
AbSciCon
2019

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

2
00:00:11,110 --> 00:00:09,150
[Applause]

3
00:00:12,549 --> 00:00:11,120
so I'm going to talk about some recent

4
00:00:14,140 --> 00:00:12,559
work that I've been conducting over the

5
00:00:15,850 --> 00:00:14,150
last years looking at these interesting

6
00:00:17,710 --> 00:00:15,860
microbial populations from hot springs

7
00:00:19,720 --> 00:00:17,720
and how they might give us a little bit

8
00:00:23,620 --> 00:00:19,730
of a better idea of the early evolution

9
00:00:25,089 --> 00:00:23,630
of sulfate reducers so microbial

10
00:00:26,620 --> 00:00:25,099
dissimilatory sulfate reduction is an

11
00:00:29,710 --> 00:00:26,630
incredibly important process on

12
00:00:31,479 --> 00:00:29,720
contemporary earth it has the the

13
00:00:33,520 --> 00:00:31,489

function of coupling both sulfur and

14
00:00:35,830 --> 00:00:33,530
carbon biogeochemical cycling on earth

15
00:00:38,350 --> 00:00:35,840
in fact over 11 Terra moles of sulfate

16
00:00:41,189 --> 00:00:38,360
are estimated to be reduced by microbial

17
00:00:44,319 --> 00:00:41,199
dissimilatory sulfate reduction annually

18
00:00:46,329 --> 00:00:44,329
and via the concerted oxidation of

19
00:00:48,849 --> 00:00:46,339
organic carbon and sediments up to about

20
00:00:50,110 --> 00:00:48,859
30% estimated of the organic carbon

21
00:00:52,930 --> 00:00:50,120
that's delivered at the sea floor is

22
00:00:55,270 --> 00:00:52,940
actually oxidized via the sulfate

23
00:00:57,040 --> 00:00:55,280
reduction and has the effect of of being

24
00:01:01,809 --> 00:00:57,050
a very important process on contemporary

25
00:01:04,240 --> 00:01:01,819
earth and we've got idea this microbial

26
00:01:07,540 --> 00:01:04,250
metabolism has been an important part of

27
00:01:10,330 --> 00:01:07,550
life since very early on through lots of

28
00:01:12,040 --> 00:01:10,340
work particularly through analysis

29
00:01:13,810 --> 00:01:12,050
investigation of the dresser formation

30
00:01:15,430 --> 00:01:13,820
in Western Australia we've heard several

31
00:01:18,340 --> 00:01:15,440
great talks that have highlighted some

32
00:01:21,070 --> 00:01:18,350
of the great finds coming from this area

33
00:01:22,780 --> 00:01:21,080
we know that microbial sulfate reducers

34
00:01:26,500 --> 00:01:22,790
have likely been around since about 3.5

35
00:01:28,540 --> 00:01:26,510
billion years ago via biotic sulfur

36
00:01:32,380 --> 00:01:28,550
fractionation of sulfides and bare

37
00:01:33,970 --> 00:01:32,390
islets I know interestingly we also have

38
00:01:35,770 --> 00:01:33,980

a good idea that sulfate concentration

39
00:01:39,850 --> 00:01:35,780
oceans have changed dramatically since

40
00:01:42,160 --> 00:01:39,860
the onset of these sulphur isotope

41
00:01:44,170 --> 00:01:42,170
fractionation and in fact sulfur sulfate

42
00:01:45,760 --> 00:01:44,180
concentrations in oceans have increased

43
00:01:47,830 --> 00:01:45,770
orders of magnitude since the early

44
00:01:51,850 --> 00:01:47,840
Archaean when we think microbial sulfate

45
00:01:54,490 --> 00:01:51,860
reducers would have evolved and so this

46
00:01:56,650 --> 00:01:54,500
has led to a bit of an apparent paradox

47
00:01:58,840 --> 00:01:56,660
and that we have the origination or

48
00:02:00,340 --> 00:01:58,850
presumed origination of microbial

49
00:02:02,350 --> 00:02:00,350
sulfate reducers in the early archaea

50
00:02:03,580 --> 00:02:02,360
but not very much sulfate around in the

51
00:02:05,200 --> 00:02:03,590
sulfate that was present is thought to

52
00:02:08,109 --> 00:02:05,210
be primarily derived from the photolysis

