



SERPENTINIZING SYSTEMS SCIENCE



WORKSHOP
WITHOUT
WALLS

1
00:00:04,390 --> 00:00:02,629
well good morning everyone um i hope you

2
00:00:07,430 --> 00:00:04,400
enjoyed the wonderful musical

3
00:00:09,110 --> 00:00:07,440
accompaniment uh provided by sam dosher

4
00:00:11,669 --> 00:00:09,120
who is one of the ones we'd like to

5
00:00:13,509 --> 00:00:11,679
thank today for helping from nai central

6
00:00:15,990 --> 00:00:13,519
and organizing and structuring this

7
00:00:17,269 --> 00:00:16,000
event so sam that was wonderful and mike

8
00:00:19,029 --> 00:00:17,279
i wanted to say thank you too for

9
00:00:20,390 --> 00:00:19,039
bringing dunkin donuts this morning so

10
00:00:22,310 --> 00:00:20,400
thank you those of us sitting here in

11
00:00:24,310 --> 00:00:22,320
colorado are well sugared and fed to

12
00:00:26,950 --> 00:00:24,320
start start our day

13
00:00:29,349 --> 00:00:26,960

um but more seriously um really thrilled

14

00:00:31,349 --> 00:00:29,359

to see a lot of people online and ready

15

00:00:32,709 --> 00:00:31,359

to participate today in this workshop

16

00:00:35,350 --> 00:00:32,719

without walls

17

00:00:36,389 --> 00:00:35,360

it's focused on serpentinizing system

18

00:00:38,950 --> 00:00:36,399

science

19

00:00:40,229 --> 00:00:38,960

and um it's been under discussion over

20

00:00:42,869 --> 00:00:40,239

the last year i'll give a little bit of

21

00:00:44,869 --> 00:00:42,879

a history of how to enact such a

22

00:00:46,950 --> 00:00:44,879

workshop and try to

23

00:00:48,950 --> 00:00:46,960

use this as an effort to build a sense

24

00:00:50,229 --> 00:00:48,960

of community amongst the disparate areas

25

00:00:51,990 --> 00:00:50,239

of research that are going on in

26

00:00:54,549 --> 00:00:52,000

serpentinizing systems science at the

27

00:00:56,950 --> 00:00:54,559

moment both supported by nasa and by

28

00:00:58,790 --> 00:00:56,960

multiple agencies including many in our

29

00:01:00,229 --> 00:00:58,800

international partners some of which

30

00:01:03,510 --> 00:01:00,239

could join us today which is exciting

31

00:01:04,710 --> 00:01:03,520

too from both europe and from japan

32

00:01:07,030 --> 00:01:04,720

um

33

00:01:08,789 --> 00:01:07,040

in the flyers that have been distributed

34

00:01:11,429 --> 00:01:08,799

i think the way it's been described so

35

00:01:13,109 --> 00:01:11,439

far is that one of the hopes over these

36

00:01:15,350 --> 00:01:13,119

next three days that we're going to be

37

00:01:17,670 --> 00:01:15,360

convened is that we'll highlight recent

38

00:01:19,670 --> 00:01:17,680

advances in understanding how surprising

39

00:01:21,910 --> 00:01:19,680

systems function chemically and

40

00:01:24,149 --> 00:01:21,920

biologically and geologically within our

41

00:01:26,149 --> 00:01:24,159

solar system

42

00:01:28,789 --> 00:01:26,159

and in many ways the question is why are

43

00:01:31,030 --> 00:01:28,799

we having this workshop now and it is to

44

00:01:33,270 --> 00:01:31,040

come back and re-examine any of the

45

00:01:34,230 --> 00:01:33,280

couplings between these three

46

00:01:36,310 --> 00:01:34,240

um

47

00:01:39,030 --> 00:01:36,320

multiple processes and understand them

48

00:01:41,350 --> 00:01:39,040

in the lens of why sepanizing systems

49

00:01:42,870 --> 00:01:41,360

are a compelling astrobiological target

50

00:01:46,870 --> 00:01:42,880

in our search for life in the solar

51

00:01:49,910 --> 00:01:48,069

and

52

00:01:52,389 --> 00:01:49,920

it's an interesting discussion that came

53

00:01:53,990 --> 00:01:52,399

up about a year ago at apps icon

54

00:01:55,749 --> 00:01:54,000

2015 2015

55

00:01:57,910 --> 00:01:55,759

the idea is that serpentinization has

56

00:02:00,469 --> 00:01:57,920

been discussed in astrobiological terms

57

00:02:02,230 --> 00:02:00,479

for a long time now and it's

58

00:02:05,190 --> 00:02:02,240

extraordinarily well

59

00:02:07,830 --> 00:02:05,200

studied as a geological process

60

00:02:10,150 --> 00:02:07,840

and the reason that it seems timely to

61

00:02:12,470 --> 00:02:10,160

have a workshop like this and to and

62

00:02:14,790 --> 00:02:12,480

again to be brought together from these

63

00:02:17,589 --> 00:02:14,800

various disciplines is to really

64
00:02:19,670 --> 00:02:17,599
ask them what do we understand about the

65
00:02:21,830 --> 00:02:19,680
conditions that give rise to an

66
00:02:23,910 --> 00:02:21,840
inhabited state in serpentinizing

67
00:02:26,470 --> 00:02:23,920
systems have we been able to start to

68
00:02:28,470 --> 00:02:26,480
recognize when that occurs

69
00:02:30,470 --> 00:02:28,480
what is it when and where does the

70
00:02:33,270 --> 00:02:30,480
hydration of ultramafic rocks actually

71
00:02:35,830 --> 00:02:33,280
give rise to states that

72
00:02:38,229 --> 00:02:35,840
can sustain life activity because not

73
00:02:39,589 --> 00:02:38,239
all serenizing systems necessarily are

74
00:02:42,070 --> 00:02:39,599
alive when

75
00:02:43,750 --> 00:02:42,080
are they how do we know that and i'm

76
00:02:45,750 --> 00:02:43,760
hoping we'll explore that again through

77
00:02:47,430 --> 00:02:45,760
a bunch of the proposed talks that are

78
00:02:49,509 --> 00:02:47,440
in the schedule as well as in some of

79
00:02:51,430 --> 00:02:49,519
the pop-up talks already planned at the

80
00:02:52,710 --> 00:02:51,440
moment and some that might get inspired

81
00:02:53,990 --> 00:02:52,720
by the discussions that are going to

82
00:02:57,110 --> 00:02:54,000
happen

83
00:03:00,149 --> 00:02:57,120
so lisa to give you the next line

84
00:03:02,149 --> 00:03:00,159
um this is just um was me on my iphone

85
00:03:04,949 --> 00:03:02,159
this morning going back to

86
00:03:07,430 --> 00:03:04,959
june 2015. it was about 40 of us

87
00:03:10,229 --> 00:03:07,440
convened in an impromptu discussion at

88
00:03:12,869 --> 00:03:10,239

appsidedecon um in the middle of that week

89

00:03:14,550 --> 00:03:12,879

just to again bring together people in

90

00:03:16,550 --> 00:03:14,560

many of the diverse areas that relate to

91

00:03:18,470 --> 00:03:16,560

subpoenaizing system science to ask the

92

00:03:20,470 --> 00:03:18,480

question of whether there needed to be

93

00:03:23,670 --> 00:03:20,480

