because

370
00:11:43,140 --> 00:11:41,500
he's actually been starting thinking

371
00:11:44,790 --> 00:11:43,150
about this he was very much a climate

372
00:11:46,530 --> 00:11:44,800
modeler he's been interested in snowball

373
00:11:48,090 --> 00:11:46,540
earth what was happening 700 million

374
00:11:49,500 --> 00:11:48,100
years ago so we already have some

375
00:11:51,690 --> 00:11:49,510
preliminary models of what would happen

376
00:11:54,150 --> 00:11:51,700
in a completely ice-covered Earth's

377
00:11:55,530 --> 00:11:54,160
ocean where you have an isothermal

378
00:11:57,360 --> 00:11:55,540
surface when you have the ice water

379
00:11:59,430 --> 00:11:57,370
interface everywhere and so circulation

380
00:12:00,840 --> 00:11:59,440
is driven primarily by by Helin

381
00:12:02,580 --> 00:12:00,850
circulation rather than thermohaline

382
00:12:03,840 --> 00:12:02,590
circulation that it's basically Brian

383
00:12:05,850 --> 00:12:03,850
exclusion would actually be driving

384
00:12:07,230 --> 00:12:05,860
global scale convection because that's

385
00:12:08,520 --> 00:12:07,240
one end member although another one

386
00:12:09,930 --> 00:12:08,530
could be if there's geothermal energy

387
00:12:11,790 --> 00:12:09,940
from below that's driving the

388
00:12:13,440 --> 00:12:11,800

circulations that's that kind of

389
00:12:14,730 --> 00:12:13,450
parameter space but then we're also

390
00:12:16,590 --> 00:12:14,740
gonna be working with andreas turn her

391
00:12:19,020 --> 00:12:16,600
from Lamont who's gonna be putting some

392
00:12:20,580 --> 00:12:19,030
honesty into that stuff he spends a lot

393
00:12:22,380 --> 00:12:20,590
of time thinking about how to apocrypha

394
00:12:24,210 --> 00:12:22,390
shaped circulation on local scale

395
00:12:26,100 --> 00:12:24,220
processes both in terms of ice water

396
00:12:27,390 --> 00:12:26,110
interface and at the seafloor so that's

397
00:12:29,250 --> 00:12:27,400
what the couple of examples are here

398
00:12:31,710 --> 00:12:29,260
there's a plan view of work down in

399
00:12:33,570 --> 00:12:31,720
Antarctica of ice water rocking or

400
00:12:35,160 --> 00:12:33,580
seafloor interactions and then also the

401
00:12:37,050 --> 00:12:35,170
larger scale of fracture zones the fact

402
00:12:38,070 --> 00:12:37,060
that there are lumps on the seafloor

403
00:12:42,270 --> 00:12:38,080
even if they're not volcanically active

404
00:12:43,110 --> 00:12:42,280
today the last of the investigations is

405
00:12:45,060 --> 00:12:43,120
tending to be looking at the

406
00:12:46,350 --> 00:12:45,070
biogeochemical fate of materials in the

407
00:12:48,330 --> 00:12:46,360
oceans and then I think one of the

408
00:12:49,740 --> 00:12:48,340
cleverest slights of hand in our

409
00:12:52,080 --> 00:12:49,750
proposal or I think that's really quite

410
00:12:54,540 --> 00:12:52,090
elegant is the idea that particulate

411
00:12:55,770 --> 00:12:54,550
material in Earth's oceans biogenic

412
00:12:58,350 --> 00:12:55,780
particulate material and mineral

413
00:13:00,660 --> 00:12:58,360

particulate material has already pre

414
00:13:02,580 --> 00:13:00,670
concentrated interesting stories for us

415
00:13:03,750 --> 00:13:02,590
that compared to going up filtering

416
00:13:05,430 --> 00:13:03,760
large volumes of seawater and seeing

417
00:13:06,900 --> 00:13:05,440
what's dissolved in the seawater

418
00:13:07,980 --> 00:13:06,910
actually the mineral materials can

419
00:13:09,000 --> 00:13:07,990
actually tell you something about the

420
00:13:10,920 --> 00:13:09,010
processes that are already been

421
00:13:12,600 --> 00:13:10,930
happening in that ocean and they also

422
00:13:14,520 --> 00:13:12,610
have the potential to survive the stuff

423
00:13:16,110 --> 00:13:14,530
I picked up from Europa Lander report

424
00:13:17,550 --> 00:13:16,120
was the idea that if you wanted to go

425
00:13:19,470 --> 00:13:17,560
and grind up your seawater and melt it

426
00:13:20,820 --> 00:13:19,480
and filter it then you've been a good

