
AB
GRAD
CON23

1
00:00:04,230 --> 00:00:11,110
[Music]

2
00:00:16,790 --> 00:00:14,870
hi everyone I'm Emily and I'm a PhD

3
00:00:19,130 --> 00:00:16,800
candidate in the DECA slab at Stanford

4
00:00:22,550 --> 00:00:19,140
University and I study the limits of

5
00:00:24,890 --> 00:00:22,560
life in hyper saline environments

6
00:00:26,390 --> 00:00:24,900
so as we all probably know Brian's are

7
00:00:28,609 --> 00:00:26,400
one of the targets for a life detection

8
00:00:31,130 --> 00:00:28,619
mission to other ocean worlds including

9
00:00:33,830 --> 00:00:31,140
Europa and Enceladus and even past ocean

10
00:00:36,530 --> 00:00:33,840
worlds like Mars and so by understanding

11
00:00:38,870 --> 00:00:36,540
the limits of salty life on Earth we can

12
00:00:41,410 --> 00:00:38,880
understand how and where to look for

13
00:00:43,970 --> 00:00:41,420

life on these other places

14
00:00:45,470 --> 00:00:43,980
one of the ways we can assess a brine

15
00:00:48,110 --> 00:00:45,480
environment is through this measurement

16
00:00:49,850 --> 00:00:48,120
called water activity and water activity

17
00:00:51,950 --> 00:00:49,860
depends on vapor pressure but you can

18
00:00:54,170 --> 00:00:51,960
think of it about as how many water

19
00:00:56,630 --> 00:00:54,180
molecules are available to a cell in

20
00:00:58,250 --> 00:00:56,640
solution so on the left is an image of

21
00:01:00,350 --> 00:00:58,260
what pure water would be this is where

22
00:01:02,330 --> 00:01:00,360
all the water molecules are free to

23
00:01:04,789 --> 00:01:02,340
become Vapor move about the cabin that

24
00:01:07,310 --> 00:01:04,799
would be a water activity of one

25
00:01:09,230 --> 00:01:07,320
now if there's ions in solution water

26
00:01:11,630 --> 00:01:09,240
would be attracted to those molecules

27
00:01:13,390 --> 00:01:11,640
and a water activity would decrease so

28
00:01:16,250 --> 00:01:13,400
the lower the water activity the more

29
00:01:18,350 --> 00:01:16,260
uninhabitable an environment is

30
00:01:20,510 --> 00:01:18,360
and since water is required for all Life

31
00:01:23,690 --> 00:01:20,520
as We Know It water activity can be used

32
00:01:25,969 --> 00:01:23,700
to assess assess habitability so some

33
00:01:27,710 --> 00:01:25,979
common items in their water activities

34
00:01:28,969 --> 00:01:27,720
are listed on the left including sea

35
00:01:31,070 --> 00:01:28,979
water which has a pretty high water

36
00:01:33,050 --> 00:01:31,080
activity and the salinity of seawater is

37
00:01:34,670 --> 00:01:33,060
about 3.5 percent

38
00:01:37,130 --> 00:01:34,680

and then honey has a water activity of

39
00:01:39,649 --> 00:01:37,140
0.6 and some of Mars special regions or

40
00:01:42,950 --> 00:01:39,659
areas where we might detect life on Mars

41
00:01:44,749 --> 00:01:42,960
are in no lower than 0.5

42
00:01:47,090 --> 00:01:44,759
and there's been a lot of really great

43
00:01:49,730 --> 00:01:47,100
pure culture work on the limits of life

44
00:01:52,010 --> 00:01:49,740
and cell division at different water

45
00:01:54,050 --> 00:01:52,020
activities and to sum it up the

46
00:01:55,850 --> 00:01:54,060
predicted or theoretical water activity

47
00:01:58,310 --> 00:01:55,860
limit for all life on Earth including

48
00:02:00,710 --> 00:01:58,320
eukaryotes and prokaryotes is about 0.6

49
00:02:02,929 --> 00:02:00,720
and this is based on pure culture so

50
00:02:04,730 --> 00:02:02,939
like our speaker last night mentioned

51
00:02:06,649 --> 00:02:04,740
not all the things in the world are in

