2017 Astrobiology Graduate Conference

Charlottesville, VA

1
00:00:00,790 --> 00:00:08,320
[Music]

2
00:00:12,740 --> 00:00:11,360
this is kind of a side project that I

3
00:00:14,749 --> 00:00:12,750
work on

4
00:00:16,790 --> 00:00:14,759
I don't normally study salty systems

5
00:00:20,000 --> 00:00:16,800
this is kind of like a side pet project

6
00:00:24,800 --> 00:00:20,010
that we have going on until my other

7
00:00:26,900 --> 00:00:24,810
samples come in next year so why do we

8
00:00:28,880 --> 00:00:26,910
care about salt flats and astrobiology

9
00:00:32,359 --> 00:00:28,890
because we know there are salt flats on

10
00:00:37,340 --> 00:00:32,369
Mars these are the salt flats that were

11
00:00:39,619 --> 00:00:37,350
studied in 2005 and they're thought to

12
00:00:41,990 --> 00:00:39,629
be a remnant of a large body of water

13
00:00:45,020 --> 00:00:42,000

that used to be in that area a long time

14
00:00:47,840 --> 00:00:45,030
ago and these are the Salt Flats in Utah

15
00:00:52,459 --> 00:00:47,850
that I'm currently working on that were

16
00:00:54,680 --> 00:00:52,469
also where a Lake Bonneville used to be

17
00:00:57,770 --> 00:00:54,690
and then when Lake Bonneville evaporated

18
00:01:00,049 --> 00:00:57,780
we are left with the Bonneville Salt

19
00:01:02,060 --> 00:01:00,059
Flats and so there's a couple very key

20
00:01:04,340 --> 00:01:02,070
difference things between these two

21
00:01:06,770 --> 00:01:04,350
places one is that the Salt Flats in

22
00:01:09,710 --> 00:01:06,780
Utah undergo these ephemeral wet/dry

23
00:01:11,810 --> 00:01:09,720
cycles and so right now and all winter

24
00:01:16,700 --> 00:01:11,820
long they were covered in a layer water

25
00:01:19,429 --> 00:01:16,710
and then as it heats up and warms up the

26
00:01:24,039 --> 00:01:19,439
water evaporates off and dries out and

27
00:01:26,270 --> 00:01:24,049
then you get the salt crust formation so

28
00:01:28,940 --> 00:01:26,280
there haven't been too many studies on

29
00:01:31,730 --> 00:01:28,950
the salt crust formation and what are

30
00:01:34,310 --> 00:01:31,740
the biophysical chemical properties that

31
00:01:36,140 --> 00:01:34,320
lead to it um there have been some

32
00:01:38,630 --> 00:01:36,150
geology studies where they've gone and

33
00:01:40,340 --> 00:01:38,640
drilled cores and looked at like kind of

34
00:01:42,679 --> 00:01:40,350
what are the mineral components on these

35
00:01:44,539 --> 00:01:42,689
salt flats um but the only microbiology

36
00:01:46,880 --> 00:01:44,549
studies that have been done to date our

37
00:01:49,249 --> 00:01:46,890
culture dependent one of our

38
00:01:51,530 --> 00:01:49,259

collaborators has gone out and tried to

39
00:01:53,870 --> 00:01:51,540
grow things from them and isolated your

40
00:01:55,969 --> 00:01:53,880
standard halo archaea some Salona back

41
00:01:57,289 --> 00:01:55,979
there things like that that we know are

42
00:02:02,810 --> 00:01:57,299
insult these systems and aren't very

43
00:02:05,030 --> 00:02:02,820
interesting from my perspective so when

44
00:02:07,280 --> 00:02:05,040
we culture things we only get like 1% of

45
00:02:09,790 --> 00:02:07,290
the microbial community so we're taking

46
00:02:13,070 --> 00:02:09,800
a culture independent approach and

47
00:02:13,760 --> 00:02:13,080
looking at what are the total anaerobic

48
00:02:16,460 --> 00:02:13,770
and aerobic

49
00:02:18,530 --> 00:02:16,470
microbe communities out there and then I

50
00:02:20,300 --> 00:02:18,540
want to dig a little bit deeper and sort

51
00:02:22,820 --> 00:02:20,310
of ask this question what are they doing

52
00:02:24,590 --> 00:02:22,830
and what are the species that are really

53
00:02:27,410 --> 00:02:24,600
responsible for the primary carbon

54
00:02:30,380 --> 00:02:27,420
fixation in the system and do they need

55
00:02:33,730 --> 00:02:30,390
hydrogen as the electron source and so

56
00:02:36,770 --> 00:02:33,740
this second question sort of comes more

57
00:02:38,750 --> 00:02:36,780
into play when we think about the

58
00:02:41,300 --> 00:02:38,760
anaerobic community members that could

59
00:02:43,610 --> 00:02:41,310
be fixing carbon in there and more

60
00:02:46,070 --> 00:02:43,620
specifically the methanogens and the

61
00:02:48,770 --> 00:02:46,080
asita jhin's that um might possibly be

62
00:02:52,010 --> 00:02:48,780
there because they both need hydrogen as

63
00:02:57,010 --> 00:02:52,020

electron donor and so the Bonneville

64
00:02:59,300 --> 00:02:57,020
Salt Flats are also an interesting space

65
00:03:00,650 --> 00:02:59,310
aside from other salt flats because you

66
00:03:04,190 --> 00:03:00,660
have a lot of human activities that go

67
00:03:05,960 --> 00:03:04,200
