
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:17,620 --> 00:00:14,160
[Music]

3
00:00:20,500 --> 00:00:17,630
hello I'm Mary Sue Buddha I'm from

4
00:00:22,060 --> 00:00:20,510
Michigan State University and I'm going

5
00:00:23,320 --> 00:00:22,070
to be bringing up some topics that have

6
00:00:25,540 --> 00:00:23,330
been covered a little bit in the

7
00:00:28,210 --> 00:00:25,550
previous session and some things that

8
00:00:31,990 --> 00:00:28,220
people have touched upon throughout apps

9
00:00:36,009 --> 00:00:32,000
icon so far but the point of this talk

10
00:00:38,619 --> 00:00:36,019
is to look at five geochemical

11
00:00:41,619 --> 00:00:38,629
interfaces in 17 izing systems at a much

12
00:00:44,470 --> 00:00:41,629
finer scale specifically we focused on

13
00:00:46,450 --> 00:00:44,480

the case study in June 2016

14
00:00:50,530 --> 00:00:46,460
at the coast range a few light microbial

15
00:00:53,110 --> 00:00:50,540
Observatory so surprising systems we

16
00:00:55,900 --> 00:00:53,120
know are common throughout the world in

17
00:00:58,660 --> 00:00:55,910
Oman Portugal Italy Newfoundland and LA

18
00:01:00,360 --> 00:00:58,670
City but for this work we study at the

19
00:01:03,700 --> 00:01:00,370
coast range Oh feel light in California

20
00:01:06,790 --> 00:01:03,710
it was in place 155 270 million years

21
00:01:08,499 --> 00:01:06,800
ago during the Jurassic period and we

22
00:01:10,650 --> 00:01:08,509
know that serpentinization mobilizes

23
00:01:13,600 --> 00:01:10,660
volatile such as hydrogen and methane

24
00:01:15,219 --> 00:01:13,610
and those ground waters can host reduced

25
00:01:16,950 --> 00:01:15,229
carbon compounds that microbes can use

26
00:01:20,109 --> 00:01:16,960
as sources of nutrients and energy

27
00:01:22,660 --> 00:01:20,119
however because the environment is

28
00:01:23,440 --> 00:01:22,670
extremely alkaline and there's low

29
00:01:25,000 --> 00:01:23,450
dissolved oxygen

30
00:01:26,950 --> 00:01:25,010
it creates really harsh environments for

31
00:01:29,320 --> 00:01:26,960
microbes to live so it's important to

32
00:01:33,910 --> 00:01:29,330
study these organisms and understand how

33
00:01:35,890 --> 00:01:33,920
they can cope with these stresses and so

34
00:01:38,320 --> 00:01:35,900
dependent associated fluids can also

35
00:01:40,690 --> 00:01:38,330
lead to limitations and availability the

36
00:01:42,910 --> 00:01:40,700
availability of nutrients such as di C

37
00:01:46,030 --> 00:01:42,920
to support growth because calcium and

38
00:01:49,690 --> 00:01:46,040

carbonate can react to precipitate s

39
00:01:52,420 --> 00:01:49,700
calcite so chromel is about three hours

40
00:01:55,149 --> 00:01:52,430
north of San Francisco of Lex my

41
00:01:57,819 --> 00:01:55,159
colleagues mentioned earlier look there

42
00:02:00,280 --> 00:01:57,829
are two well sites well clusters Cory

43
00:02:02,109 --> 00:02:00,290
Valley no.8 to the west and then core

44
00:02:04,420 --> 00:02:02,119
shed Wells to the east they're about one

45
00:02:06,280 --> 00:02:04,430
and a half kilometers apart they are

46
00:02:08,280 --> 00:02:06,290
drilled in 2011 and they are drilled to

47
00:02:11,319 --> 00:02:08,290
a bunch of different depths in order to

48
00:02:14,620 --> 00:02:11,329
gain a big-picture perspective of the

49