427
00:13:23,460 --> 00:13:20,830
shape to actually go and look at some

428
00:13:25,530 --> 00:13:23,470
stuff and then of course if you're

429
00:13:26,850 --> 00:13:25,540
thinking about places like Europa then

430
00:13:28,560 --> 00:13:26,860
there's also what's the fate of that

431
00:13:30,060 --> 00:13:28,570
stuff once it gets out onto the surface

432
00:13:31,740 --> 00:13:30,070
and how would it survive in a radiation

433
00:13:32,820 --> 00:13:31,750
that if you had a mission that was

434
00:13:34,470 --> 00:13:32,830
actually just gonna go and scrape the

435
00:13:36,060 --> 00:13:34,480
surface and look at stuff how would that

436
00:13:37,440 --> 00:13:36,070
have been modified compared to whatever

437
00:13:41,130 --> 00:13:37,450
it was like when it left the pristine

438
00:13:42,600 --> 00:13:41,140

ocean sometime over the way we're gonna

439
00:13:44,610 --> 00:13:42,610
synthesize the whole thing and pull it

440
00:13:45,900 --> 00:13:44,620
all together but just to wrap up I want

441
00:13:47,730 --> 00:13:45,910
to show you that basically this is where

442
00:13:50,280 --> 00:13:47,740
you guys get involve basically what we

443
00:13:52,260 --> 00:13:50,290
have is three phases over 18 months each

444
00:13:53,490 --> 00:13:52,270
over the next year and a half we're

445
00:13:55,260 --> 00:13:53,500
basically going to go away and try and

446
00:13:56,760 --> 00:13:55,270
put together a conceptual model of how

447
00:13:57,990 --> 00:13:56,770
all those different parts would link

448
00:13:59,610 --> 00:13:58,000
together and then we want to bring that

449
00:14:00,780 --> 00:13:59,620
back to a community workshop and you can

450
00:14:02,220 --> 00:14:00,790
all beat the hell out of us and tell us

451
00:14:04,080 --> 00:14:02,230
what we've missed and what's missing and

452
00:14:05,430 --> 00:14:04,090
then once we've done that then we'll go

453
00:14:07,380 --> 00:14:05,440
and work out how to parameterize that

454
00:14:08,520 --> 00:14:07,390
and turn that into a forward model that

455
00:14:10,470 --> 00:14:08,530
can make millions and millions of

456
00:14:12,900 --> 00:14:10,480
forward calculations that'll be the

457
00:14:14,340 --> 00:14:12,910
second 18-month phase and then the third

458
00:14:16,140 --> 00:14:14,350
part which is the really critical part

459
00:14:18,830 --> 00:14:16,150
is how do we do the sensitivity analysis

460
00:14:22,200 --> 00:14:18,840
we can make billions of predictions

461
00:14:24,420 --> 00:14:22,210
based on no knowledge whatsoever but

462
00:14:25,890 --> 00:14:24,430
just like a flicker roll of the dice I

463
00:14:27,660 --> 00:14:25,900

will predict that most of those

464
00:14:29,070 --> 00:14:27,670
different combinations of parameter

465
00:14:31,080 --> 00:14:29,080
space will come out looking really

466
00:14:32,700 --> 00:14:31,090
barren and boring and unproductive and

467
00:14:34,440 --> 00:14:32,710
they'll be a tiny subset will be the

468
00:14:36,360 --> 00:14:34,450
places that actually tell us whether

469
00:14:38,580 --> 00:14:36,370
we're the juicy results might come from

470
00:14:39,960 --> 00:14:38,590
and if we can get all that done in the

471
00:14:41,430 --> 00:14:39,970
next four and a half years that'll give

472
00:14:42,810 --> 00:14:41,440
us six more months to actually prepare a

473
00:14:44,160 --> 00:14:42,820
lookup table for the Europa clipper

474
00:14:46,500 --> 00:14:44,170
mission or we can be nice and mass

475
00:14:47,910 --> 00:14:46,510
irrelevant so that's really and the

476
00:14:49,650 --> 00:14:47,920
mechanism we actually want to do for all

477
00:14:51,030 --> 00:14:49,660
of that is through this new network for

478
00:14:52,920 --> 00:14:51,040
ocean world so if you come along this

479
00:14:54,720 --> 00:14:52,930
evening to the town hall Allison Murray

480
00:14:55,920 --> 00:14:54,730
is a co-lead of that with me and Alisa

481
00:15:00,600 --> 00:14:55,930
Roden will be there to tell you all

482
00:15:01,530 --> 00:15:00,610
about that okay thank you very much