on out there so these high speed land

68
00:03:09,020 --> 00:03:05,970
races take place every year that the

69
00:03:10,640 --> 00:03:09,030
salt crust thickness um is actually

70
00:03:13,250 --> 00:03:10,650
thick enough for them to occur and so

71
00:03:14,870 --> 00:03:13,260
you have like the highest speeds that

72
00:03:16,310 --> 00:03:14,880
have occurred on land have been out here

73
00:03:20,690 --> 00:03:16,320
and also the highest speeds on a

74
00:03:22,580 --> 00:03:20,700
barstool have taken place there and so

75
00:03:24,620 --> 00:03:22,590
we also have mining processes that are

76
00:03:27,530 --> 00:03:24,630
going on there they pump out the

77
00:03:31,040 --> 00:03:27,540
underground water and pump it into

78
00:03:33,020 --> 00:03:31,050
evaporating ponds and then sell that as

79
00:03:35,680 --> 00:03:33,030
table salt so you might be eating salt

80
00:03:40,400 --> 00:03:35,690
from Utah with your dinner tonight um

81
00:03:41,990 --> 00:03:40,410
okay so we went out and sampled some

82
00:03:44,600 --> 00:03:42,000
things as we do as environmental

83
00:03:46,699 --> 00:03:44,610
microbiologist so we paired up with our

84
00:03:49,430 --> 00:03:46,709
geology collaborators and the geology

85
00:03:52,640 --> 00:03:49,440
took samples all over here from every

86
00:03:55,280 --> 00:03:52,650
single site labeled they actually use

87
00:03:57,830 --> 00:03:55,290
this really cool drill and drilled them

88
00:03:59,630 --> 00:03:57,840

out and they got down there fairly deep

89
00:04:01,040 --> 00:03:59,640
however all of these samples were

90
00:04:03,410 --> 00:04:01,050
useless to us because they collected

91
00:04:06,440 --> 00:04:03,420
them in a way that was not aseptic there

92
00:04:10,820 --> 00:04:06,450
was no way to drill them cleanly um so

93
00:04:13,940 --> 00:04:10,830
we went out and instead dug pits um so

94
00:04:16,550 --> 00:04:13,950
we we sterilized our tools between sites

95
00:04:22,460 --> 00:04:16,560
as best as we could with ethanol and

96
00:04:24,440 --> 00:04:22,470
flame and these okay these are the sites

97
00:04:27,230 --> 00:04:24,450
that we sampled in red right here and so

98
00:04:29,480 --> 00:04:27,240
um this black line right here is the

99
00:04:31,400 --> 00:04:29,490
racetrack and so we tried to get a

100
00:04:33,950 --> 00:04:31,410
sample on and off the racetrack and sort

101
00:04:37,610 --> 00:04:33,960
of in this transect across the entire

102
00:04:39,680 --> 00:04:37,620
area and these are what our pits look

103
00:04:43,370 --> 00:04:39,690
like at each one of those sites um so

104
00:04:44,570 --> 00:04:43,380
you can see in in this site right here

105
00:04:44,839 --> 00:04:44,580
oh these aren't really coming up too

106
00:04:49,969 --> 00:04:44,849
well

107
00:04:51,770 --> 00:04:49,979
textural layers as you got down and so

108
00:04:55,070 --> 00:04:51,780
they looked different and we split them

109
00:04:57,409 --> 00:04:55,080
up according to those like visual and

110
00:04:59,629 --> 00:04:57,419
textural layers some of them had only

111
00:05:04,059 --> 00:04:59,639
two layers and some of them had three

112
00:05:07,370 --> 00:05:04,069
layers and one of them had four layers

113
00:05:09,469 --> 00:05:07,380

and so we got back to the lab with all

114
00:05:11,870 --> 00:05:09,479
of these samples homogenized them

115
00:05:14,689 --> 00:05:11,880
extracted DNA from them sent a subset

116
00:05:18,710 --> 00:05:14,699
off to geology to do mineral analysis

117
00:05:21,589 --> 00:05:18,720
and then we sequence them using 16s

118
00:05:24,920 --> 00:05:21,599
sequencing and we will be doing

119
00:05:26,600 --> 00:05:24,930
metagenomic sequencing on a select few

120
00:05:28,370 --> 00:05:26,610
of these hits we haven't decided which

121
00:05:31,909 --> 00:05:28,380
ones to do that yet that's kind of the

122
00:05:34,459 --> 00:05:31,919
next step and I also set up these

123
00:05:35,450 --> 00:05:34,469
enriched carbon incubations try to get

124
00:05:37,219 --> 00:05:35,460
at this question of what are the

125
00:05:39,320 --> 00:05:37,229
microbes doing there so I wanted to dig

126
00:05:40,999 --> 00:05:39,330
a little bit deeper beyond who is there

127
00:05:45,350 --> 00:05:41,009
and try to answer this what are they

128
00:05:50,659 --> 00:05:45,360
doing and so I use stable isotope

129
00:05:53,240 --> 00:05:50,669
tracing with 13c carbon so these are all

130
00:05:55,999 --> 00:05:53,250
of the media that I set up incubations

131
00:05:57,499 --> 00:05:56,009
with I chose glucose to sort of get an

132
00:06:01,010 --> 00:05:57,509
idea of what the heterotrophic community

133
00:06:03,379 --> 00:06:01,020
is like so what are the organisms that

134
00:06:04,760 --> 00:06:03,389