00:02:18,460 --> 00:02:14,630
subsurface at crumble and kind of gain

50
00:02:20,860 --> 00:02:18,470
insight into processes happening with

51
00:02:23,440 --> 00:02:20,870
depth so as a result the pH ranges from

52
00:02:25,540 --> 00:02:23,450
seven and a half to twelve dissolved

53
00:02:26,380 --> 00:02:25,550
oxygen ranges from point zero nine to

54
00:02:29,290 --> 00:02:26,390
two point four

55
00:02:31,809 --> 00:02:29,300
and eh or oxidation reduction potential

56
00:02:34,120 --> 00:02:31,819
ranges from negative 297 which is very

57
00:02:38,440 --> 00:02:34,130
reducing to 116 millivolts which is

58
00:02:42,280 --> 00:02:38,450
pretty exciting so the point of our

59
00:02:44,110 --> 00:02:42,290
study was to because serpentinization

60
00:02:46,830 --> 00:02:44,120
leads to natural gradients in water

61
00:02:50,020 --> 00:02:46,840
chemistry and all life as we know it

62
00:02:52,840 --> 00:02:50,030
requires generating energy from chemical

63
00:02:55,210 --> 00:02:52,850

gradients so we wanted to elucidate the

64
00:02:57,699 --> 00:02:55,220
relationship between microbial community

65
00:02:59,130 --> 00:02:57,709
compositions and chemical variances

66
00:03:02,430 --> 00:02:59,140
within the serpentine high ground water

67
00:03:05,830 --> 00:03:02,440
and then use that as an analogue for

68
00:03:07,900 --> 00:03:05,840
guiding our efforts in the search for a

69
00:03:11,590 --> 00:03:07,910
stir biologically relevant surprising

70
00:03:15,310 --> 00:03:11,600
systems in life elsewhere so what we did

71
00:03:19,180 --> 00:03:15,320
is in June 2016 we created a top-down

72
00:03:20,710 --> 00:03:19,190
profile of one of the well c SW 1.1 and

73
00:03:22,330 --> 00:03:20,720
the purpose was to understand how those

74
00:03:24,009 --> 00:03:22,340
chemical gradients within the energy

75
00:03:26,110 --> 00:03:24,019
limited and serpent event hosted ground

76
00:03:27,910 --> 00:03:26,120
waters could influence microbial

77
00:03:28,930 --> 00:03:27,920
community compositions and I just want

78
00:03:31,509 --> 00:03:28,940
to emphasize that this is one of the

79
00:03:33,520 --> 00:03:31,519
first comprehensive Wells comprehensive

80
00:03:36,039 --> 00:03:33,530
profiles of us repent o night hosted

81
00:03:38,830 --> 00:03:36,049
groundwater well so it's pretty

82
00:03:41,140 --> 00:03:38,840
important but this is the schematic I

83
00:03:43,840 --> 00:03:41,150
came up with for this I want to explain

84
00:03:45,819 --> 00:03:43,850
it in detail a little bit but we thought

85
00:03:48,190 --> 00:03:45,829
really long and hard about how we would

86
00:03:49,690 --> 00:03:48,200
create a profile without disturbing the

87
00:03:51,400 --> 00:03:49,700
water column and within the time

88
00:03:55,330 --> 00:03:51,410

constraints we had available to us

89
00:03:57,819 --> 00:03:55,340
that's what we did is we took tubing the

90
00:04:00,400 --> 00:03:57,829
depth to water meter an ultra-sensitive

91
00:04:02,710 --> 00:04:00,410
dissolved oxygen probe and sterile tygon

92
00:04:04,870 --> 00:04:02,720
tubing zip-tied together ethanol

93
00:04:07,449 --> 00:04:04,880
everything made sure was as clean and

94
00:04:08,860 --> 00:04:07,459
sterile as possible and then hooked one

95
00:04:11,440 --> 00:04:08,870
end of the tubing up to a peristaltic

96
00:04:16,180 --> 00:04:11,450