broader discourse about some of our

94

00:03:25,750 --> 00:03:23,680

recent findings and the strong answer

95

00:03:28,070 --> 00:03:25,760

from that was yes and the question has

96

00:03:29,350 --> 00:03:28,080

been then how to best do that

97

00:03:31,430 --> 00:03:29,360

you can see the guy sitting in the back

98

00:03:33,670 --> 00:03:31,440

right corner there tory holler

99

00:03:35,190 --> 00:03:33,680

he jumped to his feet and said we must

100

00:03:37,509 --> 00:03:35,200

do this yes

101

00:03:39,190 --> 00:03:37,519

jen blink who is also a co-convener of

102

00:03:41,509 --> 00:03:39,200

this jumped to her feet and said we must

103

00:03:43,430 --> 00:03:41,519

do this um but more honest more

104

00:03:45,110 --> 00:03:43,440

seriously the two of them have been

105

00:03:47,830 --> 00:03:45,120

absolutely wonderful in helping to

106

00:03:49,670 --> 00:03:47,840

create a framework and a structure for

107

00:03:51,030 --> 00:03:49,680

putting together a workshop without

108

00:03:53,350 --> 00:03:51,040

walls

109

00:03:54,949 --> 00:03:53,360

as an outgrowth of this in the beginning

110

00:03:56,869 --> 00:03:54,959

of a discussion of whether or not there

111

00:03:58,789 --> 00:03:56,879

should be the establishment of a working

112

00:04:00,949 --> 00:03:58,799

group

113

00:04:02,149 --> 00:04:00,959

that can further build on potentially

114

00:04:04,390 --> 00:04:02,159

some of the discussions we're going to

115

00:04:06,149 --> 00:04:04,400

start in these next few days um we don't

116

00:04:08,869 --> 00:04:06,159

necessarily need a working group and so

117

00:04:11,830 --> 00:04:08,879

i urge you to consider that as we are

118

00:04:13,270 --> 00:04:11,840

as the workshop proceeds and to please

119

00:04:15,750 --> 00:04:13,280

send your comments and thoughts and

120

00:04:17,509 --> 00:04:15,760

ideas about that directly to jen and

121

00:04:20,150 --> 00:04:17,519

she'll have her email up again later in

122

00:04:21,590 --> 00:04:20,160

the workshop genblanketna

123

00:04:23,270 --> 00:04:21,600

nasa.gov

124

00:04:24,710 --> 00:04:23,280

to be able to take some of the input and

125

00:04:26,390 --> 00:04:24,720

information on that

126
00:04:27,990 --> 00:04:26,400
because regardless i think we have a lot

127
00:04:29,909 --> 00:04:28,000
that we can do together in these next

128
00:04:31,990 --> 00:04:29,919
three days again trying to to highlight

129
00:04:34,870 --> 00:04:32,000
some of these recent advances

130
00:04:38,469 --> 00:04:34,880
um so if you go to the next one okay

131
00:04:41,510 --> 00:04:38,479
okay so um again i'd really like to

132
00:04:42,950 --> 00:04:41,520
thank the nasa astrobiology institute

133
00:04:45,590 --> 00:04:42,960
there's been many discussions through

134
00:04:48,070 --> 00:04:45,600
both executive council and with nai

135
00:04:51,110 --> 00:04:48,080
central about ways to support what they

136
00:04:53,189 --> 00:04:51,120
could see is a lot of potential synergy

137
00:04:55,189 --> 00:04:53,199
in research themes between programs

138
00:04:56,629 --> 00:04:55,199

they're directly funding such as some of

139

00:04:58,950 --> 00:04:56,639

the members of the different nasa

140

00:05:00,870 --> 00:04:58,960

astrobiology institutes a lot of active

141

00:05:03,029 --> 00:05:00,880

ongoing research in serpentizing

142

00:05:05,350 --> 00:05:03,039

system science in many of the teams at

143

00:05:07,590 --> 00:05:05,360

the moment but also well beyond

144

00:05:09,590 --> 00:05:07,600

necessarily any of the specific

145

00:05:11,909 --> 00:05:09,600

ongoing institutes but on other nasa

146

00:05:15,350 --> 00:05:11,919

supported programs and in many research

147

00:05:17,350 --> 00:05:15,360

labs again internationally and so how to

148

00:05:19,830 --> 00:05:17,360

um make sure that the

149

00:05:21,590 --> 00:05:19,840

best collaborative outcomes and building

150

00:05:24,070 --> 00:05:21,600

upon each other findings could happen

151
00:05:25,510 --> 00:05:24,080
and so again to mike and estelle and sam

152
00:05:27,189 --> 00:05:25,520
in particular for helping us figure out

153
00:05:28,710 --> 00:05:27,199
how to structure a workshop like this i

154
00:05:29,990 --> 00:05:28,720
say thank you

155
00:05:31,430 --> 00:05:30,000
um

156
00:05:33,749 --> 00:05:31,440
so

157
00:05:34,550 --> 00:05:33,759
one of the

158
00:05:37,909 --> 00:05:34,560
um

159
00:05:39,670 --> 00:05:37,919
overarching discussions i think that can

160
00:05:41,110 --> 00:05:39,680
occur as we move forward is trying to

161
00:05:43,110 --> 00:05:41,120
figure out how to

162
00:05:45,270 --> 00:05:43,120
continuously reintegrate some of our

163
00:05:46,870 --> 00:05:45,280

perspectives from planetary surface

164

00:05:48,710 --> 00:05:46,880

processes

165

00:05:50,790 --> 00:05:48,720

where we see evidence of active

166

00:05:52,310 --> 00:05:50,800

serpentinization in the modern in our

167

00:05:54,230 --> 00:05:52,320

solar system as well as past

168

00:05:56,230 --> 00:05:54,240

serpentinization activity

169

00:05:58,629 --> 00:05:56,240

to any evidence for inhabitation of

170

00:05:59,909 --> 00:05:58,639

those systems and we'll treat a lot of

171

00:06:01,110 --> 00:05:59,919

this workshop from in the reverse

172

00:06:03,749 --> 00:06:01,120

direction we're going to start with

173

00:06:05,510 --> 00:06:03,759

looking at activity and

174

00:06:06,469 --> 00:06:05,520

surrendering systems on earth right

175

00:06:08,710 --> 00:06:06,479

now

176

00:06:10,550 --> 00:06:08,720

if there's so much active research in

177

00:06:12,629 --> 00:06:10,560

that realm and build it back towards how

178

00:06:14,870 --> 00:06:12,639

does this fit into our understandings of

179

00:06:17,189 --> 00:06:14,880

planetary surface processes that give

180

00:06:18,629 --> 00:06:17,199

rise to serpentinization or dependent

181

00:06:21,270 --> 00:06:18,639

upon it

182

00:06:23,830 --> 00:06:21,280

um

183

00:06:25,590 --> 00:06:23,840

again just trying to think about

184

00:06:26,870 --> 00:06:25,600

all of these different research themes

185

00:06:28,870 --> 00:06:26,880

that are occurring at the moment if

186

00:06:30,790 --> 00:06:28,880

you'll move to the next slide too

187