52
00:02:09,229 --> 00:02:06,659
pure culture yet so that leaves out

53
00:02:11,570 --> 00:02:09,239
about 90 or more of the biodiversity on

54
00:02:13,010 --> 00:02:11,580
Earth and our ability to assess what the

55
00:02:16,910 --> 00:02:13,020
limit of life for each of those strains

56
00:02:20,869 --> 00:02:18,589
so brine environments are really

57
00:02:23,510 --> 00:02:20,879
widespread on Earth they're everywhere

58
00:02:25,850 --> 00:02:23,520
um and a lot of great work has gone into

59
00:02:27,589 --> 00:02:25,860
assessing metagenomics like the

60
00:02:29,270 --> 00:02:27,599
taxonomic diversity the potential

61
00:02:31,390 --> 00:02:29,280
metabolic metabolic potential of

62
00:02:33,350 --> 00:02:31,400
microbes in these environments

63
00:02:35,390 --> 00:02:33,360

metatranscriptomes and even some bulk

64
00:02:37,070 --> 00:02:35,400
activity measurements but metabolic

65
00:02:38,330 --> 00:02:37,080
activity is rarely measured at the

66
00:02:40,130 --> 00:02:38,340
Single Cell level

67
00:02:42,290 --> 00:02:40,140
and this can be really important because

68
00:02:44,030 --> 00:02:42,300
when a cell is stressed out they might

69
00:02:46,430 --> 00:02:44,040
have really low levels of activity that

70
00:02:47,869 --> 00:02:46,440
are not detected with both techniques

71
00:02:49,910 --> 00:02:47,879
so today I'll be talking a little bit

72
00:02:51,770 --> 00:02:49,920
about my work in solar cell turns and

73
00:02:55,630 --> 00:02:51,780
then transition into the my current work

74
00:02:58,670 --> 00:02:55,640
in Western Australia aesthetic brands

75
00:03:01,130 --> 00:02:58,680
so like I mentioned when life is

76
00:03:03,410 --> 00:03:01,140
reaching its limit a metabolic activity

77
00:03:05,449 --> 00:03:03,420
can be really low and so single cell

78
00:03:07,729 --> 00:03:05,459
analysis can help us detect the slow

79
00:03:11,149 --> 00:03:07,739
level of activity by lowering detection

80
00:03:13,130 --> 00:03:11,159
limits so a cell needs to acquire 50 new

81
00:03:15,589 --> 00:03:13,140
biomass to be able to divide into two

82
00:03:17,809 --> 00:03:15,599
new daughter cells however with Nano

83
00:03:20,270 --> 00:03:17,819
Sims for example we only need to detect

84
00:03:22,670 --> 00:03:20,280
about five percent maximum we can even

85
00:03:24,890 --> 00:03:22,680
get as low as less than one percent of

86
00:03:27,290 --> 00:03:24,900
new biomass to detect active life in a

87
00:03:29,030 --> 00:03:27,300
sample it also provides quantitative

88
00:03:31,309 --> 00:03:29,040

results so we can do a lot with this

89
00:03:33,110 --> 00:03:31,319
data on a quantitative level and it also

90
00:03:35,630 --> 00:03:33,120
reveals trends that are often obscured

91
00:03:37,309 --> 00:03:35,640
by bulk analysis

92
00:03:38,690 --> 00:03:37,319
and when I'm talking about metabolic

93
00:03:41,330 --> 00:03:38,700
activity in this talk I'm talking

94
00:03:43,070 --> 00:03:41,340
specifically about anabolic activity so

95
00:03:44,690 --> 00:03:43,080
there's catabolic activity that produces

96
00:03:46,850 --> 00:03:44,700
energy for a cell and then there's

97
00:03:48,649 --> 00:03:46,860
anabolic activity where a cell can take

98
00:03:50,990 --> 00:03:48,659
substrates from the environment like

99
00:03:53,089 --> 00:03:51,000
amino acids and glucose and take that

100
00:03:56,030 --> 00:03:53,099
carbon and nitrogen and then produce new

101
00:03:59,449 --> 00:03:56,040
cell biomass which includes proteins DNA

102
00:04:03,170 --> 00:04:01,789