are consuming carbon produced by other

135
00:06:06,950 --> 00:06:04,770
species there

136
00:06:10,300 --> 00:06:06,960
I chose acetate because I'm interested

137
00:06:12,670 --> 00:06:10,310
in the interplay between asita jhin's

138
00:06:16,520 --> 00:06:12,680

organisms that make acetate methanogens

139
00:06:18,260 --> 00:06:16,530
organisms to make methane and that have

140
00:06:19,580 --> 00:06:18,270
trophic community so can the

141
00:06:23,420 --> 00:06:19,590
heterotrophic community consume the

142
00:06:27,439 --> 00:06:23,430
acetate made by the citizens and I set

143
00:06:29,180 --> 00:06:27,449
up these bicarbonate incubations also to

144
00:06:31,010 --> 00:06:29,190
sort of get at this play between

145
00:06:35,120 --> 00:06:31,020
methanogens and its citizens they both

146
00:06:37,519 --> 00:06:35,130
usually compete for co2 as well as even

147
00:06:39,589 --> 00:06:37,529
sometimes you have sulfate reducers that

148
00:06:42,019 --> 00:06:39,599
can use all of these compounds

149
00:06:43,429 --> 00:06:42,029
and so sulfate readers will generally

150
00:06:45,709 --> 00:06:43,439
out-compete both the citizens and

151
00:06:49,100 --> 00:06:45,719
methanogens for things there's much

152
00:06:52,519 --> 00:06:49,110
better at grabbing these things and they

153
00:06:53,839 --> 00:06:52,529
it takes some much less energy to do

154
00:06:58,010 --> 00:06:53,849
what they're doing then the methanogens

155
00:06:59,419 --> 00:06:58,020
and these heated ins um so so that's why

156
00:07:02,559 --> 00:06:59,429
I did all of these and then we had one

157
00:07:05,419 --> 00:07:02,569
with hydrogen and one without hydrogen

158
00:07:07,339 --> 00:07:05,429
again this is because the citizens and

159
00:07:09,469 --> 00:07:07,349
the methanogens specifically need the

160
00:07:11,179 --> 00:07:09,479
hydrogen as electron donor as well as

161
00:07:14,269 --> 00:07:11,189
bicarbonate to grow um

162
00:07:16,189 --> 00:07:14,279
and so these are the incubations right

163
00:07:19,939 --> 00:07:16,199

here they hung out on my bench for about

164
00:07:23,059 --> 00:07:19,949
sixty days and then I extracted all of

165
00:07:27,230 --> 00:07:23,069
the headspace um inside of these EXA

166
00:07:29,149 --> 00:07:27,240
Taner tubes and split that up into two

167
00:07:31,999 --> 00:07:29,159
samples for the glucose and acetate

168
00:07:33,920 --> 00:07:32,009
samples one to be sent off for thirteen

169
00:07:38,839 --> 00:07:33,930
co2 analysis one to be sent off for

170
00:07:40,429 --> 00:07:38,849
thirteen ch4 analysis um and so the

171
00:07:43,159 --> 00:07:40,439
reason we did this is because if you

172
00:07:46,309 --> 00:07:43,169
have something consuming glucose that is

173
00:07:48,769 --> 00:07:46,319
labeled with this 13 C they'll respire

174
00:07:50,779 --> 00:07:48,779
it out as 13 co2 and so you can catch

175
00:07:52,609 --> 00:07:50,789
that in the headspace and likewise with

176
00:07:54,049 --> 00:07:52,619
methane if you have active methanogens

177
00:07:57,319 --> 00:07:54,059
in your community that are using any of

178
00:07:59,959 --> 00:07:57,329
these urgency car pot compounds um they

179
00:08:04,399 --> 00:07:59,969
will you can see that as a tracer in the

180
00:08:05,749 --> 00:08:04,409
headspace gases so this kind of answers

181
00:08:07,309 --> 00:08:05,759
the question of what is the total

182
00:08:09,889 --> 00:08:07,319
microbial community doing but doesn't

183
00:08:12,290 --> 00:08:09,899
get at the individuals that are doing it

184
00:08:15,949 --> 00:08:12,300
and so I'm also doing these single cell

185
00:08:17,480 --> 00:08:15,959
Raman sorting experiments um using a

186
00:08:20,329 --> 00:08:17,490
microfluidic device that I'm currently

187
00:08:22,429 --> 00:08:20,339
in the process of designing and I'm not

188
00:08:24,259 --> 00:08:22,439

going to talk too much about this um

189
00:08:26,119 --> 00:08:24,269
because I don't actually have any data

190
00:08:28,489 --> 00:08:26,129
or results to show you guys or even a

191
00:08:31,759 --> 00:08:28,499
device to do them with but the idea is

192
00:08:34,279 --> 00:08:31,769
basically you can shine a Raman laser on

193
00:08:36,800 --> 00:08:34,289
a single cell and if that single cell

194
00:08:40,759 --> 00:08:36,810
has incorporated 13c into its biomass

195
00:08:43,040 --> 00:08:40,769
you'll see a shift in the spectra so you

196
00:08:45,829 --> 00:08:43,050
can then take that single cell sort it

197
00:08:48,079 --> 00:08:45,839
off to the side sequence it and answer

198
00:08:50,350 --> 00:08:48,089
the question of what cell was using

199
00:08:54,770 --> 00:08:50,360
these 13 C carbon compounds

200
00:08:56,450 --> 00:08:54,780