53
00:02:10,530 --> 00:02:08,119
of atmospheric sulfur dioxide to sulfate

54
00:02:12,550 --> 00:02:10,540
that's then rained out in the oceans and

55
00:02:14,199 --> 00:02:12,560
so this has led to several different

56
00:02:17,830 --> 00:02:14,209
hypotheses in order to try to reconcile

57
00:02:19,179 --> 00:02:17,840
the origin of sulfate and sulfite

58
00:02:20,450 --> 00:02:19,189
reducing organisms which I'll refer to

59
00:02:23,090 --> 00:02:20,460
as SRO for the

60
00:02:25,130 --> 00:02:23,100
- the talk with these low concentrations

61
00:02:27,680 --> 00:02:25,140
of sulfate and these various hypotheses

62
00:02:29,150 --> 00:02:27,690
have different merits and rather than go

63
00:02:30,830 --> 00:02:29,160

into the various merits of all these

64
00:02:33,380 --> 00:02:30,840
different policies during this talk what

65
00:02:35,660 --> 00:02:33,390
I would like to do is try to provide an

66
00:02:37,520 --> 00:02:35,670
alternative hypothesis and alternative

67
00:02:39,950 --> 00:02:37,530
framework of thinking about the early

68
00:02:42,530 --> 00:02:39,960
evolution of sulfate reducers and that

69
00:02:44,680 --> 00:02:42,540
is looking at environments that are that

70
00:02:46,550 --> 00:02:44,690
were so for rich so continental

71
00:02:48,500 --> 00:02:46,560
hydrothermal spring so you can see from

72
00:02:51,290 --> 00:02:48,510
these couple pictures that they're

73
00:02:53,420 --> 00:02:51,300
indeed very sulfur rich is you can know

74
00:02:56,900 --> 00:02:53,430
from the precipitated elemental sulfur

75
00:02:59,150 --> 00:02:56,910
there these springs have the effect of

76
00:03:02,300 --> 00:02:59,160
concentrating sulfate so we can get very

77
00:03:04,130 --> 00:03:02,310
high levels of sulfate particularly in

78
00:03:05,870 --> 00:03:04,140
an acidic pH from the tens of millimolar

79
00:03:07,850 --> 00:03:05,880
to hundreds of millimolar concentrations

80
00:03:09,020 --> 00:03:07,860
so this is some data from collaborator

81
00:03:12,230 --> 00:03:09,030
Everett shocked over several hundred

82
00:03:14,990 --> 00:03:12,240
different hot springs and others showing

83
00:03:16,700 --> 00:03:15,000
the you know these Springs have the

84
00:03:21,560 --> 00:03:16,710
ability to concentrate sulfate at very

85
00:03:23,360 --> 00:03:21,570
high levels in addition is Martin Cronin

86
00:03:25,190 --> 00:03:23,370
Rand Cronin dog laid out in a really

87
00:03:28,730 --> 00:03:25,200
nice talk earlier this week at his

88
00:03:30,530 --> 00:03:28,740

plenary session on Wednesday this early

89
00:03:32,270 --> 00:03:30,540
as isotopic evidence for this SRO

90
00:03:34,160 --> 00:03:32,280
activity from the dresser formation it

91
00:03:36,470 --> 00:03:34,170
is what we used to sort of infer the

92
00:03:39,290 --> 00:03:36,480
early evolution well we now know through

93
00:03:41,150 --> 00:03:39,300
work through Martin's lab and others

94
00:03:42,590 --> 00:03:41,160
that this area of the formation appears

95
00:03:44,870 --> 00:03:42,600
to have been associated with a

96
00:03:46,910 --> 00:03:44,880
hydrothermal spring environments and a

97
00:03:49,130 --> 00:03:46,920
paper that this figures taken from by

98
00:03:50,480 --> 00:03:49,140
joka chat al just a couple years ago it

99
00:03:52,610 --> 00:03:50,490
shows a very nice go Matic of what a

100
00:03:54,170 --> 00:03:52,620
there is or t'v hydrothermal spring

101
00:03:56,810 --> 00:03:54,180
environment around the dresser formation

102
00:03:58,490 --> 00:03:56,820
might have been so this prompts the

103
00:04:00,200 --> 00:03:58,500
question then could these continental

104
00:04:03,980 --> 00:04:00,210