so first the work that I've done at this

103
00:04:05,390 --> 00:04:03,180
um solar Salter and it's called South

104
00:04:07,850 --> 00:04:05,400
Bay saltworks it's in here in San Diego

105
00:04:10,309 --> 00:04:07,860
and basically they bring sea water in

106
00:04:12,649 --> 00:04:10,319
from San Diego Bay and it goes through a

107
00:04:14,449 --> 00:04:12,659
series of evapo concentration ponds and

108
00:04:16,310 --> 00:04:14,459
as the water evaporates out of the sea

109
00:04:18,409 --> 00:04:16,320
water different salts are left behind

110
00:04:20,990 --> 00:04:18,419
producing a series of ponds that range

111
00:04:23,090 --> 00:04:21,000
in water activity from 0.98 that of

112
00:04:25,070 --> 00:04:23,100
seawater to that well below the known

113
00:04:27,590 --> 00:04:25,080

limit of Life at 0.4

114
00:04:30,230 --> 00:04:27,600
and so we measured anabolic activity of

115
00:04:32,570 --> 00:04:30,240
over 6 000 individual cells from a

116
00:04:34,969 --> 00:04:32,580
series of five of these brines with five

117
00:04:36,890 --> 00:04:34,979
different isotopic substrates from amino

118
00:04:39,650 --> 00:04:36,900
acids ammonium and bicarbonate glucose

119
00:04:41,990 --> 00:04:39,660
and nitrate and that sort of thing

120
00:04:43,730 --> 00:04:42,000
we measured their anabolic activity with

121
00:04:46,129 --> 00:04:43,740
nano SIM so on the left this is what

122
00:04:47,870 --> 00:04:46,139
this looks like cells that are circled

123
00:04:50,629 --> 00:04:47,880
in red are considered enriched and this

124
00:04:52,310 --> 00:04:50,639
is for carbon from amino acids and then

125
00:04:54,290 --> 00:04:52,320
the cells that are circled in white

126
00:04:56,810 --> 00:04:54,300
would be considered less active or less

127
00:04:58,189 --> 00:04:56,820
enriched in the sample

128
00:05:00,710 --> 00:04:58,199
and when you plot this with water

129
00:05:02,810 --> 00:05:00,720
activity you see that microbial activity

130
00:05:05,210 --> 00:05:02,820
decreases exponentially with water

131
00:05:07,249 --> 00:05:05,220
activity however there's certain areas

132
00:05:09,350 --> 00:05:07,259
so you can

133
00:05:11,390 --> 00:05:09,360
see certain subsets of cells are more

134
00:05:13,790 --> 00:05:11,400
active than most of the cells in

135
00:05:15,650 --> 00:05:13,800
seawater at a higher water activity with

136
00:05:17,150 --> 00:05:15,660
even just low decreases in water

137
00:05:19,430 --> 00:05:17,160
activity

138
00:05:21,770 --> 00:05:19,440

um we also detected cell biomass through

139
00:05:23,629 --> 00:05:21,780
dappy and nanosims in the slow water

140
00:05:25,610 --> 00:05:23,639
activity magnesium chloride brine

141
00:05:28,010 --> 00:05:25,620
however we didn't detect any activity

142
00:05:29,749 --> 00:05:28,020
here and the incubation time was two

143
00:05:31,670 --> 00:05:29,759
days long so there's several reasons for

144
00:05:37,490 --> 00:05:31,680
this

145
00:05:40,070 --> 00:05:37,500
estimate a new predicted lower limit of

146
00:05:42,050 --> 00:05:40,080
Life at 0.54 so that's a little

147
00:05:44,270 --> 00:05:42,060
significantly biologically significantly

148
00:05:48,050 --> 00:05:44,280
lower than the 0.6 previous limit

149
00:05:49,610 --> 00:05:48,060
detected sorry predicted and this data

150
00:05:51,110 --> 00:05:49,620
I'd love to talk more about it but it's

151
00:05:52,969 --> 00:05:51,120
been submitted and I just got word that

152
00:05:54,590 --> 00:05:52,979
it's now in review as of this morning so

153
00:05:55,850 --> 00:05:54,600