okay um so I will talk to you about the

201
00:09:00,740 --> 00:08:56,460
headspace data because I have some of

202
00:09:02,750 --> 00:09:00,750
that back so this is all of the data

203
00:09:05,000 --> 00:09:02,760
that I have back in a really complicated

204
00:09:09,020 --> 00:09:05,010
chart um I will just kind of go through

205
00:09:11,480 --> 00:09:09,030
it step by step so um we'll look at the

206
00:09:16,220 --> 00:09:11,490
methane data first so as I told you

207
00:09:19,120 --> 00:09:16,230
methanogens need hydrogen to grow um so

208
00:09:21,500 --> 00:09:19,130
we would expect methanogens to be only

209
00:09:24,020 --> 00:09:21,510
producing methane in this control right

210
00:09:26,630 --> 00:09:24,030
here with hydrogen however we can see

211
00:09:29,720 --> 00:09:26,640
that there is some methane production in

212
00:09:35,180 --> 00:09:29,730
these other incue bation x' without

213
00:09:37,580 --> 00:09:35,190

hydrogen so this kind of indicates that

214
00:09:38,960 --> 00:09:37,590
methanogens might be using hydrogen but

215
00:09:43,820 --> 00:09:38,970
they could also be using something else

216
00:09:46,670 --> 00:09:43,830
for their electron donor and so we did

217
00:09:49,940 --> 00:09:46,680
aerobic and anaerobic incubations were

218
00:09:51,920 --> 00:09:49,950
not really expecting any sort of methane

219
00:09:53,420 --> 00:09:51,930
production in these aerobic incubations

220
00:09:56,120 --> 00:09:53,430
because methanogens or anaerobic

221
00:09:58,430 --> 00:09:56,130
organisms and oxygen generally kills

222
00:10:01,250 --> 00:09:58,440
them if they're exposed to it for a

223
00:10:02,600 --> 00:10:01,260
really long time so this is kind of what

224
00:10:07,430 --> 00:10:02,610
we expected to see across the board

225
00:10:09,290 --> 00:10:07,440
either in one of these two however in

226
00:10:11,630 --> 00:10:09,300
this one pit fifty-six

227
00:10:14,030 --> 00:10:11,640
we did get some methane production in

228
00:10:18,590 --> 00:10:14,040
the aerobic incubations and not the

229
00:10:21,200 --> 00:10:18,600
anaerobic incubations um so this is very

230
00:10:22,970 --> 00:10:21,210
strange and I don't really have too many

231
00:10:26,000 --> 00:10:22,980
ideas of what's going on here um

232
00:10:29,900 --> 00:10:26,010
especially because you can see in layer

233
00:10:32,900 --> 00:10:29,910
four you have a lot of it and maybe they

234
00:10:35,030 --> 00:10:32,910
were consuming all of the oxygen that

235
00:10:36,530 --> 00:10:35,040
was in the - or maybe other my grew new

236
00:10:38,420 --> 00:10:36,540
members were consuming all oxygen in the

237
00:10:40,490 --> 00:10:38,430
tube really quickly and so you get to

238
00:10:43,100 --> 00:10:40,500

that anaerobic state fairly fast

239
00:10:45,890 --> 00:10:43,110
um I didn't set up anaerobic incubations

240
00:10:48,130 --> 00:10:45,900
for that layer because our koi chamber

241
00:10:51,310 --> 00:10:48,140
sort of crapped out on us that night and

242
00:10:54,140 --> 00:10:51,320
refused to work because it had no gas um

243
00:10:56,810 --> 00:10:54,150
so I wasn't able to set up once for that

244
00:10:59,360 --> 00:10:56,820
layer unfortunately but also I had a

245
00:11:03,620 --> 00:10:59,370
little bit of methane production right

246
00:11:06,140 --> 00:11:03,630
here in this layer too

247
00:11:08,480 --> 00:11:06,150
as you'll note up here we also had

248
00:11:10,850 --> 00:11:08,490
methane production from glucose which is

249
00:11:13,130 --> 00:11:10,860
very strange because methanogens can't

250
00:11:16,520 --> 00:11:13,140
use glucose they can't even transport it

251
00:11:19,250 --> 00:11:16,530
inside of their cell and so because this

252
00:11:21,920 --> 00:11:19,260
occurred in aerobic incubations and not

253
00:11:23,300 --> 00:11:21,930
the anaerobic incubations this kind of

254
00:11:25,610 --> 00:11:23,310
suggests that there's some sort of

255
00:11:27,380 --> 00:11:25,620
partnering going on with the aerobic

256
00:11:34,940 --> 00:11:27,390
microbial community members and the

257
00:11:37,910 --> 00:11:34,950
methanogens and so we can kind of extend

258
00:11:39,250 --> 00:11:37,920
this into pit 12v where I also saw the

259
00:11:41,660 --> 00:11:39,260
same thing

260
00:11:43,700 --> 00:11:41,670
there was methane production from

261
00:11:46,790 --> 00:11:43,710
glucose going on under aerobic

262
00:11:49,400 --> 00:11:46,800
conditions but not anaerobic conditions

263
00:11:52,580 --> 00:11:49,410

down here and so this was kind of a

264
00:11:54,500 --> 00:11:52,590
strange result but it also kind of makes

265
00:11:58,370 --> 00:11:54,510
sense when you look at the co2 data so

266
00:12:02,270 --> 00:11:58,380
in these same tubes right here where I