00:06:32,790 --> 00:06:30,800

we hope to capture just a fraction of

188

00:06:35,350 --> 00:06:32,800

them in the three days there that are

189

00:06:38,710 --> 00:06:35,360

coming so we're really lucky to have

190

00:06:41,350 --> 00:06:38,720

three theme leads billy brazelton tom

191

00:06:43,670 --> 00:06:41,360

mccollum and steve vance all of them

192

00:06:45,350 --> 00:06:43,680

were essentially requested through a lot

193

00:06:47,749 --> 00:06:45,360

of that community input

194

00:06:50,710 --> 00:06:47,759

apps icon and in follow-up discussions

195

00:06:53,830 --> 00:06:50,720

is the three people that um most people

196

00:06:56,230 --> 00:06:53,840

would like to see bring together

197

00:06:57,830 --> 00:06:56,240

perspectives on these topics which are

198

00:07:00,150 --> 00:06:57,840

going to be the focus of the three days

199

00:07:02,150 --> 00:07:00,160

that come in particular we're going to

200

00:07:03,670 --> 00:07:02,160

have a chance to look at serpentinizing

201
00:07:05,430 --> 00:07:03,680
systems on earth

202
00:07:07,909 --> 00:07:05,440
and there will be a very

203
00:07:09,670 --> 00:07:07,919
active focus on what we are starting to

204
00:07:11,589 --> 00:07:09,680
understand about geochemical dynamics

205
00:07:13,990 --> 00:07:11,599
and microbial activity within those

206
00:07:16,469 --> 00:07:14,000
systems there's so much active research

207
00:07:17,909 --> 00:07:16,479
at the moment at sites worldwide that

208
00:07:20,150 --> 00:07:17,919
the discovery potential has been

209
00:07:22,870 --> 00:07:20,160
enormous regarding the types of life

210
00:07:24,950 --> 00:07:22,880
activity and how we recognize it

211
00:07:27,189 --> 00:07:24,960
the physiological adaptations to the

212
00:07:29,430 --> 00:07:27,199
conditions that exist in actively

213
00:07:31,749 --> 00:07:29,440

subpoenaizing systems

214

00:07:34,550 --> 00:07:31,759

and almost can't keep up fast enough

215

00:07:36,309 --> 00:07:34,560

with hearing who and when and where some

216

00:07:39,270 --> 00:07:36,319

of these biological processes are being

217

00:07:40,870 --> 00:07:39,280

supported by fentanylization

218

00:07:43,430 --> 00:07:40,880

at the same time

219

00:07:47,749 --> 00:07:43,440

there's experiments being continuously

220

00:07:53,830 --> 00:07:50,629

it's interactive hey i can see you guys

221

00:07:55,350 --> 00:07:53,840

um so in the uh um

222

00:07:57,990 --> 00:07:55,360

in when we look at what's going on in

223

00:07:59,589 --> 00:07:58,000

experimental systems um there's been a

224

00:08:01,029 --> 00:07:59,599

large number of recent experimental

225

00:08:02,869 --> 00:08:01,039

results particularly in the high

226

00:08:04,790 --> 00:08:02,879

temperature realm again looking at the

227

00:08:07,589 --> 00:08:04,800

pathways of serpentinization how that

228

00:08:09,189 --> 00:08:07,599

process proceeds and and the new

229

00:08:10,469 --> 00:08:09,199

insights into some of the products that

230

00:08:12,309 --> 00:08:10,479

are occurring particularly with respect

231

00:08:13,510 --> 00:08:12,319

to carbon compounds and civetinizing

232

00:08:15,589 --> 00:08:13,520

systems

233

00:08:17,270 --> 00:08:15,599

but we need this feedback between the

234

00:08:18,869 --> 00:08:17,280

state of environments undergoing

235

00:08:21,589 --> 00:08:18,879

serpentinization in the experiments that

236

00:08:23,430 --> 00:08:21,599

also best mimic that and allow us to see

237

00:08:26,150 --> 00:08:23,440

the rates and the mechanisms of these

238

00:08:28,550 --> 00:08:26,160

processes and how they feedback so we

239

00:08:30,309 --> 00:08:28,560

have a chance again to look into the

240

00:08:33,110 --> 00:08:30,319

structure of new experiments that are

241

00:08:35,589 --> 00:08:33,120

being designed um modeling that has

242

00:08:37,509 --> 00:08:35,599

shown some of the most fruitful regimes

243

00:08:39,430 --> 00:08:37,519

to try and either simulate and

244

00:08:41,110 --> 00:08:39,440

experiments or go seek in the natural

245

00:08:42,550 --> 00:08:41,120

environment

246

00:08:44,230 --> 00:08:42,560

i think we're going to get a chance too

247

00:08:46,389 --> 00:08:44,240

even in some of the pop-up talks i hope

248

00:08:47,670 --> 00:08:46,399

to hear about some of the new designs of

249

00:08:48,710 --> 00:08:47,680

reactors

250

00:08:53,590 --> 00:08:48,720

and

251
00:08:54,389 --> 00:08:53,600
ways that allow us to really experiment

252
00:08:56,949 --> 00:08:54,399
and

253
00:08:59,829 --> 00:08:56,959
test how organisms function under the

254
00:09:02,630 --> 00:08:59,839
in-situ condition of serpentization

255
00:09:06,630 --> 00:09:02,640
and the again some of the boundary

256
00:09:11,750 --> 00:09:09,190
and then lastly again into this realm

257
00:09:13,030 --> 00:09:11,760
back into the planetary is going

258
00:09:14,790 --> 00:09:13,040
as our

259
00:09:17,269 --> 00:09:14,800
advancement in the theory and

260
00:09:19,190 --> 00:09:17,279
observation of life activity and

261
00:09:20,949 --> 00:09:19,200
habitable conditions and serbianizing

262
00:09:23,190 --> 00:09:20,959
systems expands

263
00:09:24,949 --> 00:09:23,200

how are we feeding that back to our

264

00:09:27,829 --> 00:09:24,959

ability to

265

00:09:29,350 --> 00:09:27,839

seek and detect those environments

266

00:09:31,430 --> 00:09:29,360

elsewhere particularly in our solar

267

00:09:32,310 --> 00:09:31,440

system as well as beyond

268

00:09:35,430 --> 00:09:32,320

how

269

00:09:39,750 --> 00:09:37,269

in many ways um

270

00:09:41,509 --> 00:09:39,760

both becoming more adept at identifying

271

00:09:44,230 --> 00:09:41,519

actively serpentinizing environments

272

00:09:45,030 --> 00:09:44,240

right now in the chemical signatures of

273

00:09:47,350 --> 00:09:45,040

that

274

00:09:49,190 --> 00:09:47,360

um and evidence for where this has

275

00:09:51,350 --> 00:09:49,200

occurred in the past

276

00:09:52,630 --> 00:09:51,360

there's a giant open door

277

00:09:55,590 --> 00:09:52,640

that has

278

00:09:57,430 --> 00:09:55,600

um many open questions regarding what

279

00:09:59,350 --> 00:09:57,440

are we looking for in those

280

00:10:01,910 --> 00:09:59,360

serpentinized environments that might

281