hydrothermal systems have promoted the

105
00:04:05,990 --> 00:04:03,990
origins of sro and on top of that if so

106
00:04:08,270 --> 00:04:06,000
didn't sulfate or perhaps the less

107
00:04:10,600 --> 00:04:08,280
oxidized sulfur act oxyanion like

108
00:04:15,050 --> 00:04:10,610
sulfite have supported these early SRO

109
00:04:18,470 --> 00:04:15,060
organisms and so i became interested in

110
00:04:20,450 --> 00:04:18,480
this in this area via some previous

111
00:04:22,310 --> 00:04:20,460
analysis that i had done of this spring

112
00:04:23,000 --> 00:04:22,320
as env2 spring in Yellowstone National

113
00:04:25,910 --> 00:04:23,010

Park

114
00:04:27,560 --> 00:04:25,920
it's a moderately acidic spring a pH of

115
00:04:29,420 --> 00:04:27,570
about three to five depending on when

116
00:04:31,520 --> 00:04:29,430
you sample it moderate temperatures at

117
00:04:33,440 --> 00:04:31,530
fifty to seventy degrees Celsius roughly

118
00:04:34,350 --> 00:04:33,450
and it sits in an area with some of the

119
00:04:35,999 --> 00:04:34,360
highest levels of gas

120
00:04:37,800 --> 00:04:36,009
the flux in Yellowstone and so I had

121
00:04:39,899 --> 00:04:37,810
conducted some metagenomic analysis of

122
00:04:41,640 --> 00:04:39,909
the spring in order to identify how

123
00:04:43,140 --> 00:04:41,650
individual microbial populations are

124
00:04:45,719 --> 00:04:43,150
interacting with each other at the level

125
00:04:48,510 --> 00:04:45,729
of sulfur and carbon and what we found

126
00:04:50,339 --> 00:04:48,520
was this new group of SRO here that it

127
00:04:52,350 --> 00:04:50,349
not been previously identified using

128
00:04:55,350 --> 00:04:52,360
these meta genomic reconstructions of

129
00:04:57,089 --> 00:04:55,360
genomes or mags and in fact these

130
00:04:58,649 --> 00:04:57,099
organisms appear to be a potentially in

131
00:05:01,020 --> 00:04:58,659
the order or a new class level of the

132
00:05:03,020 --> 00:05:01,030
UDR Keota which i refer to after the

133
00:05:05,309 --> 00:05:03,030
rest of this talk is the URI SRO

134
00:05:09,330 --> 00:05:05,319
distantly related to other organisms

135
00:05:11,129 --> 00:05:09,340
from deep sea hydrothermal vents so one

136
00:05:12,480 --> 00:05:11,139
of the ways we can get an idea about

137
00:05:14,219 --> 00:05:12,490
what these organisms are doing is by

138
00:05:16,860 --> 00:05:14,229

looking for key genes involved in

139
00:05:18,899 --> 00:05:16,870
metabolism like Yan was talking about

140
00:05:20,730 --> 00:05:18,909
just a second ago and that is similar is

141
00:05:22,980 --> 00:05:20,740
dissimilar Torrey sulfite reductase

142
00:05:25,499 --> 00:05:22,990
enzyme is one of the key genes for

143
00:05:26,429 --> 00:05:25,509
sulfur a reduction but it's important to

144
00:05:28,679 --> 00:05:26,439
note that it's actually involved in

145
00:05:31,920 --> 00:05:28,689
sulfite reduction not sulfate reduction

146
00:05:33,149 --> 00:05:31,930
per se as this hope sorry I went ahead

147
00:05:34,860 --> 00:05:33,159
little note just a little bit there so

148
00:05:35,790 --> 00:05:34,870
as this diagram showing from a paper a

149
00:05:37,559 --> 00:05:35,800
few years ago there's several steps

150
00:05:39,420 --> 00:05:37,569
involved in sulfate reduction that

151
00:05:42,990 --> 00:05:39,430
includes the activation of sulfate early

152
00:05:46,200 --> 00:05:43,000
on followed by the sulfite reduction via

153
00:05:47,790 --> 00:05:46,210
DSR a B but in fact the the proteins

154
00:05:50,129 --> 00:05:47,800
that are involved in sulfate activation

155
00:05:51,209 --> 00:05:50,139
were absent in these URI SCR genomes