267
00:12:04,700 --> 00:12:02,280
have methane production from glucose we

268
00:12:06,410 --> 00:12:04,710
know that there's labeled co2 in there

269
00:12:09,430 --> 00:12:06,420
so I kind of have even more evidence

270
00:12:12,140 --> 00:12:09,440
that these aerobic community members are

271
00:12:14,090 --> 00:12:12,150
aerobic lee respiring glucose turning it

272
00:12:16,130 --> 00:12:14,100
into 13 co2 and then the most antigens

273
00:12:18,950 --> 00:12:16,140
are able to use that 13 co2 and making

274
00:12:22,610 --> 00:12:18,960
methane and I think a similar story is

275
00:12:27,290 --> 00:12:22,620
happening with acetate right here in pit

276
00:12:29,720 --> 00:12:27,300
12b and so some methanogens can directly

277
00:12:31,520 --> 00:12:29,730
use acetate to make methane however I

278
00:12:37,820 --> 00:12:31,530
don't think that's going on because if

279
00:12:40,940 --> 00:12:37,830
we look at the whoops okay um so if we

280
00:12:47,420 --> 00:12:40,950
look at the anaerobic ones down here

281
00:12:49,670 --> 00:12:47,430
with acetate and uh yeah so if we look

282
00:12:51,470 --> 00:12:49,680
at the the ones down here that are

283
00:12:55,310 --> 00:12:51,480
anaerobic with acetate there is no

284
00:12:57,020 --> 00:12:55,320
methane production so methanogens are

285
00:12:58,580 --> 00:12:57,030
anaerobic if they were able to use

286
00:13:00,130 --> 00:12:58,590
acetate directly we would expect to see

287
00:13:04,300 --> 00:13:00,140
methane production in the anaerobic

288
00:13:07,280 --> 00:13:04,310

controls also but we only see it in the

289
00:13:11,480 --> 00:13:07,290
aerobic ones so this is further evidence

290
00:13:13,370 --> 00:13:11,490
that there is in fact some sort of

291
00:13:15,040 --> 00:13:13,380
interaction between the aerobic

292
00:13:16,790 --> 00:13:15,050
community members and the methanogens

293
00:13:25,840 --> 00:13:16,800
especially in

294
00:13:31,250 --> 00:13:25,850
layer two right here okay so um whoops

295
00:13:32,509 --> 00:13:31,260
let me go on to what's going on Oh okay

296
00:13:37,730 --> 00:13:32,519
so that was what I just mentioned where

297
00:13:39,290 --> 00:13:37,740
you have um no so you have no methane

298
00:13:44,660 --> 00:13:39,300
production right here from bicarbonate

299
00:13:46,670 --> 00:13:44,670
also uh in layer one all right right

300
00:13:48,920 --> 00:13:46,680
here yeah so in layer one you have no

301
00:13:52,519 --> 00:13:48,930
methane production in the anaerobic

302
00:13:54,410 --> 00:13:52,529
controls from bicarbonate but we kind of

303
00:13:57,500 --> 00:13:54,420
see it as we go deeper in the pits and

304
00:13:59,630 --> 00:13:57,510
so this is a result that sort of makes

305
00:14:01,430 --> 00:13:59,640
sense because you would expect

306
00:14:03,590 --> 00:14:01,440
methanogens to be deeper down in the

307
00:14:07,910 --> 00:14:03,600
soil where they're kind of isolated from

308
00:14:10,460 --> 00:14:07,920
that oxygen that's getting to them okay

309
00:14:13,940 --> 00:14:10,470
and then lastly we'll kind of look up

310
00:14:16,310 --> 00:14:13,950
here at what was going on in the aerobic

311
00:14:18,410 --> 00:14:16,320
bicarbonate incubations and so you can

312
00:14:23,030 --> 00:14:18,420
see there's a little bit of methane

313
00:14:24,079 --> 00:14:23,040

production in that first layer um so for

314
00:14:26,150 --> 00:14:24,089
some reason there were a little bit of

315
00:14:28,400 --> 00:14:26,160
methanogens that maybe we're hanging out

316
00:14:30,170 --> 00:14:28,410
in here but they can't really do

317
00:14:31,430 --> 00:14:30,180
anything because they're not they're not

318
00:14:32,510 --> 00:14:31,440
doing anything right here when it's in

319
00:14:34,069 --> 00:14:32,520
aerobic they can't really do anything

320
00:14:38,840 --> 00:14:34,079
unless they have their aerobic partners

321
00:14:40,610 --> 00:14:38,850
um so this pit right here definitely

322
00:14:43,670 --> 00:14:40,620
there's some interesting things going on

323
00:14:45,079 --> 00:14:43,680
and I don't really have too much else to

324
00:14:47,870 --> 00:14:45,089
say about that other than there's some

325
00:14:50,000 --> 00:14:47,880
evidence that it's happening um but I

326
00:14:51,440 --> 00:14:50,010
don't really know too much more until I

327
00:14:55,940 --> 00:14:51,450
dig a little bit deeper into this story

328
00:14:59,210 --> 00:14:55,950
um okay so who are the microbial

329
00:15:03,620 --> 00:14:59,220
community members so this is our total

330
00:15:06,350 --> 00:15:03,630
16s sequencing of all of the archaea

331
00:15:08,750 --> 00:15:06,360
unity members and from sample to sample

332
00:15:12,350 --> 00:15:08,760