00:10:04,310 --> 00:10:01,920

really be an indicator or of a signature

282

00:10:06,790 --> 00:10:04,320

of life activity a biosignature hosted

283

00:10:08,870 --> 00:10:06,800

by a serpentinizing system let alone the

284

00:10:10,710 --> 00:10:08,880

tafonomy of those biosignatures and how

285

00:10:12,470 --> 00:10:10,720

they're preserved but what are the true

286

00:10:14,790 --> 00:10:12,480

targets that we're starting to recognize

287

00:10:17,190 --> 00:10:14,800

that that we should be incorporating

288

00:10:18,949 --> 00:10:17,200

into our life detection strategies and

289

00:10:21,350 --> 00:10:18,959

into our mission targets both where

290

00:10:23,750 --> 00:10:21,360

we're landing or where we are sending

291

00:10:26,230 --> 00:10:23,760

orbiters or sending probes and how we

292

00:10:28,310 --> 00:10:26,240

would deploy in that mission to detect

293

00:10:30,710 --> 00:10:28,320

um life that we believe should be

294

00:10:32,470 --> 00:10:30,720

sustained by subpoenaization activity so

295

00:10:34,870 --> 00:10:32,480

again we could have gone in any order

296

00:10:36,790 --> 00:10:34,880

with these three and the hope is that

297

00:10:38,550 --> 00:10:36,800

these themes can feed back on each other

298

00:10:40,870 --> 00:10:38,560

over these next few days and we can at

299

00:10:43,350 --> 00:10:40,880

least keep these concepts in our mind as

300

00:10:45,509 --> 00:10:43,360

we change from the topics that billy and

301
00:10:47,190 --> 00:10:45,519
tom and steve were going to lead for us

302
00:10:50,230 --> 00:10:47,200
and in trying to

303
00:10:51,670 --> 00:10:50,240
again build a base of um recent

304
00:10:53,590 --> 00:10:51,680
discovery and

305
00:10:55,430 --> 00:10:53,600
and state of the art of our thinking in

306
00:10:57,350 --> 00:10:55,440
many of these topic areas

307
00:10:58,710 --> 00:10:57,360
so with that i'm excited to be able to

308
00:11:00,310 --> 00:10:58,720
sit back some but i hope there'll be a

309
00:11:03,030 --> 00:11:00,320
lot of active chat in the windows as

310
00:11:05,269 --> 00:11:03,040
people are thinking about things use use

311
00:11:07,509 --> 00:11:05,279
these other channels too to

312
00:11:09,430 --> 00:11:07,519
to inject some of your thoughts as you

313
00:11:11,590 --> 00:11:09,440

hear these speakers and everyone feel

314

00:11:12,630 --> 00:11:11,600

free to to comment and reply because

315

00:11:15,110 --> 00:11:12,640

that's where we'll get a lot of the

316

00:11:17,350 --> 00:11:15,120

vibrancy of this event

317

00:11:19,430 --> 00:11:17,360

and with that i can see you bailey and

318

00:11:21,670 --> 00:11:19,440

we send it off to you and thank you for

319

00:11:23,670 --> 00:11:21,680

leaving today's event so alexis actually

320

00:11:25,990 --> 00:11:23,680

um adrian brown's asking in the chat

321

00:11:27,829 --> 00:11:26,000

room um about the background picture of

322

00:11:30,550 --> 00:11:27,839

your intro slides yes we have a couple

323

00:11:32,870 --> 00:11:30,560

minutes if you want to do we yeah

324

00:11:34,550 --> 00:11:32,880

um hi adrian um i can't see you right

325

00:11:36,550 --> 00:11:34,560

now we had a lovely visit when adrian

326

00:11:39,030 --> 00:11:36,560

came here this summer

327

00:11:47,350 --> 00:11:39,040

that picture can you even delete the

328

00:11:51,030 --> 00:11:49,590

yeah that picture is common to a lot of

329

00:11:53,269 --> 00:11:51,040

different pendanizing systems that

330

00:11:55,350 --> 00:11:53,279

specifically comes from oman

331

00:11:57,430 --> 00:11:55,360

in an area that we visited with a close

332

00:11:58,150 --> 00:11:57,440

collaborator peter kelleman that we work

333

00:12:01,110 --> 00:11:58,160

with

334

00:12:03,430 --> 00:12:01,120

um these are rocks that even the more

335

00:12:05,430 --> 00:12:03,440

dramatic version them is strongly banded

336

00:12:07,590 --> 00:12:05,440

from red to green and then has all of

337

00:12:09,829 --> 00:12:07,600

this

338

00:12:12,150 --> 00:12:09,839

veining across it with essentially

339

00:12:14,470 --> 00:12:12,160

strong oxygen fugacity gradients

340

00:12:15,750 --> 00:12:14,480

incredibly interesting mineralogy that

341

00:12:17,030 --> 00:12:15,760

no one can quite

342

00:12:18,870 --> 00:12:17,040

figure out though

343

00:12:20,230 --> 00:12:18,880

so there's some uh great challenges and

344

00:12:21,910 --> 00:12:20,240

what the true mineralogy of some of

345

00:12:24,150 --> 00:12:21,920

these cepetonites are

346

00:12:26,389 --> 00:12:24,160

but in this particular case too um

347

00:12:28,069 --> 00:12:26,399

there's been an extensive fracturing and

348

00:12:30,389 --> 00:12:28,079

evidence of fluid flow and

349

00:12:32,389 --> 00:12:30,399

mineralization that has occurred in the

350

00:12:34,470 --> 00:12:32,399

system so there's so many different

351

00:12:36,389 --> 00:12:34,480

states of the environment captured in

352

00:12:39,430 --> 00:12:36,399

something like that rock that's pictured

353

00:12:41,030 --> 00:12:39,440

there because in the dark green matrix

354

00:12:42,710 --> 00:12:41,040

itself is the area where all the

355

00:12:44,389 --> 00:12:42,720

reactions are occurring that for example

356

00:12:46,629 --> 00:12:44,399

may be producing molecular hydrogen or

357

00:12:48,870 --> 00:12:46,639

reduced organic compounds

358

00:12:50,790 --> 00:12:48,880

but that fluid environment of the high

359

00:12:53,269 --> 00:12:50,800

transfer potential very different again

360

00:12:54,949 --> 00:12:53,279

redox state and oxygen fugacity may be

361

00:12:56,629 --> 00:12:54,959

again an area where there is a lot of

362

00:12:58,230 --> 00:12:56,639

mixing and dynamics of fluids from

363

00:13:00,550 --> 00:12:58,240

different parts of the system where we

364

00:13:03,269 --> 00:13:00,560

may find say an enhanced habitable

365

00:13:05,430 --> 00:13:03,279

condition and evidence of biosignatures

366

00:13:07,030 --> 00:13:05,440

and understanding how to seek and

367

00:13:08,550 --> 00:13:07,040

unravel those kinds of rocks is

368

00:13:09,670 --> 00:13:08,560

definitely a great challenge at the

369

00:13:12,470 --> 00:13:09,680

moment

370

00:13:14,069 --> 00:13:12,480

um i do want to say too for those of you

371