156
00:05:52,800 --> 00:05:51,219
that we were able to recover from

157
00:05:54,689 --> 00:05:52,810
Yellowstone hot springs despite the fact

158
00:05:56,100 --> 00:05:54,699
that they're nearly complete genomes

159
00:05:58,260 --> 00:05:56,110
suggesting that they did not have the

160
00:06:02,730 --> 00:05:58,270
capacity to activate sulfate but rather

161
00:06:04,740 --> 00:06:02,740
we're just reducing sulfite so these

162
00:06:06,059 --> 00:06:04,750
organisms appear to be lacking the

163
00:06:08,909 --> 00:06:06,069

capacity to activate sulfate as I

164
00:06:12,600 --> 00:06:08,919
mentioned they're probably only reducing

165
00:06:15,149 --> 00:06:12,610
sulfate in fact if we take sediments

166
00:06:16,829 --> 00:06:15,159
from mv2 spring and we inoculate them

167
00:06:19,499 --> 00:06:16,839
with some hydrogen as well as some

168
00:06:20,939 --> 00:06:19,509
organic carbon like peptone as well as

169
00:06:24,480 --> 00:06:20,949
different oxides including sulfite

170
00:06:25,980 --> 00:06:24,490
sulfate and amendments without anything

171
00:06:27,800 --> 00:06:25,990
we see that we get hydrogen sulfide

172
00:06:29,969 --> 00:06:27,810
production and only with sulfite

173
00:06:34,559 --> 00:06:29,979
indicating that this capacity is present

174
00:06:37,170 --> 00:06:34,569
in these native sediments so the

175
00:06:40,920 --> 00:06:37,180
question that we wanted to take to get

176
00:06:43,200 --> 00:06:40,930
at is in context of other sro how do

177
00:06:45,810 --> 00:06:43,210
these organisms inform about

178
00:06:47,640 --> 00:06:45,820
the evolution of of SRO in general

179
00:06:50,670 --> 00:06:47,650
instead of do that we reconstructed the

180
00:06:52,710 --> 00:06:50,680
evolutionary history of these D s Rab

181
00:06:53,280 --> 00:06:52,720
enzymes what I'm showing here is an

182
00:06:56,280 --> 00:06:53,290
unrated

183
00:07:01,380 --> 00:06:56,290
phylogeny of a concatenation of dsr ABM

184
00:07:04,140 --> 00:07:01,390
logs and so surprisingly what it found

185
00:07:06,560 --> 00:07:04,150
is that these URI Ser sro branch out

186
00:07:08,700 --> 00:07:06,570
very early on in the evolution of sro

187
00:07:10,860 --> 00:07:08,710
they group with other thermophilic

188
00:07:13,440 --> 00:07:10,870

archaea from a different type of archaea

189
00:07:15,680 --> 00:07:13,450
though crenarchaeota in addition to some

190
00:07:18,690 --> 00:07:15,690
other oddball

191
00:07:21,060 --> 00:07:18,700
esra be homologous including a second

192
00:07:22,680 --> 00:07:21,070
genomic copy from thermophilic mirela

193
00:07:25,620 --> 00:07:22,690
which are widely studied as a citizen's

194
00:07:27,750 --> 00:07:25,630
as well as ESR homologues from

195
00:07:28,920 --> 00:07:27,760
uncultured Maggs from various

196
00:07:33,270 --> 00:07:28,930
environments including hydrothermal

197
00:07:36,060 --> 00:07:33,280
vents subsurface reservoirs and peds and

198
00:07:37,920 --> 00:07:36,070
all the other SR esra be from other sra

199
00:07:39,720 --> 00:07:37,930
as well as from sulfur oxidizing and

200
00:07:41,670 --> 00:07:39,730
bacteria which used ESR in the reverse

201
00:07:43,710 --> 00:07:41,680
direction including an toxigenic

202
00:07:47,190 --> 00:07:43,720
phototrophs all belonged in this group

203
00:07:48,540 --> 00:07:47,200
that's much later branching and as I

204
00:07:50,490 --> 00:07:48,550
mentioned this tree is an unrooted

205
00:07:51,660 --> 00:07:50,500
phylogenetic reconstruction so the

206
00:07:54,030 --> 00:07:51,670
presumed origin would be somewhere

207
00:07:56,550 --> 00:07:54,040
around this trifurcation point here but

208