it's really exciting and if you'd like

154
00:05:57,650 --> 00:05:55,860
to hear more about that please talk to

155
00:05:59,570 --> 00:05:57,660
me later

156
00:06:01,610 --> 00:05:59,580
so now to kind of get into the topic of

157
00:06:03,170 --> 00:06:01,620
this talk which is I'm talking about the

158
00:06:05,330 --> 00:06:03,180
limits of life in acidic brine

159
00:06:08,210 --> 00:06:05,340
environments there's a lot of things

160
00:06:10,189 --> 00:06:08,220
that happen in brines so you can have

161
00:06:12,230 --> 00:06:10,199
salinity as a limiting factor you can

162
00:06:13,310 --> 00:06:12,240
have high metal concentrations you can

163
00:06:15,350 --> 00:06:13,320

have high ionic strength and

164
00:06:17,270 --> 00:06:15,360
chaotropicity but one thing that really

165
00:06:19,189 --> 00:06:17,280
stood out to me about this sample set

166
00:06:21,469 --> 00:06:19,199
was that most of the brines that had

167
00:06:23,210 --> 00:06:21,479
high levels of activity actually had a

168
00:06:25,270 --> 00:06:23,220
pH about seven or eight so like

169
00:06:28,010 --> 00:06:25,280
relatively neutral to slightly basic pH

170
00:06:30,770 --> 00:06:28,020
however this magnesium chloride brine

171
00:06:33,230 --> 00:06:30,780
which had no detectable activity had a

172
00:06:35,270 --> 00:06:33,240
pH of about 5.4

173
00:06:37,670 --> 00:06:35,280
and so my question was how does pH

174
00:06:39,230 --> 00:06:37,680
affect microbial activity in brine

175
00:06:40,430 --> 00:06:39,240
environments and is this an important

176
00:06:43,309 --> 00:06:40,440
factor

177
00:06:45,950 --> 00:06:43,319
in the limits of life

178
00:06:48,230 --> 00:06:45,960
so last summer our team went to Western

179
00:06:51,050 --> 00:06:48,240
Australia to sample a bunch of acidic

180
00:06:53,150 --> 00:06:51,060
brines and these brines are considered

181
00:06:55,010 --> 00:06:53,160
Mars analogs because of the geochemistry

182
00:06:57,469 --> 00:06:55,020
and weathering systems that created them

183
00:07:00,290 --> 00:06:57,479
over millions of years

184
00:07:02,150 --> 00:07:00,300
um just in a short oxidation of sulfides

185
00:07:04,430 --> 00:07:02,160
acidified the water and then evaporation

186
00:07:06,650 --> 00:07:04,440
concentrated ions and other salts over

187
00:07:08,510 --> 00:07:06,660
time creating these really acidic Briny

188
00:07:10,309 --> 00:07:08,520

environments

189
00:07:12,050 --> 00:07:10,319
there's hundreds of these lakes and we

190
00:07:14,870 --> 00:07:12,060
were really lucky to sample a really

191
00:07:16,969 --> 00:07:14,880
broad spectrum of them so on the x-axis

192
00:07:19,909 --> 00:07:16,979
is water activity and on the y-axis is

193
00:07:22,610 --> 00:07:19,919
pH and I was really thrilled to get a

194
00:07:25,010 --> 00:07:22,620
nice group of lakes to sample for

195
00:07:27,409 --> 00:07:25,020
activity analysis especially these ones

196
00:07:30,350 --> 00:07:27,419
that are boxed these are were at a water

197
00:07:32,450 --> 00:07:30,360
activity at 0.7 and they range in PH so

198
00:07:35,870 --> 00:07:32,460
it's a really good opportunity to kind

199
00:07:38,270 --> 00:07:35,880
of look at how pH affects metabolism at

200
00:07:42,469 --> 00:07:38,280
low water activity

201
00:07:44,629 --> 00:07:42,479
so at this this study I analyzed

202
00:07:47,270 --> 00:07:44,639
metabolic activity specifically anabolic

203
00:07:50,089 --> 00:07:47,280
activity by incubating these brines with

204
00:07:52,490 --> 00:07:50,099
an analog amino acid called hpg

205