00:13:15,269 --> 00:13:14,079

who are thinking about pop-up talks and

372

00:13:16,710 --> 00:13:15,279

things

373

00:13:18,150 --> 00:13:16,720

some of the pop-up talks might be a few

374

00:13:20,710 --> 00:13:18,160

slides but if you just want to inject

375

00:13:23,110 --> 00:13:20,720

one image or one idea again please feel

376

00:13:25,509 --> 00:13:23,120

free not for today but to send your

377

00:13:27,590 --> 00:13:25,519

requests forward for the next two days

378

00:13:29,350 --> 00:13:27,600

to put those ideas in

379

00:13:31,750 --> 00:13:29,360

and again you get inspired at the moment

380

00:13:33,910 --> 00:13:31,760

i have there'll be one student from here

381

00:13:36,069 --> 00:13:33,920

at colorado katie rumford who's going to

382

00:13:38,310 --> 00:13:36,079

do a quick pop-up talk today i see

383

00:13:40,629 --> 00:13:38,320

hannah miller here as an example um and

384

00:13:42,470 --> 00:13:40,639

i would have had requested that she give

385

00:13:44,310 --> 00:13:42,480

a pop-up except that she defended her

386

00:13:46,710 --> 00:13:44,320

phd thesis yesterday and i was trying to

387

00:13:48,949 --> 00:13:46,720

be gentle and kind after such a

388

00:13:51,590 --> 00:13:48,959

important event but the reason that i

389

00:13:53,350 --> 00:13:51,600

would have asked for example

390

00:13:55,189 --> 00:13:53,360

someone like hannah to give a

391

00:13:56,389 --> 00:13:55,199

quick pop-up

392

00:13:57,670 --> 00:13:56,399

and you might want to encourage your

393

00:13:59,350 --> 00:13:57,680

students and post-docs and other

394

00:14:01,269 --> 00:13:59,360

research scientists working with you to

395

00:14:03,590 --> 00:14:01,279

give a quick pop-up is

396

00:14:05,269 --> 00:14:03,600

um two major outcomes from her thesis

397

00:14:07,829 --> 00:14:05,279

work which are starting to come out into

398

00:14:09,269 --> 00:14:07,839

various publications are one

399

00:14:11,509 --> 00:14:09,279

some of the key reactions that actually

400

00:14:13,590 --> 00:14:11,519

make molecular hydrogen at temperatures

401
00:14:15,110 --> 00:14:13,600
within the temperature limits of life so

402
00:14:16,389 --> 00:14:15,120
she's been trying to see reactions

403
00:14:18,069 --> 00:14:16,399
within

404
00:14:19,990 --> 00:14:18,079
actively subpoenaizing rocks that make

405
00:14:21,910 --> 00:14:20,000
hydrogen and identify those and that's

406
00:14:24,310 --> 00:14:21,920
been really changed our thinking about

407
00:14:26,389 --> 00:14:24,320
where to go look for life activity

408
00:14:27,750 --> 00:14:26,399
the second one was a part of her thesis

409
00:14:29,990 --> 00:14:27,760
that worked on

410
00:14:31,509 --> 00:14:30,000
looking at methanogens a type of life

411
00:14:33,110 --> 00:14:31,519
that we think should should be

412
00:14:35,670 --> 00:14:33,120
functionally active in serpentinizing

413
00:14:38,069 --> 00:14:35,680

systems how they who they are and how

414

00:14:40,069 --> 00:14:38,079

they work at the

415

00:14:42,230 --> 00:14:40,079

high alkaline phs that we often see in

416

00:14:44,069 --> 00:14:42,240

surbatinizing systems and the carbon

417

00:14:46,710 --> 00:14:44,079

isotope signatures of the methane they

418

00:14:48,150 --> 00:14:46,720

make so depending on how things evolve i

419

00:14:49,990 --> 00:14:48,160

may have to twist your arm and ask you

420

00:14:51,590 --> 00:14:50,000

to talk about that later this week but

421

00:14:55,430 --> 00:14:51,600

for now again sending it back to you

422

00:15:00,470 --> 00:14:56,829

thank you

423

00:15:02,710 --> 00:15:00,480

alexis yes as alexa said i am the day

424

00:15:05,430 --> 00:15:02,720

one theme lead

425

00:15:08,389 --> 00:15:05,440

uh which is civilization systems on

426

00:15:10,949 --> 00:15:08,399

earth so we have a very specific topic

427

00:15:13,430 --> 00:15:10,959

of only serpentinization on earth not

428

00:15:15,590 --> 00:15:13,440

other planets you see the schedule here

429

00:15:17,829 --> 00:15:15,600

before we get to our four featured

430

00:15:20,949 --> 00:15:17,839

invited talks i'm going to give a quick

431

00:15:23,110 --> 00:15:20,959

scientific overview of serpentinization

432

00:15:24,829 --> 00:15:23,120

um so go ahead and go to the next slide

433

00:15:26,310 --> 00:15:24,839

to give

434

00:15:27,110 --> 00:15:26,320

um uh

435

00:15:28,470 --> 00:15:27,120

the

436

00:15:30,949 --> 00:15:28,480

just some background information because

437

00:15:32,470 --> 00:15:30,959

we want to be welcoming to everyone even

438

00:15:35,350 --> 00:15:32,480

those who may not already be familiar

439

00:15:37,829 --> 00:15:35,360

with defensiveness this is this workshop

440

00:15:39,670 --> 00:15:37,839

is not intended to be exclusive to

441

00:15:43,189 --> 00:15:39,680

serpentinization fanatics we're

442

00:15:45,269 --> 00:15:43,199

welcoming everybody so here's a

443

00:15:46,710 --> 00:15:45,279

introduction for those people

444

00:15:49,269 --> 00:15:46,720

um

445

00:15:51,110 --> 00:15:49,279

we know of two energy sources in the

446

00:15:52,710 --> 00:15:51,120

solar system that we know can support

447

00:15:55,350 --> 00:15:52,720

life there's the sun of course that

448

00:15:57,110 --> 00:15:55,360

supports all green plants and therefore

449

00:15:58,790 --> 00:15:57,120

all other surface-based life on this

450

00:16:00,389 --> 00:15:58,800

planet everything you eat comes from the

451
00:16:01,749 --> 00:16:00,399
sun

452
00:16:04,069 --> 00:16:01,759
and then when hydrothermal vents were

453
00:16:05,829 --> 00:16:04,079
discovered in the late 70s we realized

454
00:16:08,710 --> 00:16:05,839
that magmatic heat from the earth's

455
00:16:10,629 --> 00:16:08,720
mantle can also support ecosystems on

456
00:16:12,230 --> 00:16:10,639
earth independent from the sun so from

457
00:16:14,629 --> 00:16:12,240
an astrobiological perspective when

458
00:16:17,110 --> 00:16:14,639
we're looking for life we need to find

459
00:16:21,430 --> 00:16:17,120
solar powered life or

460
00:16:22,790 --> 00:16:21,440
uh geologically active planets or both

461
00:16:23,760 --> 00:16:22,800
with the recent discovery of

462
00:16:25,590 --> 00:16:23,770
serpentinization

463
00:16:27,749 --> 00:16:25,600

[Music]