00:07:59,730 --> 00:07:56,560
the nice thing about DSR is that you can

209
00:08:02,730 --> 00:07:59,740
actually reciprocally root DSR homologs

210
00:08:04,110 --> 00:08:02,740
because the DSR a/b subunits are thought

211
00:08:06,480 --> 00:08:04,120
to be evolutionarily derived from one

212
00:08:08,450 --> 00:08:06,490
another so it's thought there was a gene

213
00:08:11,030 --> 00:08:08,460

duplication event that led to the

214
00:08:14,130 --> 00:08:11,040
production of DSR A or B from the other

215
00:08:16,230 --> 00:08:14,140
subunit and so you can use these two

216
00:08:17,730 --> 00:08:16,240
reciprocally route the subunits and get

217
00:08:21,540 --> 00:08:17,740
a better handle on the evolutionary

218
00:08:24,270 --> 00:08:21,550
trajectory of DSR a B enzymes and so I

219
00:08:26,520 --> 00:08:24,280
did that and what I found again was that

220
00:08:27,630 --> 00:08:26,530
these Morales suck in genomic copies

221
00:08:30,450 --> 00:08:27,640
were of course some of their earliest

222
00:08:34,680 --> 00:08:30,460
branching DSR home logs but so were

223
00:08:36,840 --> 00:08:34,690
these URI s ro DSR home logs as well as

224
00:08:38,190 --> 00:08:36,850
those from the crenarchaeota and some of

225
00:08:40,890 --> 00:08:38,200
these other uncultured Maggs

226
00:08:43,620 --> 00:08:40,900
well the the triangle showed it in

227
00:08:46,980 --> 00:08:43,630
orange there is essentially everything

228
00:08:48,660 --> 00:08:46,990
else all the other s ro which includes

229
00:08:52,950 --> 00:08:48,670
all the model organisms that is so for

230
00:08:54,870 --> 00:08:52,960
vibrios archaea Clos bailey's etc so

231
00:08:56,070 --> 00:08:54,880
taking a closer look at who some of

232
00:08:58,320 --> 00:08:56,080
these organisms are to try

233
00:09:00,720 --> 00:08:58,330
and for something about the ecology of

234
00:09:03,269 --> 00:09:00,730
these organisms these deeply branching

235
00:09:04,860 --> 00:09:03,279
IDs are homologues from mirela or from

236
00:09:07,769 --> 00:09:04,870
organisms that don't actually reduce

237
00:09:08,370 --> 00:09:07,779
sulfate or sulfite nevertheless they're

238
00:09:09,690 --> 00:09:08,380

thermophilic

239
00:09:12,300 --> 00:09:09,700
a lot of these have been isolated from

240
00:09:13,590 --> 00:09:12,310
hot springs and these TS are as I

241
00:09:15,750 --> 00:09:13,600
mentioned earlier represent a second

242
00:09:17,220 --> 00:09:15,760
genetic copy and so it's unclear what

243
00:09:19,319 --> 00:09:17,230
these functions what the function of

244
00:09:20,579 --> 00:09:19,329
these enzymes are at the moment given

245
00:09:23,579 --> 00:09:20,589
that these organisms can't produce

246
00:09:25,889 --> 00:09:23,589
sulfate and sulfite nevertheless these

247
00:09:27,120 --> 00:09:25,899
URI SRO we believe to be sulphide

248
00:09:29,819 --> 00:09:27,130
reducers that are president of hot

249
00:09:32,370 --> 00:09:29,829
springs likewise for this group of

250
00:09:34,139 --> 00:09:32,380
largely crenarchaeota archaea it

251
00:09:38,730 --> 00:09:34,149
includes both sulfite and sulfate

252
00:09:40,069 --> 00:09:38,740
reducers from hot springs as well and

253
00:09:42,509 --> 00:09:40,079
while this other early branching group

254
00:09:45,810 --> 00:09:42,519
includes both sulfite and sulfate

255
00:09:47,850 --> 00:09:45,820
reducers as well as or potentially sorry

256
00:09:49,139 --> 00:09:47,860
these are uncultured organisms so we

257
00:09:50,490 --> 00:09:49,149
don't know for sure what they're

258
00:09:52,440 --> 00:09:50,500
conducting but it's possible it could be

259
00:09:54,600 --> 00:09:52,450
sulphide ore sulfate reduction as well