00:07:54,589 --> 00:07:52,500
cells that are active in the sample will

206
00:07:56,930 --> 00:07:54,599
take up hpg and incorporate them into

207
00:07:59,930 --> 00:07:56,940
their new proteins that are produced and

208
00:08:01,969 --> 00:07:59,940
then the hpg has a alkyne group on the

209
00:08:04,370 --> 00:08:01,979
end that later on in lab you can perform

210
00:08:06,529 --> 00:08:04,380
click chemistry on and click a 404 to it

211
00:08:08,330 --> 00:08:06,539
so all the cells that are active in the

212
00:08:11,029 --> 00:08:08,340
sample turn out green under the

213
00:08:13,189 --> 00:08:11,039

microscope or in flow cytometry and then

214
00:08:15,230 --> 00:08:13,199
that can be counter-stained or compared

215
00:08:17,510 --> 00:08:15,240
to cells that are stained blue via DNA

216
00:08:19,129 --> 00:08:17,520
stain of doping and so with this data

217
00:08:22,309 --> 00:08:19,139
you can calculate the percent of active

218
00:08:24,170 --> 00:08:22,319
cells across these Lakes

219
00:08:25,670 --> 00:08:24,180
so this is just an example of what this

220
00:08:27,589 --> 00:08:25,680
data set looks like these are just four

221
00:08:29,749 --> 00:08:27,599
of the 13 or 14 lakes that we were able

222
00:08:32,510 --> 00:08:29,759
to do this with on the left the lakes

223
00:08:33,709 --> 00:08:32,520
are ordered and decreasing pH and I

224
00:08:35,630 --> 00:08:33,719
thought it was also kind of interesting

225
00:08:36,949 --> 00:08:35,640
the color changes so you can admire

226
00:08:38,810 --> 00:08:36,959
those I don't know why they do that but

227
00:08:40,730 --> 00:08:38,820
that's the way it is and then in the

228
00:08:43,070 --> 00:08:40,740
middle are the dappy stain cells under

229
00:08:44,750 --> 00:08:43,080
the microscope and then on the right are

230
00:08:46,910 --> 00:08:44,760
the active cells that are tagged with

231
00:08:48,949 --> 00:08:46,920
the green fluorophore

232
00:08:50,269 --> 00:08:48,959
and you can also notice like the

233
00:08:52,850 --> 00:08:50,279
different cell morphologies and

234
00:08:55,550 --> 00:08:52,860
abundances that change with ph which is

235
00:08:57,949 --> 00:08:55,560
really fascinating and also that pH

236
00:09:00,170 --> 00:08:57,959
didn't affect the assay itself we do see

237
00:09:02,750 --> 00:09:00,180
some cells that are active at these low

238
00:09:07,130 --> 00:09:02,760

PHS and sometimes you have brines where

239
00:09:10,250 --> 00:09:08,810
so when you calculate the percent of

240
00:09:12,470 --> 00:09:10,260
active cells and you put this all in a

241
00:09:14,389 --> 00:09:12,480
plot I'll just Orient you so on the

242
00:09:17,449 --> 00:09:14,399
x-axis here we have water activity

243
00:09:19,310 --> 00:09:17,459
decreasing and on the y-axis is pH

244
00:09:21,650 --> 00:09:19,320
decreasing in this direction so you

245
00:09:24,350 --> 00:09:21,660
would expect the most extreme acidic

246
00:09:27,170 --> 00:09:24,360
brines to be kind of in this region

247
00:09:29,090 --> 00:09:27,180
this dotted line is that newly predicted

248
00:09:30,769 --> 00:09:29,100
water activity limit of life that I

249
00:09:32,690 --> 00:09:30,779
talked about earlier and then this

250
00:09:35,030 --> 00:09:32,700
dotted line represents the percent of

251
00:09:37,850 --> 00:09:35,040
active cells dropping below 50 percent

252
00:09:39,530 --> 00:09:37,860
at this pH so this color block each of

253
00:09:42,110 --> 00:09:39,540
the dots is one Lake and the color bar

254
00:09:43,550 --> 00:09:42,120
was colored on a green gradient if the