464

00:16:29,990 --> 00:16:27,759

i can control the slides

465

00:16:31,829 --> 00:16:30,000

yes

466

00:16:34,470 --> 00:16:31,839

no next slide please

467

00:16:36,790 --> 00:16:34,480

uh yeah billy click the down arrow in

468

00:16:38,949 --> 00:16:36,800

the lower left of the slides the down

469

00:16:42,470 --> 00:16:38,959

arrow not the right arrow

470

00:16:46,790 --> 00:16:44,870

so here is my very simplistic uh

471

00:16:48,710 --> 00:16:46,800

introduction to serpentization and

472

00:16:51,110 --> 00:16:48,720

later on this workshop i'm sure we will

473

00:16:53,030 --> 00:16:51,120

get more comprehensive and more precise

474

00:16:54,470 --> 00:16:53,040

definitions of what serpentization

475

00:16:56,629 --> 00:16:54,480

reactions

476

00:16:58,870 --> 00:16:56,639

are and what they can do

477

00:17:00,870 --> 00:16:58,880

but my microbiologist's definition of

478

00:17:02,550 --> 00:17:00,880

serpentinization is here it's the

479

00:17:04,710 --> 00:17:02,560

process by which the pretty green rock

480

00:17:06,949 --> 00:17:04,720

turns into the ugly black rock

481

00:17:08,230 --> 00:17:06,959

and from a biological perspective what's

482

00:17:10,069 --> 00:17:08,240

exciting about that is that it's

483

00:17:12,390 --> 00:17:10,079

exothermic it releases energy it

484

00:17:14,549 --> 00:17:12,400

releases hydrogen the hydrogen can

485

00:17:17,189 --> 00:17:14,559

potentially create organic matter that

486

00:17:18,470 --> 00:17:17,199

can support life so this is potentially

487

00:17:21,189 --> 00:17:18,480

a third

488

00:17:23,750 --> 00:17:21,199

source of energy that could support life

489

00:17:25,029 --> 00:17:23,760

this is one of the things that everyone

490

00:17:26,390 --> 00:17:25,039

[Music]

491

00:17:28,150 --> 00:17:26,400

many of the people involved in this

492

00:17:29,750 --> 00:17:28,160

workshop want to be able to study is can

493

00:17:31,430 --> 00:17:29,760

this support life and can it in fact

494

00:17:33,510 --> 00:17:31,440

support life independent of the other

495

00:17:36,470 --> 00:17:33,520

two sources of energy we know about

496

00:17:38,549 --> 00:17:36,480

stars and mag and magma

497

00:17:40,070 --> 00:17:38,559

is dependentization our geochemical

498

00:17:42,310 --> 00:17:40,080

reactions a

499

00:17:43,590 --> 00:17:42,320

a third kind of energy that can support

500

00:17:46,390 --> 00:17:43,600

life on their own we don't know that's

501

00:17:47,909 --> 00:17:46,400

what we're here to discuss

502

00:17:49,909 --> 00:17:47,919

and to make this a little bit more

503

00:17:51,430 --> 00:17:49,919

concrete in my short overview i'm going

504

00:17:53,510 --> 00:17:51,440

to give you one example of a

505

00:17:55,669 --> 00:17:53,520

serpentinizing system on earth

506

00:17:57,750 --> 00:17:55,679

this is the tablelands of light in

507

00:17:59,430 --> 00:17:57,760

grossmore national park in newfoundland

508

00:18:01,909 --> 00:17:59,440

where matt shrink and i have been

509

00:18:04,230 --> 00:18:01,919

working with penny morrell

510

00:18:05,669 --> 00:18:04,240

who's a memorial university in st john's

511

00:18:08,230 --> 00:18:05,679

and i really like this picture because

512

00:18:10,470 --> 00:18:08,240

it's an overview of the watershed where

513

00:18:12,870 --> 00:18:10,480

we find ph 12

514

00:18:14,150 --> 00:18:12,880

springs coming out of serpentinites and

515

00:18:16,150 --> 00:18:14,160

i also like this picture because it

516

00:18:19,029 --> 00:18:16,160

looks a little bit like mars

517

00:18:21,909 --> 00:18:19,039

which is not entirely a coincidence the

518

00:18:24,710 --> 00:18:21,919

serpentinites are toxic to most plants

519

00:18:26,310 --> 00:18:24,720

and so the vegetation is very sparse

520

00:18:27,990 --> 00:18:26,320

here are some beautiful pictures of

521

00:18:29,510 --> 00:18:28,000

pencil nights do you see the snake skin

522

00:18:31,750 --> 00:18:29,520

texture which gives the name to

523

00:18:34,310 --> 00:18:31,760

serpentine tonight

524

00:18:35,990 --> 00:18:34,320

and um

525

00:18:38,549 --> 00:18:36,000

here

526

00:18:41,190 --> 00:18:38,559

i think i have to do this

527

00:18:42,789 --> 00:18:41,200

now you can see my pointer i think

528

00:18:43,750 --> 00:18:42,799

nope

529

00:18:45,750 --> 00:18:43,760

okay

530

00:18:48,470 --> 00:18:45,760

how that works

531

00:18:50,320 --> 00:18:48,480

right around here is a spring coming out

532

00:18:53,990 --> 00:18:50,330

of the serpentinites

533

00:18:55,590 --> 00:18:54,000

[Music]