260
00:09:56,130 --> 00:09:54,610
as sulfur oxidation and again these are

261
00:09:58,319 --> 00:09:56,140
found in hydrothermal vents above

262
00:10:00,630 --> 00:09:58,329
surface agua sewers and Peet's and

263
00:10:04,199 --> 00:10:00,640

here's everything else so these are

264
00:10:06,060 --> 00:10:04,209
results give us an implication that the

265
00:10:07,710 --> 00:10:06,070
prevalence of these early branching dsr

266
00:10:09,510 --> 00:10:07,720
homologues largely from thermophilic

267
00:10:11,790 --> 00:10:09,520
organisms that are implicated not in

268
00:10:13,800 --> 00:10:11,800
sulfate reduction suggest an early

269
00:10:16,710 --> 00:10:13,810
evolution of dsr to catalyze potentially

270
00:10:18,780 --> 00:10:16,720
other reactions besides those coupled to

271
00:10:21,420 --> 00:10:18,790
sulfate reduction including simply

272
00:10:24,690 --> 00:10:21,430
sulfate reduction and only in thermal

273
00:10:26,310 --> 00:10:24,700
files and so this naturally it's the

274
00:10:27,630 --> 00:10:26,320
question of whether or not a sulfide

275
00:10:30,660 --> 00:10:27,640
would actually be present in these

276
00:10:32,069 --> 00:10:30,670
environments and so while there has been

277
00:10:33,960 --> 00:10:32,079
some evidence that sulfide as present

278
00:10:35,400 --> 00:10:33,970
and you also in hot springs from some

279
00:10:36,930 --> 00:10:35,410
early work by Thomas Brock and others

280
00:10:38,280 --> 00:10:36,940
there's been little data to actually

281
00:10:40,590 --> 00:10:38,290
constrain its presence across

282
00:10:42,870 --> 00:10:40,600
geochemical gradients so we wanted to to

283
00:10:44,460 --> 00:10:42,880
better understand whether or not

284
00:10:46,050 --> 00:10:44,470
sulfide could be something that we would

285
00:10:48,360 --> 00:10:46,060
rationally expect to see in these types

286
00:10:50,160 --> 00:10:48,370
of environments knowing of course the

287
00:10:52,290 --> 00:10:50,170
sulfite rapidly oxidizes in the presence

288
00:10:53,910 --> 00:10:52,300

of oxygen or ferric iron but otherwise

289
00:10:56,939 --> 00:10:53,920
can be stable so we took a laboratory

290
00:10:58,740 --> 00:10:56,949
microcosm approach and this was work

291
00:11:00,180 --> 00:10:58,750
that an undergrad that I recruited to

292
00:11:02,400 --> 00:11:00,190
work on this project Maria Clara

293
00:11:04,050 --> 00:11:02,410
Fernandez did in a really good set of

294
00:11:06,200 --> 00:11:04,060
laboratory studies where we have elated

295
00:11:08,720 --> 00:11:06,210
the stability of sulfite across

296
00:11:10,330 --> 00:11:08,730
the temperature range that we see at MVT

297
00:11:12,800 --> 00:11:10,340
spring just to see whether or not

298
00:11:15,170 --> 00:11:12,810
sulfite would be stable and this is

299
00:11:16,730 --> 00:11:15,180
under both oxic and anoxic conditions

300
00:11:18,890 --> 00:11:16,740
and as you can see from the graph here

301
00:11:20,810 --> 00:11:18,900
the amount of sulfite that remains in

302
00:11:22,970 --> 00:11:20,820
these microcosms after 24 hours under

303
00:11:24,620 --> 00:11:22,980
oxy conditions is essentially zero at

304
00:11:26,060 --> 00:11:24,630
higher temperatures so there's a

305
00:11:27,740 --> 00:11:26,070
temperature dependent effect effects

306
00:11:29,780 --> 00:11:27,750
here in in addition to the oxygen

307
00:11:32,680 --> 00:11:29,790
dependent effect well so far I mean

308
00:11:37,010 --> 00:11:32,690
basically stable under anoxic conditions

309
00:11:38,270 --> 00:11:37,020
we also did this under a range of pH as

310
00:11:41,300 --> 00:11:38,280
well to see whether or not so fight

311