pump at the ground surface and then

97
00:04:18,310 --> 00:04:16,190
lowered the collective tubes into the

98
00:04:22,380 --> 00:04:18,320
well proof the top of the well in order

99
00:04:26,170 --> 00:04:22,390
to start sampling and so we chose for

100
00:04:28,870 --> 00:04:26,180
dissolved oxygen depths as a start so we

101
00:04:34,300 --> 00:04:28,880
chose 100 percent air saturation 50

102
00:04:35,470 --> 00:04:34,310
percent 15 and 0 so as we went down we

103
00:04:37,420 --> 00:04:35,480
saw

104
00:04:38,770 --> 00:04:37,430
but when we normally pump the well at

105
00:04:42,340 --> 00:04:38,780
the bottom of the well it's extremely

106
00:04:44,710 --> 00:04:42,350
anoxic so we realize there'd be a

107
00:04:47,040 --> 00:04:44,720
gradient of course with that and so we

108
00:04:50,380 --> 00:04:47,050
used it as a proxy

109
00:04:53,920 --> 00:04:50,390
so we nos are cations anions organic

110
00:04:56,140 --> 00:04:53,930
acids gases sulfide BSE and your water

111
00:04:58,990 --> 00:04:56,150
quality parameters as well as cell

112
00:05:05,670 --> 00:04:59,000
abundances cubit for DNA fluorescence

113
00:05:08,350 --> 00:05:05,680

and 16s RNA sequencing so the idea is

114
00:05:10,260 --> 00:05:08,360
after we finished pumping from the

115
00:05:12,520 --> 00:05:10,270
previous trip the water would infiltrate

116
00:05:14,650 --> 00:05:12,530
riah collaborate with the groundwater

117
00:05:16,990 --> 00:05:14,660
with the new conditions and then the

118
00:05:18,610 --> 00:05:17,000
gradients between the surface or air

119
00:05:20,140 --> 00:05:18,620
saturation and the bottom of the well

120
00:05:22,540 --> 00:05:20,150
would develop and things would stabilize

121
00:05:25,360 --> 00:05:22,550
and then during that process microbes

122
00:05:28,030 --> 00:05:25,370
could take advantage of the gradients

123
00:05:32,350 --> 00:05:28,040
and the mic for basically generating

124
00:05:35,770 --> 00:05:32,360
energy so what we see is other than

125
00:05:38,860 --> 00:05:35,780
dissolved oxygen decreasing pH

126
00:05:43,240 --> 00:05:38,870
temperature pH and conductivity were all

127
00:05:47,020 --> 00:05:43,250
analyzed and it looks like between 9.2

128
00:05:48,670 --> 00:05:47,030
and 4.6 pH decreased but then

129
00:05:52,000 --> 00:05:48,680
temperature eh and conductivity

130
00:05:55,870 --> 00:05:52,010
increased and then between four point

131
00:05:58,620 --> 00:05:55,880
six six and one point four pH increased

132
00:06:01,270 --> 00:05:58,630
and then subsequently temperature eh and

133
00:06:03,580 --> 00:06:01,280
conductivity decreased so we see some

134
00:06:04,840 --> 00:06:03,590
interfaces going on there and we want to

135
00:06:09,820 --> 00:06:04,850
explore this a little more through

136
00:06:12,400 --> 00:06:09,830
microbial analysis before you do that we

137
00:06:16,060 --> 00:06:12,410
analyzed a bunch of anions and dissolved

138
00:06:19,000 --> 00:06:16,070

gases so in the top right here we have

139
00:06:20,770 --> 00:06:19,010
hydrogen and carbon monoxide all these

140
00:06:22,810 --> 00:06:20,780
plots show dissolved oxygen on the y

141
00:06:26,880 --> 00:06:22,820
axis and then concentration of the

142
00:06:30,550 --> 00:06:26,890
parameters are on all the x axis x axis

143
00:06:32,800 --> 00:06:30,560