534

00:18:58,070 --> 00:18:55,600

and

535

00:19:01,029 --> 00:18:58,080

what i want to show you is that

536

00:19:02,390 --> 00:19:01,039

this show you this as an example of a

537

00:19:03,990 --> 00:19:02,400

conceptual

538

00:19:05,590 --> 00:19:04,000

and intellectual challenge we have

539

00:19:08,070 --> 00:19:05,600

almost anywhere we're going to study

540

00:19:09,430 --> 00:19:08,080

serpentinization so in this site you

541

00:19:11,190 --> 00:19:09,440

have

542

00:19:13,110 --> 00:19:11,200

subsurface water

543

00:19:15,669 --> 00:19:13,120

coming out it's very high ph very

544

00:19:17,430 --> 00:19:15,679

extreme and you have surface water in

545

00:19:19,190 --> 00:19:17,440

this case coming from a swamp that is

546

00:19:21,350 --> 00:19:19,200

flowing into this pool and there's a

547

00:19:23,270 --> 00:19:21,360

mixing zone in between them and we look

548

00:19:26,789 --> 00:19:23,280

at the microbial diversity at these

549

00:19:30,460 --> 00:19:30,070

we see a lot of kinds of microbes coming

550

00:19:33,750 --> 00:19:30,470

from

551
00:19:33,760 --> 00:19:36,549
i don't know

552
00:19:39,430 --> 00:19:37,909
a lot of you just click where you want

553
00:19:41,190 --> 00:19:39,440
the pointer to go it's better than

554
00:19:44,150 --> 00:19:41,200
dragging it

555
00:19:45,590 --> 00:19:44,160
no dragging just click got it thank you

556
00:19:47,669 --> 00:19:45,600
lots of different kinds of microbes come

557
00:19:49,430 --> 00:19:47,679
from the swamp as you might expect

558
00:19:54,230 --> 00:19:49,440
very few kinds of microbes are coming

559
00:20:00,789 --> 00:19:57,029
and when they where they mix you have

560
00:20:03,029 --> 00:20:00,799
a mix of microbes that is not surprising

561
00:20:05,669 --> 00:20:03,039
so our challenge when we study places

562
00:20:07,750 --> 00:20:05,679
like this is that

563
00:20:09,510 --> 00:20:07,760

what we really want to know is what is

564

00:20:11,110 --> 00:20:09,520

going on in the subsurface where it's

565

00:20:13,350 --> 00:20:11,120

not affected by the

566

00:20:14,549 --> 00:20:13,360

oxygenated earth's atmosphere right we

567

00:20:17,110 --> 00:20:14,559

don't really care what lives in the

568

00:20:18,870 --> 00:20:17,120

swamp if we were a swamp biologist we

569

00:20:20,390 --> 00:20:18,880

couldn't care but we

570

00:20:22,310 --> 00:20:20,400

are studying super fentanization and we

571

00:20:24,310 --> 00:20:22,320

want to remove that effect of the

572

00:20:26,149 --> 00:20:24,320

microbes coming from the swamp and we're

573

00:20:27,750 --> 00:20:26,159

also not that interested in the mixing

574

00:20:29,190 --> 00:20:27,760

zone although it's really biologically

575

00:20:30,870 --> 00:20:29,200

interesting that's usually where we see

576

00:20:32,710 --> 00:20:30,880

the most biological activity because

577

00:20:34,870 --> 00:20:32,720

mixing zones are where biology really

578

00:20:37,110 --> 00:20:34,880

thrives and one of the big questions

579

00:20:39,430 --> 00:20:37,120

that i think will be a theme of this

580

00:20:41,830 --> 00:20:39,440

workshop especially day one

581

00:20:44,630 --> 00:20:41,840

is how can we figure out what's going on

582

00:20:46,630 --> 00:20:44,640

in this heavily heavily serpentinization

583

00:20:48,549 --> 00:20:46,640

influenced environment even though we

584

00:20:50,789 --> 00:20:48,559

have to work on the surface of the earth

585

00:20:52,230 --> 00:20:50,799

and it's contaminated and mixed with all

586

00:20:56,310 --> 00:20:52,240

these other things that we may not care

587

00:21:00,390 --> 00:20:58,230

and here is

588

00:21:02,549 --> 00:21:00,400

one more slide showing this is a general

589

00:21:03,830 --> 00:21:02,559

trend this is a data set i compiled

590

00:21:05,510 --> 00:21:03,840

several years ago

591

00:21:06,870 --> 00:21:05,520

it's old now i need to make a new one

592

00:21:08,710 --> 00:21:06,880

but it

593

00:21:11,590 --> 00:21:08,720

very nicely illustrates this point that

594

00:21:12,549 --> 00:21:11,600

as ph goes up and

595

00:21:15,350 --> 00:21:12,559

in

596

00:21:16,950 --> 00:21:15,360

places where i got this data ph is an

597

00:21:18,789 --> 00:21:16,960

indicator of the degree of

598

00:21:22,549 --> 00:21:18,799

serpentinization

599

00:21:24,710 --> 00:21:22,559

becomes more and more important the

600

00:21:25,830 --> 00:21:24,720

diversity and the units on the y-axis

601
00:21:27,830 --> 00:21:25,840
are not so important here what's

602
00:21:30,630 --> 00:21:27,840
important is that the diversity of the

603
00:21:32,710 --> 00:21:30,640
microbes is going down down down down

604
00:21:34,549 --> 00:21:32,720
as the ph goes up as serpentinization

605
00:21:37,590 --> 00:21:34,559
becomes more important and in many of

606
00:21:40,070 --> 00:21:37,600
the places not only is the diversity low

607
00:21:41,590 --> 00:21:40,080
the biomass is also very low as an

608
00:21:44,070 --> 00:21:41,600
indication these are very difficult

609
00:21:46,789 --> 00:21:44,080
places to live

610
00:21:48,710 --> 00:21:46,799
so this magnifies the problem of

611
00:21:50,950 --> 00:21:48,720
contamination of the surface because the

612
00:21:53,110 --> 00:21:50,960
surface has more stuff it has more kinds

613
00:21:55,669 --> 00:21:53,120

of stuff and it totally swamps out the

614

00:21:57,830 --> 00:21:55,679

signal from the subsurface in many cases

615

00:21:59,590 --> 00:21:57,840

and this is a very challenging problem

616

00:22:01,190 --> 00:21:59,600

that we will also for example probably

617

00:22:03,669 --> 00:22:01,200

have to deal with on mars or any other

618

00:22:06,149 --> 00:22:03,679

planet that we study

619

00:22:07,750 --> 00:22:06,159

and uh later this morning you will hear

620

00:22:09,430 --> 00:22:07,760

from matt shrink more about the

621

00:22:13,830 --> 00:22:09,440

microbial diversity of microbes that's

622

00:22:18,950 --> 00:22:16,789

one more point is that um that

623

00:22:21,590 --> 00:22:18,960

example i just showed you was one type

624

00:22:23,669 --> 00:22:21,600

of a serpentinization system on land

625

00:22:25,669 --> 00:22:23,679

uh here's another one in italy you can

626
00:22:27,430 --> 00:22:25,679
also have serpentinizing systems on the

627
00:22:29,270 --> 00:22:27,440
seafloor this is the lost city

628
00:22:30,710 --> 00:22:29,280
hydrothermal field and these huge

629
00:22:32,789 --> 00:22:30,720
carbonate chimneys that form on the

630
00:22:35,029 --> 00:22:32,799
seafloor and the point i want to make is

631
00:22:37,590 --> 00:22:35,039
in both cases all the biological

632
00:22:39,590 --> 00:22:37,600
activity that we can easily study anyway

633
00:22:41,190 --> 00:22:39,600
is occurring at these mixing zones so i

634
00:22:43,510 --> 00:22:41,200
showed you the example

635
00:22:45,110 --> 00:22:43,520
a table lands where most activity is

636
00:22:47,270 --> 00:22:45,120
where the subsurface water comes to the

637
00:22:49,669 --> 00:22:47,280
surface and mixes that's most of the

638
00:22:51,590 --> 00:22:49,679

activity that we can detect velocity is