00:11:44,150 --> 00:11:41,310
would have a pH dependent a stability

312
00:11:46,100 --> 00:11:44,160
effect which Maria found that it did so

313
00:11:51,080 --> 00:11:46,110

at higher pH we found that sulfite was

314
00:11:52,880 --> 00:11:51,090
more stable after 24 hours so sulfite is

315
00:11:55,520 --> 00:11:52,890
likely to be present hot hot springs but

316
00:11:57,380 --> 00:11:55,530
it's its presence is likely dependent on

317
00:11:59,450 --> 00:11:57,390
the availability of oxygen as well as

318
00:12:04,990 --> 00:11:59,460
lower temperatures and relatively higher

319
00:12:07,340 --> 00:12:05,000
PHS and so with this information in hand

320
00:12:08,810 --> 00:12:07,350
mv2 is actually a pretty geochemical a

321
00:12:10,730 --> 00:12:08,820
dynamic spring which gives us an

322
00:12:12,620 --> 00:12:10,740
opportunity to evaluate the potential

323
00:12:15,320 --> 00:12:12,630
activity of these organisms over a broad

324
00:12:16,610 --> 00:12:15,330
geochemical range so we sampled env2

325
00:12:18,320 --> 00:12:16,620
over three different years and just to

326
00:12:20,690 --> 00:12:18,330
determine the presence and potential

327
00:12:23,720 --> 00:12:20,700
activity of these organisms using

328
00:12:26,660 --> 00:12:23,730
targeted transcriptomics and so this

329
00:12:29,030 --> 00:12:26,670
covers a pH range of a little bit less

330
00:12:31,100 --> 00:12:29,040
than this temperatures of about 55 to 70

331
00:12:33,620 --> 00:12:31,110
degrees Celsius and what we found is

332
00:12:36,020 --> 00:12:33,630
that these urea SRO were present in all

333
00:12:37,880 --> 00:12:36,030
the samples but there dsr were only

334
00:12:39,710 --> 00:12:37,890
transcribed and the pH was higher in the

335
00:12:42,770 --> 00:12:39,720
spring and so what I'm showing here as

336
00:12:45,110 --> 00:12:42,780
DSR a transcription levels and these

337
00:12:47,090 --> 00:12:45,120
dates were ordered by pH going from

338
00:12:48,890 --> 00:12:47,100

lower to higher here and so we only

339
00:12:50,240 --> 00:12:48,900
found that dsr a was transcribed at

340
00:12:51,320 --> 00:12:50,250
these higher pH despite the fact that

341
00:12:54,650 --> 00:12:51,330
they were actually present in these

342
00:12:57,590 --> 00:12:54,660
lower the dsr a copies from your ESR

343
00:13:01,580 --> 00:12:57,600
were also present in these lower pH

344
00:13:03,830 --> 00:13:01,590
samples as well and this seems to be

345
00:13:06,830 --> 00:13:03,840
consistent with our early results that

346
00:13:08,020 --> 00:13:06,840
pH has this I'm sorry so flight

347
00:13:10,250 --> 00:13:08,030
stability has this pH dependent

348
00:13:12,320 --> 00:13:10,260
relationship and also the fact that

349
00:13:15,020 --> 00:13:12,330
there's a simple speciation processes

350
00:13:16,970 --> 00:13:15,030
where we expect by sulfite and sulfite

351
00:13:18,269 --> 00:13:16,980
to be more prevalent than sulphur

352
00:13:19,860 --> 00:13:18,279
dioxide at higher

353
00:13:22,139 --> 00:13:19,870
pH at least it's qualitatively

354
00:13:27,329 --> 00:13:22,149
inconsistent with these two pieces of

355
00:13:29,879 --> 00:13:27,339
evidence so with that if in fact the

356
00:13:31,110 --> 00:13:29,889
earliest evidence for SR SR oor

357
00:13:33,720 --> 00:13:31,120
associated with the sulphate at

358
00:13:35,939 --> 00:13:33,730
hydrothermal spring deposits as some

359
00:13:37,679 --> 00:13:35,949
recent evidence suggested then it

360
00:13:39,749 --> 00:13:37,689
suggests that these early rsrm may have

361
00:13:41,100 --> 00:13:39,759
actually been thermo set of philic which

362
00:13:42,869 --> 00:13:41,110
is consistent with a lot of other