but hydrogen and carbon monoxide up here

144
00:06:36,190 --> 00:06:32,810
generally show an increase with

145
00:06:38,980 --> 00:06:36,200
decreasing dissolved oxygen v.i.c and

146
00:06:41,130 --> 00:06:38,990
methane show a decrease bromide of

147
00:06:44,680 --> 00:06:41,140
fluoride show a decrease and then

148
00:06:46,890 --> 00:06:44,690
hydrogen sulfide and sulfate redox

149
00:06:48,659 --> 00:06:46,900
parameters show opposite trends which

150
00:06:52,589 --> 00:06:48,669
indicate that

151
00:06:55,559 --> 00:06:52,599
at with decreasing dissolved oxygen it's

152
00:06:58,649 --> 00:06:55,569
becoming more reducing what's up so and

153
00:07:01,649 --> 00:06:58,659
then chloride also shows a decreasing

154
00:07:02,820 --> 00:07:01,659
turns so we'll draw preliminary data and

155
00:07:04,800 --> 00:07:02,830
we need to look at the cations and

156
00:07:07,350 --> 00:07:04,810
anions and balance when we get that data

157
00:07:10,830 --> 00:07:07,360
back to really understand what's

158
00:07:13,379 --> 00:07:10,840
happening but generally in terms of cell

159
00:07:15,239 --> 00:07:13,389
abundances microbial cell counts a

160
00:07:17,369 --> 00:07:15,249
decrease in cell abundance was observed

161
00:07:20,489 --> 00:07:17,379
as oxygen decreased in the wealth as

162
00:07:27,269 --> 00:07:23,719
so from 16s sequences that we received

163
00:07:29,490 --> 00:07:27,279

this one here as the 4.6 six milligrams

164
00:07:32,700 --> 00:07:29,500
per liter dissolved oxygen and then over

165
00:07:35,909 --> 00:07:32,710
here is the 0.075 or deeper into that

166
00:07:37,679 --> 00:07:35,919
profile and always see as a dominance of

167
00:07:39,929 --> 00:07:37,689
beta Proteobacteria as we've heard quite

168
00:07:43,230 --> 00:07:39,939
a lot throughout these talks they

169
00:07:46,320 --> 00:07:43,240
dominate and interestingly we see more

170
00:07:50,129 --> 00:07:46,330
diversity in that bottom of the well

171
00:07:52,320 --> 00:07:50,139
they're like the 0.075 level and that's

172
00:07:55,170 --> 00:07:52,330
likely because see some1 one is case to

173
00:07:57,809 --> 00:07:55,180
a depth and then it becomes uncased and

174
00:08:00,360 --> 00:07:57,819
so it's likely that we pulled some

175
00:08:04,139 --> 00:08:00,370
laterally influenced groundwater from

176
00:08:07,439 --> 00:08:04,149
that area but we also see Dino cacti and

177
00:08:11,730 --> 00:08:07,449
then Rico micro BA and cluster dia as

178
00:08:14,159 --> 00:08:11,740
well dominating so the implications for

179
00:08:17,070 --> 00:08:14,169
this are that we likely see some

180
00:08:18,889 --> 00:08:17,080
recharge happening in a well that led to

181
00:08:21,179 --> 00:08:18,899
subsampling sub lateral groundwater flow

182
00:08:26,240 --> 00:08:21,189
but the cluster D on the route through

183
00:08:29,879 --> 00:08:26,250
Co microbial and all their smaller less

184
00:08:31,829 --> 00:08:29,889
dominant species in these areas should

185
00:08:33,240 --> 00:08:31,839
be looked into a little bit more in

186
00:08:36,269 --> 00:08:33,250
depth to see who's there and exactly

187
00:08:38,040 --> 00:08:36,279
what they're doing but the idea is that

188
00:08:39,600 --> 00:08:38,050

those other organisms may be thriving

189
00:08:43,230 --> 00:08:39,610
off the reduced products of

190
00:08:46,110 --> 00:08:43,240