layer to layer it all pretty much looked

333
00:15:15,530 --> 00:15:12,360
like this and so it's mainly dominated

334
00:15:18,350 --> 00:15:15,540
by hey Leo Beck bye halo bacteria AC II

335
00:15:21,290 --> 00:15:18,360
which isn't too surprising they're from

336
00:15:24,410 --> 00:15:21,300
Salt Flats so layer 1 to layer 3 you

337
00:15:26,900 --> 00:15:24,420
just get a bunch of halo back t racy and

338
00:15:29,600 --> 00:15:26,910

these are the heterotrophic halo archaea

339
00:15:32,069 --> 00:15:29,610
that we just heard to talk about

340
00:15:33,600 --> 00:15:32,079
except they're not cold-adapted they're

341
00:15:37,350 --> 00:15:33,610
kind of hanging out in normal

342
00:15:40,980 --> 00:15:37,360
temperatures okay so I looked at the

343
00:15:42,059 --> 00:15:40,990
similarity between these samples um even

344
00:15:43,319 --> 00:15:42,069
though they kind of looked all the same

345
00:15:45,989 --> 00:15:43,329
when I just look at who's there you can

346
00:15:47,819 --> 00:15:45,999
this is an MDS plot and so the Axius

347
00:15:49,379 --> 00:15:47,829
don't really matter too much they're

348
00:15:51,110 --> 00:15:49,389
largely arbitrary it's sort of like a

349
00:15:53,730 --> 00:15:51,120
PCA plot if you're familiar with that

350
00:15:55,590 --> 00:15:53,740
and it's really just the distance

351
00:15:57,780 --> 00:15:55,600
between each of these points that have

352
00:15:59,429 --> 00:15:57,790
any meaning on here and so some

353
00:16:02,129 --> 00:15:59,439
interesting trends sort of come out when

354
00:16:04,590 --> 00:16:02,139
you look at the Archaea unity in this

355
00:16:09,090 --> 00:16:04,600
way and you can see all of these circles

356
00:16:11,009 --> 00:16:09,100
on here are layer 1 all of the triangles

357
00:16:13,470 --> 00:16:11,019
on here are layer 2 and all of the

358
00:16:15,660 --> 00:16:13,480
squares are layer 3 so you kind of have

359
00:16:18,019 --> 00:16:15,670
like this general shift in your

360
00:16:21,299 --> 00:16:18,029
microbial community as you go down and

361
00:16:23,040 --> 00:16:21,309
just to kind of show you I don't have

362
00:16:25,259 --> 00:16:23,050
these labeled I just told you what was

363
00:16:27,150 --> 00:16:25,269

in there these are all just down to you

364
00:16:30,179 --> 00:16:27,160
the genus level different halo bacteria

365
00:16:32,040 --> 00:16:30,189
a seee um but it's not really shifting

366
00:16:33,629 --> 00:16:32,050
in who's there it's just the abundances

367
00:16:34,910 --> 00:16:33,639
that are shifting as we go down in

368
00:16:41,160 --> 00:16:34,920
layers

369
00:16:43,829 --> 00:16:41,170
okay so bacteria so bacteria mostly

370
00:16:45,720 --> 00:16:43,839
Salona bacter and some unclassified

371
00:16:47,249 --> 00:16:45,730
bacteria where the 16s sequences didn't

372
00:16:50,160 --> 00:16:47,259
really line up to anything in the

373
00:16:52,079 --> 00:16:50,170
database but it's pretty much dominated

374
00:16:54,030 --> 00:16:52,089
by cilona vector again not too

375
00:16:56,699 --> 00:16:54,040
surprising we would completely expect

376
00:16:58,199 --> 00:16:56,709
this um you can't see it too well but we

377
00:17:00,360 --> 00:16:58,209
have some sulfate reducers right here

378
00:17:03,480 --> 00:17:00,370
and we do actually find some sea urchins

379
00:17:05,059 --> 00:17:03,490
the acetyl Darma right here um oh I

380
00:17:07,860 --> 00:17:05,069
forgot to point it out on the air keel

381
00:17:10,559 --> 00:17:07,870
graph but we did find a tiny amount of

382
00:17:13,199 --> 00:17:10,569
methanogens um so this is really

383
00:17:15,569 --> 00:17:13,209
interesting because as I was hoping we

384
00:17:18,569 --> 00:17:15,579
do have an environment where a citizen's

385
00:17:22,079 --> 00:17:18,579
methanogens and sulfate reducers are all

386
00:17:24,569 --> 00:17:22,089
coexisting and so I want to dig into a

387
00:17:26,460 --> 00:17:24,579
little bit deeper why they're not out

388
00:17:29,130 --> 00:17:26,470

competing each other and why they're all

389
00:17:33,060 --> 00:17:29,140
able to coexist in these sort of lower

390
00:17:34,350 --> 00:17:33,070
abundances in this community but I don't

391
00:17:36,299 --> 00:17:34,360
really have an answer to that yet that's

392
00:17:40,260 --> 00:17:36,309
future work we'll be looking into that a

393
00:17:41,860 --> 00:17:40,270
little bit more and so we can look at if

394
00:17:43,870 --> 00:17:41,870
we have this same

395
00:17:45,070 --> 00:17:43,880
shift that's going on in the bacterial

396
00:17:47,590 --> 00:17:45,080
community like we did with the archaea

397
00:17:51,970 --> 00:17:47,600
unity and again we have circles our

398
00:17:56,019 --> 00:17:51,980
layer one and the triangles or layer two