363
00:13:44,730 --> 00:13:42,879

evidence suggesting that early diverging

364
00:13:47,189 --> 00:13:44,740
archaea and bacteria lineages are in

365
00:13:49,470 --> 00:13:47,199
fact thermophilic the phylogenetic

366
00:13:51,389 --> 00:13:49,480
analyses that I showed here supports

367
00:13:53,369 --> 00:13:51,399
that these early sulfate-reducing

368
00:13:55,410 --> 00:13:53,379
enzymes are generally from thermal files

369
00:13:57,239 --> 00:13:55,420
and also largely not coupled to sulfate

370
00:14:00,090 --> 00:13:57,249
reduction and some of the earliest home

371
00:14:01,290 --> 00:14:00,100
logs that we know about and it's

372
00:14:03,540 --> 00:14:01,300
possible that these moderately acidic

373
00:14:05,309 --> 00:14:03,550
springs that favored the presence and

374
00:14:06,389 --> 00:14:05,319
stability of sulfide or potential

375
00:14:09,449 --> 00:14:06,399
environments that could have supported

376
00:14:12,269 --> 00:14:09,459
earlier SRO and these deeper branching

377
00:14:13,769 --> 00:14:12,279
so fire producers but certainly lots of

378
00:14:16,110 --> 00:14:13,779
further investigation is needed of both

379
00:14:17,879 --> 00:14:16,120
these environments in the taxa in order

380
00:14:19,710 --> 00:14:17,889
to elucidate whether these organisms and

381
00:14:22,139 --> 00:14:19,720
potentially others that we've yet to

382
00:14:23,610 --> 00:14:22,149
find are involves exclusively and

383
00:14:27,449 --> 00:14:23,620
sulfide reduction or potentially other

384
00:14:29,160 --> 00:14:27,459
types of metabolisms and so with that

385
00:14:30,720 --> 00:14:29,170
there's a lots of folks I'd like to

386
00:14:32,009 --> 00:14:30,730
thank that have worked on this but

387
00:14:35,220 --> 00:14:32,019
particularly those that are highlighted

388
00:14:36,449 --> 00:14:35,230

in red here as well as funding and I

389
00:14:38,160 --> 00:14:36,459
think I'm a little short on time but I

390
00:14:40,230 --> 00:14:38,170
just like to say real quick there's

391
00:14:42,540 --> 00:14:40,240
several positions open for pissed ox and

392
00:14:44,309 --> 00:14:42,550
grad students in our lab and so if you

393
00:14:46,139 --> 00:14:44,319
know folks looking for a grad student

394
00:14:47,490 --> 00:14:46,149
positions or postdoc positions there's

395
00:14:51,480 --> 00:14:47,500
several opportunities here so feel free

396
00:14:52,590 --> 00:14:51,490
to contact myself or Eric Boyd and with

397
00:14:58,960 --> 00:14:52,600
that I think I might have time for a

398
00:14:58,970 --> 00:15:08,320
[Applause]

399
00:15:14,240 --> 00:15:12,740
have you tried thiosulfate I haven't

400
00:15:16,910 --> 00:15:14,250
tried tile sulfate the reason that we

401
00:15:19,009 --> 00:15:16,920
didn't originally is because though sofa

402
00:15:21,290 --> 00:15:19,019
is this pH dependent stability as well

403
00:15:23,569 --> 00:15:21,300
and so we you know it degrades below pH

404
00:15:25,340 --> 00:15:23,579
for essentially and so when we found

405
00:15:27,199 --> 00:15:25,350
these organisms it was only apollo' pH

406
00:15:29,750 --> 00:15:27,209
for so it didn't it wasn't something

407
00:15:33,019 --> 00:15:29,760
that was you know off the top of her

408
00:15:35,030 --> 00:15:33,029
head and so I'm actually working on some

409
00:15:37,940 --> 00:15:35,040
microcosms to sort of rework some of the

410
00:15:39,829 --> 00:15:37,950
culture dependent parts of the work this

411
00:15:41,750 --> 00:15:39,839
summer and so we have plans to include

412
00:15:43,400 --> 00:15:41,760
thiosulfate but of course only at higher

413
00:15:45,949 --> 00:15:43,410

pH because at lower pH it would just