serpentinization so additionally after

191
00:08:47,639 --> 00:08:46,120
looking at this profile we compared it

192
00:08:51,710 --> 00:08:47,649
to the bottom of the well where we

193
00:08:54,930 --> 00:08:51,720
typically sample and what we see is that

194
00:08:58,110 --> 00:08:54,940
basically sulfide increases and sulfate

195
00:09:00,610 --> 00:08:58,120
decreases with decreasing dissolved

196
00:09:02,650 --> 00:09:00,620
oxygen and then pH increases and

197
00:09:04,030 --> 00:09:02,660
conductivity also increases so it's

198
00:09:08,230 --> 00:09:04,040
getting a little bit higher in

199
00:09:10,390 --> 00:09:08,240
alkalinity and a little bit saltier so

200
00:09:14,110 --> 00:09:10,400
when we compare the 16s sequences from

201
00:09:18,250 --> 00:09:14,120
our two analyses to the well bottom work

202
00:09:19,690 --> 00:09:18,260
by Katrina Queen and authors in 2017 we

203
00:09:22,930 --> 00:09:19,700
see that it's mostly beta bacteria and

204
00:09:23,860 --> 00:09:22,940
Firmicutes again but the pH is really

205
00:09:26,940 --> 00:09:23,870
high it's still 12

206
00:09:28,900 --> 00:09:26,950
so it's likely that serpentina bonus and

207
00:09:31,990 --> 00:09:28,910
which is another beta beta

208
00:09:35,260 --> 00:09:32,000
proteobacteria is dominating there

209
00:09:40,990 --> 00:09:35,270
because it's tightly coupled to pH and

210
00:09:44,920 --> 00:09:41,000
pH 12 specifically so another figure by

211
00:09:48,100 --> 00:09:44,930
Katrina tweak this is a PCA plot just

212
00:09:50,380 --> 00:09:48,110
showing that generally chromel organisms

213
00:09:53,140 --> 00:09:50,390

are influenced by a range of chemical

214
00:09:55,390 --> 00:09:53,150
parameters for instance QV one one is

215
00:09:58,030 --> 00:09:55,400
appeared by depth and temperature

216
00:09:58,450 --> 00:09:58,040
CSM b13 is influenced by temperature and

217
00:10:00,850 --> 00:09:58,460
ORP

218
00:10:03,220 --> 00:10:00,860
but what we're looking interested in SES

219
00:10:06,000 --> 00:10:03,230
f/11 and they are influenced by organic

220
00:10:08,380 --> 00:10:06,010
acids predominantly pH and conductivity

221
00:10:10,150 --> 00:10:08,390
so when we get to organic acids added

222
00:10:13,180 --> 00:10:10,160
back we can see at the top of the well

223
00:10:17,650 --> 00:10:13,190
is still in line with what we see at the

224
00:10:20,950 --> 00:10:17,660
bottom of the well but yes then we

225
00:10:22,900 --> 00:10:20,960
compared the chromo data to the season

226
00:10:26,560 --> 00:10:22,910
one one data to the other wells at

227
00:10:28,810 --> 00:10:26,570
chromo and we see that beta

228
00:10:31,360 --> 00:10:28,820
proteobacteria alpha and gamma dominate

229
00:10:33,760 --> 00:10:31,370
in QV 1 - beta proteobacteria

230
00:10:37,270 --> 00:10:33,770
austria and alpha dominates in CS 3 1/3

231
00:10:39,790 --> 00:10:37,280
and then beta clostridia pastila and

232
00:10:42,520 --> 00:10:39,800
gamma proteobacteria dominate throughout

233
00:10:45,220 --> 00:10:42,530
QV 1 1 and so it's likely that there is

234
00:10:47,620 --> 00:10:45,230
a more bit more diversity here because

235
00:10:50,940 --> 00:10:47,630
it's less alkaline and the conditions

236
00:10:53,260 --> 00:10:50,950
aren't as harsh for organisms to survive

237
00:10:58,600 --> 00:10:53,270