399
00:17:58,210 --> 00:17:56,029
and the squares are layer three and so

400
00:17:59,830 --> 00:17:58,220
again we see sort of a little bit more

401
00:18:01,870 --> 00:17:59,840
muddled than the layer two and layer 3

402
00:18:04,120 --> 00:18:01,880
with the bacterial sequences but there

403
00:18:07,690 --> 00:18:04,130
is still like a general shift sort of a

404
00:18:10,080 --> 00:18:07,700
way from layer 1 2 as you go deeper into

405
00:18:15,639 --> 00:18:10,090
the more anaerobic community members and

406
00:18:19,090 --> 00:18:15,649
here's another plot and so this is genus

407
00:18:20,950 --> 00:18:19,100
level again and it's just kind of

408
00:18:23,560 --> 00:18:20,960
showing that it doesn't really change

409
00:18:26,639 --> 00:18:23,570
the same colors are between all of the

410
00:18:29,260 --> 00:18:26,649
sequences it's really just the sizes of

411
00:18:30,880 --> 00:18:29,270
what's there so the abundances of the

412
00:18:33,070 --> 00:18:30,890
bacterial community are changing not

413
00:18:35,500 --> 00:18:33,080

exactly the individual sequences

414
00:18:37,930 --> 00:18:35,510
themself ok

415
00:18:40,360 --> 00:18:37,940
so lastly I'm going to talk a little bit

416
00:18:42,760 --> 00:18:40,370
at how I looked at the human impact on

417
00:18:47,049 --> 00:18:42,770
these microbial communities so I

418
00:18:50,200 --> 00:18:47,059
classified all of the all of the pits as

419
00:18:54,430 --> 00:18:50,210
such these ones are on the racetrack and

420
00:18:58,240 --> 00:18:54,440
these ones were off the racetrack and so

421
00:19:00,250 --> 00:18:58,250
then you can look at this you look at

422
00:19:03,399 --> 00:19:00,260
this all using a multivariate analysis

423
00:19:05,769 --> 00:19:03,409
and the everything so if you cut it off

424
00:19:09,730 --> 00:19:05,779
at zero right here every little dot

425
00:19:14,409 --> 00:19:09,740
represents a sequence and all of these

426
00:19:17,649 --> 00:19:14,419
ones that are negative belong to one of

427
00:19:20,909 --> 00:19:17,659
those pits that were on the racetrack

428
00:19:26,139 --> 00:19:20,919
whereas all of these ones up here are

429
00:19:29,970 --> 00:19:26,149
sequences from those pits that were off

430
00:19:33,240 --> 00:19:29,980
the racetrack and so I did this using

431
00:19:35,860 --> 00:19:33,250
sequences from each layer so I split I

432
00:19:37,450 --> 00:19:35,870
go back one so I split all of the

433
00:19:39,580 --> 00:19:37,460
sequences from these pits up into layer

434
00:19:43,240 --> 00:19:39,590
1 layer 2 and layer 3 and did the same

435
00:19:45,610 --> 00:19:43,250
thing layer 1 and 3 didn't have anything

436
00:19:48,850 --> 00:19:45,620
that was significant so these ones in

437
00:19:52,000 --> 00:19:48,860
red right here are the only sequences

438
00:19:54,120 --> 00:19:52,010

that are significantly different from

439
00:19:57,990 --> 00:19:54,130
any sequences up here

440
00:20:01,770 --> 00:19:58,000
um so then all of these red dots right

441
00:20:06,180 --> 00:20:01,780
here indicate a sequence from some

442
00:20:08,400 --> 00:20:06,190
microbe that is similar to everything

443
00:20:13,830 --> 00:20:08,410
that is off the racetrack that isn't

444
00:20:17,550 --> 00:20:13,840
really um on the racetrack so then you

445
00:20:20,640 --> 00:20:17,560
can say what are those sequences and um

446
00:20:24,210 --> 00:20:20,650
this isn't really that exciting it's

447
00:20:37,680 --> 00:20:24,220
just halo back to here AC again um which

448
00:20:39,300 --> 00:20:37,690
is an archaeological primers aren't

449
00:20:41,910 --> 00:20:39,310
really acting in a domain-specific way

450
00:20:43,320 --> 00:20:41,920
there's known issues with that I have to

451
00:20:45,030 --> 00:20:43,330
look into this a little bit more and

452
00:20:47,520 --> 00:20:45,040
actually go in and pull out these exact

453
00:20:48,960 --> 00:20:47,530
sequences and see if they where they

454
00:20:51,300 --> 00:20:48,970
line up to the primers and see if

455
00:20:53,400 --> 00:20:51,310
they're actually were hitting the primer

456
00:20:56,610 --> 00:20:53,410
of it's some like weird sequencing error

457
00:20:57,480 --> 00:20:56,620
um okay so anyways I don't have too much

458
00:21:02,520 --> 00:20:57,490
to say about that

459
00:21:03,840 --> 00:21:02,530
other than that we found a little bit of

460
00:21:05,520 --> 00:21:03,850
differences that might indicate human

461
00:21:08,250 --> 00:21:05,530
impact and I'm going to look into it a

462
00:21:09,750 --> 00:21:08,260
little bit further as well as do some of

463
00:21:12,030 --> 00:21:09,760

these other things like make some more

464
00:21:14,970 --> 00:21:12,040
comparisons to are there differences in

465