255
00:09:46,310 --> 00:09:43,560
percent of active cells is above 50

256
00:09:48,710 --> 00:09:46,320
percent and on a gradient towards black

257
00:09:50,870 --> 00:09:48,720
if it was below 50 so you can kind of

258
00:09:53,389 --> 00:09:50,880
just visually see that all of the green

259
00:09:55,910 --> 00:09:53,399
like high percentage act cells cluster

260
00:09:58,070 --> 00:09:55,920
up here and all of the low percent of

261
00:09:59,509 --> 00:09:58,080
active cells clustered down here and

262
00:10:01,250 --> 00:09:59,519
when you look at it statistically there

263
00:10:03,530 --> 00:10:01,260

is a moderately stronger correlation

264
00:10:06,650 --> 00:10:03,540
with ph and activity compared to water

265
00:10:07,730 --> 00:10:06,660
activity and activity so so many times

266
00:10:10,430 --> 00:10:07,740
you can count how many times I say

267
00:10:12,949 --> 00:10:10,440
activity in this talk

268
00:10:15,650 --> 00:10:12,959
um and so some thoughts on this

269
00:10:17,930 --> 00:10:15,660
a pH of six is really high for

270
00:10:19,370 --> 00:10:17,940
environmental samples and as we've heard

271
00:10:22,070 --> 00:10:19,380
from a lot of people and as we know

272
00:10:24,050 --> 00:10:22,080
there's a lot of microbes that live in

273
00:10:26,449 --> 00:10:24,060
way more acidic environments so what's

274
00:10:28,310 --> 00:10:26,459
actually happening here I don't have an

275
00:10:30,110 --> 00:10:28,320
answer to that yet and I'm hoping to

276
00:10:32,150 --> 00:10:30,120
figure that out with future analyzes

277
00:10:33,889 --> 00:10:32,160
that include nanosims work on these

278
00:10:36,530 --> 00:10:33,899
Lakes

279
00:10:38,210 --> 00:10:36,540
um and then if this is a true signal and

280
00:10:41,329 --> 00:10:38,220
this is what what is going on in the

281
00:10:43,310 --> 00:10:41,339
environment then microbial activity may

282
00:10:46,790 --> 00:10:43,320
be detected at lower water activities

283
00:10:48,889 --> 00:10:46,800
than we know of now as long as the pH is

284
00:10:50,569 --> 00:10:48,899
within the seven to eight maybe like not

285
00:10:52,430 --> 00:10:50,579
so acidic range

286
00:10:53,990 --> 00:10:52,440
um so figuring out what that PH range is

287
00:10:55,970 --> 00:10:54,000
and how that interacts with water

288
00:11:00,110 --> 00:10:55,980

activity limits of life

289
00:11:03,110 --> 00:11:00,120
um is something of ongoing investigation

290
00:11:05,389 --> 00:11:03,120
so with that I'd like to acknowledge my

291
00:11:08,030 --> 00:11:05,399
lab the deaca slab pictured up in the

292
00:11:09,889 --> 00:11:08,040
right all of our funding sources the

293
00:11:11,449 --> 00:11:09,899
oceans across space and time team which

294
00:11:13,370 --> 00:11:11,459
is a nasa-funded project you'll hear

295
00:11:15,949 --> 00:11:13,380
about uh you'll hear from a lot of us

296
00:11:17,509 --> 00:11:15,959
throughout this conference and all of

297
00:11:19,790 --> 00:11:17,519
our collaborators in Western Australia

298
00:11:21,110 --> 00:11:19,800
including Molly the dingo who of course

299
00:11:23,329 --> 00:11:21,120
this work would not have been possible

300
00:11:24,470 --> 00:11:23,339
without

301
00:11:25,730 --> 00:11:24,480
all right and then I'll take any

302
00:11:27,470 --> 00:11:25,740
questions and I'll leave this up so you

303
00:11:28,850 --> 00:11:27,480
can stare at the dots for a little bit

304
00:11:33,900 --> 00:11:28,860
longer

305
00:11:36,170 --> 00:11:33,910
[Music]

306
00:11:49,190 --> 00:11:36,180
[Applause]