even if just by a little bit it may be

238
00:11:01,360 --> 00:10:58,610

just enough so just to conclude we still

239
00:11:03,610 --> 00:11:01,370
need to get 16s sequences back from the

240
00:11:05,830 --> 00:11:03,620
very top of the profile and the 15%

241
00:11:07,570 --> 00:11:05,840
interval so when we do that we'll be

242
00:11:08,710 --> 00:11:07,580
able to get a full column geochemistry

243
00:11:12,520 --> 00:11:08,720
and microbiology didn't really

244
00:11:13,820 --> 00:11:12,530
understand what's happening but perhaps

245
00:11:15,320 --> 00:11:13,830
we can also

246
00:11:17,510 --> 00:11:15,330
create profiles of other Wells in the

247
00:11:19,040 --> 00:11:17,520
system to compare and analyze and see if

248
00:11:20,480 --> 00:11:19,050
this is just happening in CS everyone

249
00:11:23,270 --> 00:11:20,490
one or if it's consistent throughout the

250
00:11:25,400 --> 00:11:23,280
rest and then this is important because

251
00:11:27,560 --> 00:11:25,410
that Union it lends unique insight into

252
00:11:29,030 --> 00:11:27,570
the variability of microbial species

253
00:11:31,460 --> 00:11:29,040
that can inhabit serpentine izing

254
00:11:33,830 --> 00:11:31,470
systems and the extreme conditions and

255
00:11:35,720 --> 00:11:33,840
then this will help us understand the

256
00:11:38,690 --> 00:11:35,730
distribution and activities of microbes

257
00:11:40,940 --> 00:11:38,700
in the subsurface at chromel in order to

258
00:11:44,030 --> 00:11:40,950
help us detect life in other aster

259
00:11:45,710 --> 00:11:44,040
biologically relevant scenarios so with

260
00:11:47,390 --> 00:11:45,720
that I would like to thank that Nai

261
00:11:49,160 --> 00:11:47,400
early career collaboration award because

262
00:11:51,710 --> 00:11:49,170
without that this would not have been

263
00:11:53,180 --> 00:11:51,720

possible and also Torrey and Mike for

264
00:11:57,080 --> 00:11:53,190
hosting me at Ames this past summer it

265
00:11:58,490 --> 00:11:57,090
was they were a huge help and then the

266
00:12:01,940 --> 00:11:58,500
shrink lab at Michigan State and the

267
00:12:13,250 --> 00:12:01,950
rock powered life team we're also key in

268
00:12:15,320 --> 00:12:13,260
this analysis so thank you alright we

269
00:12:24,550 --> 00:12:15,330
have time for one question and if the

270
00:12:31,129 --> 00:12:27,889
great talk Mary thank you I noticed that

271
00:12:33,650 --> 00:12:31,139
you had a spike in your geochemistry as

272
00:12:35,840 --> 00:12:33,660
you are going down the the do gradient

273
00:12:39,319 --> 00:12:35,850
so not at the very bottom but the one

274
00:12:42,470 --> 00:12:39,329
right above it do you have any idea what

275
00:12:44,120 --> 00:12:42,480
the geochemical or microbiological

276
00:12:46,310 --> 00:12:44,130
reasons or implications could be of that

277
00:12:47,480 --> 00:12:46,320
so I think it's partially because we

278
00:12:50,210 --> 00:12:47,490
have the real collaboration of the well

279
00:12:51,889 --> 00:12:50,220
but then also when we were pumping we

280
00:12:53,810 --> 00:12:51,899
saw a little bit of recharge Japanese so

281
00:12:55,340 --> 00:12:53,820
the water actually increased a little

282
00:12:58,250 --> 00:12:55,350
bit so I think we are pulling laterally

283
00:13:01,519 --> 00:12:58,260
from some probably some surprising water