00:21:16,950 --> 00:21:14,980
these pits in mineralogy elemental

466
00:21:19,590 --> 00:21:16,960
concentrations like heavy metals and

467
00:21:21,390 --> 00:21:19,600
sulfur as I mentioned before we're going

468
00:21:24,930 --> 00:21:21,400
to metagenomic Li sequence some of these

469
00:21:26,580 --> 00:21:24,940
samples to sort of get an idea of what

470
00:21:29,640 --> 00:21:26,590
genes are present and link that back to

471
00:21:31,590 --> 00:21:29,650
the incubation data and then I have some

472
00:21:33,330 --> 00:21:31,600
additional headspace results that are

473
00:21:36,810 --> 00:21:33,340
going to come in from all of those

474
00:21:38,460 --> 00:21:36,820
incubations and I'm going to do the

475
00:21:42,480 --> 00:21:38,470
Raman single cell sorting of these

476
00:21:45,480 --> 00:21:42,490
samples and then right now or earlier

477
00:21:47,160 --> 00:21:45,490
this week I guess um my lab was going

478
00:21:49,650 --> 00:21:47,170
out and sampling wells that are located

479
00:21:51,450 --> 00:21:49,660
on the Salt Flats so we have shallow

480
00:21:53,040 --> 00:21:51,460
wells and deep wells and we'll be

481
00:21:54,780 --> 00:21:53,050
sequencing those and sort of comparing

482
00:21:57,450 --> 00:21:54,790
them to the surface communities to see

483
00:21:59,670 --> 00:21:57,460
if we can see if some of the shallow

484
00:22:03,420 --> 00:21:59,680
wells in the surface communities share

485
00:22:05,130 --> 00:22:03,430
similarities um and with that I would

486
00:22:07,800 --> 00:22:05,140
like to acknowledge my lab the browser

487
00:22:10,440 --> 00:22:07,810
sin lab um as well as our clabber

488
00:22:14,220 --> 00:22:10,450

readers in the geology department Brenda

489
00:22:16,800 --> 00:22:14,230
Bowen and Betsy Club WA who was the lead

490
00:22:20,010 --> 00:22:16,810
microbiologist who was at the University

491
00:22:30,110 --> 00:22:20,020
of Westminster but has since changed to

492
00:22:36,960 --> 00:22:34,290
what kind Oh what kind of salt is on the

493
00:22:39,000 --> 00:22:36,970
on this salt flat is it just mostly

494
00:22:40,800 --> 00:22:39,010
sodium chloride or I think it's got more

495
00:22:43,830 --> 00:22:40,810
magnesium than sodium in it

496
00:22:50,850 --> 00:22:43,840
I think magnesium is more than potassium

497
00:22:53,340 --> 00:22:50,860
magnesium chloride or okay um real quick

498
00:22:55,470 --> 00:22:53,350
I looked at um it looked like the soil

499
00:22:57,030 --> 00:22:55,480
below the salt was really dark is with

500
00:22:59,130 --> 00:22:57,040
is that true when you're there is it

501
00:23:01,080 --> 00:22:59,140
really dark yeah there's a lot of

502
00:23:03,180 --> 00:23:01,090
organics I guess that are below the salt

503
00:23:04,920 --> 00:23:03,190
yes so I'm really excited to get some of

504
00:23:07,500 --> 00:23:04,930
the mineral data back from the

505
00:23:08,910 --> 00:23:07,510
geologists um they have a undergrad

506
00:23:11,220 --> 00:23:08,920
who's gonna process all those all summer

507
00:23:14,430 --> 00:23:11,230
long for me um but yeah some of these

508
00:23:16,440 --> 00:23:14,440
pits you would dig down and you you

509
00:23:18,900 --> 00:23:16,450
would hit this like weird interface

510
00:23:21,750 --> 00:23:18,910
between two salt layers that was just

511
00:23:23,370 --> 00:23:21,760
really black and sulfur II smelling like

512
00:23:25,430 --> 00:23:23,380
all you just as soon as you hit it

513
00:23:31,050 --> 00:23:25,440

you're just like oh god that's sulfur

514
00:23:35,340 --> 00:23:31,060
cool all right thank you all right we

515
00:23:37,610 --> 00:23:35,350
have time for one last question so were

516
00:23:40,230 --> 00:23:37,620
you able to remove the community members

517
00:23:44,520 --> 00:23:40,240
that were predominantly present on the

518
00:23:47,130 --> 00:23:44,530
racetrack from the rest of the data um I

519
00:23:50,760 --> 00:23:47,140
don't know if I understand let me go

520
00:23:54,360 --> 00:23:50,770
back here okay so from all of these guys

521
00:23:57,420 --> 00:23:54,370
right cuz you would assume that those

522
00:23:59,850 --> 00:23:57,430
are due to human impacts well the

523
00:24:04,230 --> 00:23:59,860
problem with this is that none of these

524
00:24:06,390 --> 00:24:04,240
were really significantly different from

525
00:24:09,330 --> 00:24:06,400
ones that were off the racetrack so it

526
00:24:12,060 --> 00:24:09,340
seemed like we had sequences that were

527
00:24:13,500 --> 00:24:12,070
different off the racetrack that weren't

528
00:24:18,270 --> 00:24:13,510
found on the racetrack so is the other

529
00:24:21,160 --> 00:24:18,280
way around got it okay thanks

530
00:24:28,140 --> 00:24:21,170
all right thank you very much