307
00:11:52,970 --> 00:11:51,710
hi uh that was really cool talk thanks

308
00:11:54,410 --> 00:11:52,980
so much

309
00:11:56,630 --> 00:11:54,420
um I was just wondering if he could

310
00:12:00,050 --> 00:11:56,640
expand a little bit on why you

311
00:12:02,090 --> 00:12:00,060
concentrate onion anabolic

312
00:12:05,449 --> 00:12:02,100
um activity as opposed to catabolic

313
00:12:08,630 --> 00:12:05,459

activity yeah so

314
00:12:10,670 --> 00:12:08,640
let's see scientifically the reason why

315
00:12:12,290 --> 00:12:10,680
I would focus on anabolic activity I

316
00:12:13,970 --> 00:12:12,300
mean both catabolic and anabolic

317
00:12:17,810 --> 00:12:13,980
activity are essential for life right

318
00:12:19,790 --> 00:12:17,820
life has to make energy to assimilate

319
00:12:22,430 --> 00:12:19,800
substrates and ground divides so both

320
00:12:24,710 --> 00:12:22,440
processes are really important

321
00:12:27,170 --> 00:12:24,720
um and they are processes that I'll be

322
00:12:29,150 --> 00:12:27,180
combining or looking at in future field

323
00:12:31,250 --> 00:12:29,160
sites

324
00:12:33,290 --> 00:12:31,260
um with anabolic activity the

325
00:12:34,730 --> 00:12:33,300
interesting thing here is that you could

326
00:12:37,069 --> 00:12:34,740
imagine that when a cell gets really

327
00:12:39,590 --> 00:12:37,079
stressed out it would stop dividing

328
00:12:42,530 --> 00:12:39,600
potentially and still accumulate

329
00:12:44,690 --> 00:12:42,540
substrates to repair DNA repair cell

330
00:12:47,329 --> 00:12:44,700
walls do all that stuff until conditions

331
00:12:50,449 --> 00:12:47,339
get better and so the idea was that or

332
00:12:52,790 --> 00:12:50,459
my original hypothesis was that by

333
00:12:55,009 --> 00:12:52,800
um that anabolic activity would extend

334
00:12:59,629 --> 00:12:55,019
beyond the known cell division limit of

335
00:13:01,129 --> 00:12:59,639
life because even as cells are um cells

336
00:13:02,870 --> 00:13:01,139
would be able to survive just by taking

337
00:13:04,550 --> 00:13:02,880
up materials and so that taking up

338
00:13:13,850 --> 00:13:04,560

process is the anabolic Activity Part

339
00:13:19,790 --> 00:13:15,410
sweet talk

340
00:13:23,050 --> 00:13:19,800
I have a question so um you mentioned

341
00:13:26,810 --> 00:13:23,060
that you guys have essentially like uh

342
00:13:29,090 --> 00:13:26,820
extrapolated uh new

343
00:13:31,269 --> 00:13:29,100
like limit for life like in terms of

344
00:13:34,850 --> 00:13:31,279
water activity it's kind of a power move

345
00:13:37,610 --> 00:13:34,860
so we're not the first ones to do this

346
00:13:39,590 --> 00:13:37,620
okay but okay but uh could you explain

347
00:13:40,970 --> 00:13:39,600
how you extrapolated that because I

348
00:13:42,829 --> 00:13:40,980
think maybe I missed that or I didn't

349
00:13:44,269 --> 00:13:42,839
understand yeah um okay we're gonna get

350
00:13:48,530 --> 00:13:44,279
into the weeds here but let me go back

351
00:13:51,650 --> 00:13:48,540
to that slide so this this idea or this

352
00:13:52,810 --> 00:13:51,660
like extrapolation is based on

353
00:13:55,670 --> 00:13:52,820
um

354
00:13:57,170 --> 00:13:55,680
these this study here so they did the

355
00:13:59,030 --> 00:13:57,180
same thing and this is how they got this

356
00:14:01,129 --> 00:13:59,040
theoretical limit of life that has now

357
00:14:02,930 --> 00:14:01,139
been cited almost 200 times from food

358
00:14:04,670 --> 00:14:02,940
preservation fields to life detection

359
00:14:06,610 --> 00:14:04,680
Fields so

360
00:14:10,009 --> 00:14:06,620
um

361
00:14:11,509 --> 00:14:10,019
hasn't been published yet

362
00:14:13,129 --> 00:14:11,519
um so the reason so they used a

363
00:14:16,009 --> 00:14:13,139

different technique and they based it on

364
00:14:17,509 --> 00:14:16,019
cell division and so we're

365
00:14:18,769 --> 00:14:17,519
um

366
00:14:20,150 --> 00:14:18,779
so hang on let me answer your first

367
00:14:21,650 --> 00:14:20,160
question so

368
00:14:24,350 --> 00:14:21,660
um the way that we did this is single

369
00:14:25,610 --> 00:14:24,360
cell analysis allows you to separate the

370
00:14:27,650 --> 00:14:25,620
cells that are active from those that

371
00:14:29,329 --> 00:14:27,660
are inactive and in a brine environment

372
00:14:31,430 --> 00:14:29,339
this is really important because brines

373
00:14:33,710 --> 00:14:31,440
are really salty and cells can fall in

374
00:14:35,870 --> 00:14:33,720
from anywhere bird poop wind whatever

375
00:14:37,730 --> 00:14:35,880
and get preserved and those can be

376
00:14:40,430 --> 00:14:37,740
inactive so those can contribute to that

377
00:14:42,829 --> 00:14:40,440
bulk analysis and not necessarily even

378
00:14:44,509 --> 00:14:42,839
be important in that environment so with

379
00:14:46,550 --> 00:14:44,519
single cell analysis we took out the

380
00:14:48,050 --> 00:14:46,560
active cells average their anabolic

381
00:14:50,750 --> 00:14:48,060
activities so we're just focusing on

382
00:14:53,509 --> 00:14:50,760
who's contributing to metabolism in that

383
00:14:56,930 --> 00:14:53,519
environment and then use detection

384
00:14:59,210 --> 00:14:56,940
limits and and math to extrapolate and

385
00:15:01,910 --> 00:14:59,220
predict or propose this new predicted

386
00:15:03,949 --> 00:15:01,920
limit of detectable life and so this is

387
00:15:05,990 --> 00:15:03,959
not the limit of life this is what our

388
00:15:08,329 --> 00:15:06,000

measurements can detect and if we found

389
00:15:10,430 --> 00:15:08,339
an environment at 0.54 Water activity

390
00:15:12,290 --> 00:15:10,440
with similar conditions to this

391
00:15:14,629 --> 00:15:12,300
environment that we extrapolated it from

392
00:15:16,490 --> 00:15:14,639
we would technically be able to detect

393
00:15:18,170 --> 00:15:16,500
life in that environment

394
00:15:19,970 --> 00:15:18,180
and this is also a really conservative

395
00:15:22,550 --> 00:15:19,980
limit so

396
00:15:24,769 --> 00:15:22,560
um we even upped the number of standard

397
00:15:27,470 --> 00:15:24,779
deviations that we would normally do for

398
00:15:29,389 --> 00:15:27,480
our like detection limit so if we were

399
00:15:31,730 --> 00:15:29,399
to do like our data processing in the

400
00:15:47,629 --> 00:15:31,740
normal way it might even be lower that

401
00:15:53,870 --> 00:15:51,050
hey George eibel from Montana State I'm

402
00:15:56,090 --> 00:15:53,880
just curious uh you're looking at the

403
00:15:58,670 --> 00:15:56,100
Active cells were you did you look at

404
00:16:03,290 --> 00:15:58,680
who they were at all whether that was by

405
00:16:05,810 --> 00:16:03,300
fish or sequencing so in this study we

406
00:16:09,310 --> 00:16:05,820
did not look at cell identity and we

407
00:16:12,949 --> 00:16:09,320
focused um on metabolism

408
00:16:15,050 --> 00:16:12,959
in Western Australia I don't have plans

409
00:16:17,569 --> 00:16:15,060
to look at the actual like I don't know

410
00:16:19,189 --> 00:16:17,579
I could look at the Active fraction of

411
00:16:20,389 --> 00:16:19,199
cells from the bond cat analysis I

412
00:16:22,069 --> 00:16:20,399
haven't decided if I want to go down

413
00:16:24,949 --> 00:16:22,079

that road yet but in the next field site

414
00:16:25,550 --> 00:16:24,959
we are planning on on doing that so

415
00:16:29,090 --> 00:16:25,560
um

416
00:16:30,590 --> 00:16:29,100
yeah not in this not in a city

417
00:16:34,020 --> 00:16:30,600
all right thank you very much Emily yeah