639

00:22:53,750 --> 00:22:51,600

the same thing these chimneys are formed

640

00:22:56,549 --> 00:22:53,760

by the mixing of subsurface fluids with

641

00:22:58,950 --> 00:22:56,559

surface woods the chimneys are only

642

00:22:59,669 --> 00:22:58,960

there because mixing is occurring

643

00:23:01,510 --> 00:22:59,679

and

644

00:23:02,789 --> 00:23:01,520

when we have visited lost city in the

645

00:23:04,390 --> 00:23:02,799

past

646

00:23:06,070 --> 00:23:04,400

we have mostly studied these beautiful

647

00:23:08,390 --> 00:23:06,080

carbonate chimneys with tons and tons of

648

00:23:10,390 --> 00:23:08,400

life on them because they were the

649

00:23:12,630 --> 00:23:10,400

obvious thing to study but if we want to

650

00:23:15,510 --> 00:23:12,640

have a general understanding of how

651
00:23:17,430 --> 00:23:15,520
serpentinization and life interact

652
00:23:19,510 --> 00:23:17,440
and sort of universal fundamental

653
00:23:21,510 --> 00:23:19,520
principles the chimneys may not be the

654
00:23:24,549 --> 00:23:21,520
best place to study we may want to study

655
00:23:25,909 --> 00:23:24,559
things down here or over here

656
00:23:27,909 --> 00:23:25,919
and we just haven't done that yet in

657
00:23:31,990 --> 00:23:27,919
many places although we will hear about

658
00:23:34,470 --> 00:23:32,000
some new studies later today

659
00:23:37,510 --> 00:23:34,480
so this is just a textual

660
00:23:38,950 --> 00:23:37,520
summary of what i just said um chimneys

661
00:23:40,870 --> 00:23:38,960
are mixing this is what we've studied

662
00:23:42,950 --> 00:23:40,880
before it's probably not what we want to

663
00:23:44,149 --> 00:23:42,960

focus on in the future

664

00:23:46,310 --> 00:23:44,159

and

665

00:23:48,230 --> 00:23:46,320

once again the reason why we we need to

666

00:23:49,990 --> 00:23:48,240

be able to sort out these subsurface

667

00:23:51,990 --> 00:23:50,000

versus surface processes is that's

668

00:23:53,510 --> 00:23:52,000

probably how we're going to be able

669

00:23:57,029 --> 00:23:53,520

to address the question of whether

670

00:23:58,630 --> 00:23:57,039

serpentinization can support life

671

00:24:00,789 --> 00:23:58,640

on another planet for example where

672

00:24:03,269 --> 00:24:00,799

there may not be an ocean of oxidized

673

00:24:05,430 --> 00:24:03,279

sea water above it or may not be

674

00:24:09,430 --> 00:24:05,440

sunlight providing oxygen and things

675

00:24:11,669 --> 00:24:10,149

so

676
00:24:14,310 --> 00:24:11,679
um

677
00:24:16,549 --> 00:24:14,320
this is uh one framework for

678
00:24:18,870 --> 00:24:16,559
understanding what the invited talks are

679
00:24:21,110 --> 00:24:18,880
going to talk about today

680
00:24:24,710 --> 00:24:21,120
what is going on underneath the chimneys

681
00:24:25,830 --> 00:24:24,720
what is going on in areas where there's

682
00:24:28,149 --> 00:24:25,840
less

683
00:24:31,190 --> 00:24:28,159
focused flow but more

684
00:24:34,630 --> 00:24:31,200
widespread on a spatial and volume basis

685
00:24:39,110 --> 00:24:36,630
among the topics that the talks later

686
00:24:40,950 --> 00:24:39,120
today will talk about so

687
00:24:43,190 --> 00:24:40,960
next up after me will be susan lang

688
00:24:46,070 --> 00:24:43,200

we'll talk about the

689

00:24:47,750 --> 00:24:46,080

carbon chemistry of sermonizing systems

690

00:24:49,669 --> 00:24:47,760

like this

691

00:24:51,669 --> 00:24:49,679

after susan everett will talk about the

692

00:24:54,149 --> 00:24:51,679

energetics of these

693

00:24:55,669 --> 00:24:54,159

molecules and how these chemical

694

00:24:56,789 --> 00:24:55,679

reactions may or may not be useful to

695

00:24:58,549 --> 00:24:56,799

biology

696

00:25:00,950 --> 00:24:58,559

and then

697

00:25:02,789 --> 00:25:00,960

beth will talk about a recent uh

698

00:25:05,430 --> 00:25:02,799

drilling expedition where we drilled

699

00:25:07,269 --> 00:25:05,440

into the rocks around

700

00:25:08,950 --> 00:25:07,279

the velocity hydrothermal field directly

701
00:25:10,950 --> 00:25:08,960
into the serpentine knights to really

702
00:25:13,830 --> 00:25:10,960
get a more direct

703
00:25:15,830 --> 00:25:13,840
study of life in the subsurface that may

704
00:25:18,149 --> 00:25:15,840
not be quite as affected by the surface

705
00:25:21,830 --> 00:25:18,159
although of course that is one thing

706
00:25:26,149 --> 00:25:24,070
so i think you guys get my my points

707
00:25:29,510 --> 00:25:26,159
here but here's one more slide

708
00:25:31,510 --> 00:25:29,520
to drive it home uh on earth we have

709
00:25:33,110 --> 00:25:31,520
this challenge that we both mostly study

710
00:25:34,870 --> 00:25:33,120
things on the surface but what we really

711
00:25:36,789 --> 00:25:34,880
want to know is whether there's some

712
00:25:38,070 --> 00:25:36,799
green slime down in the subsurface

713
00:25:39,909 --> 00:25:38,080

that's actually doing the extra

714

00:25:41,590 --> 00:25:39,919

biologically interesting stuff

715

00:25:43,830 --> 00:25:41,600

and if we send

716

00:25:45,590 --> 00:25:43,840

robots to mars or to europa or to

717

00:25:47,669 --> 00:25:45,600

enceladus i think that we will have a

718

00:25:49,830 --> 00:25:47,679

very similar intellectual problem on our

719

00:25:51,350 --> 00:25:49,840

hands which is that we mostly measure

720

00:25:52,789 --> 00:25:51,360

things on the surface but what we really

721

00:25:54,710 --> 00:25:52,799

care about is if there's some green

722

00:25:57,190 --> 00:25:54,720

slime in the subsurface that's really

723

00:25:59,909 --> 00:25:57,200

doing the interesting stuff

724

00:26:02,230 --> 00:25:59,919

so i encourage you to think about this

725

00:26:03,029 --> 00:26:02,240

kind of conceptual theme as we listen to

726

00:26:09,029 --> 00:26:03,039

the

727

00:26:11,430 --> 00:26:09,039

and um i think it might be a useful

728

00:26:13,350 --> 00:26:11,440

framework for interpreting the data that

729

00:26:15,269 --> 00:26:13,360

will be presented

730

00:26:16,310 --> 00:26:15,279

so that's all i wanted to say

731

00:26:18,230 --> 00:26:16,320

yeah

732

00:26:21,029 --> 00:26:18,240

before you um go ahead then and start

733

00:26:23,350 --> 00:26:21,039

with all the talks you lined up um we

734

00:26:26,710 --> 00:26:23,360

already had some commentary in the chat

735

00:26:28,870 --> 00:26:26,720

and darcy um meyer dombard and darcy i

736

00:26:30,230 --> 00:26:28,880

do want to say as well with someone

737

00:26:31,830 --> 00:26:30,240

who's been very willing to help

738

00:26:33,750 --> 00:26:31,840

spearhead the idea of a working group

739

00:26:36,310 --> 00:26:33,760

and i'd love to hear your input on that

740

00:26:38,149 --> 00:26:36,320

after this workshop too she says just to

741

00:26:40,710 --> 00:26:38,159

comment on the concept of the mixing

742

00:26:43,669 --> 00:26:40,720

zone and interest in them if the mixing

743

00:26:45,590 --> 00:26:43,679

zone is a true eco-tone we can sometimes

744

00:26:48,070 --> 00:26:45,600

see cool examples of the subsurface

745

00:26:49,669 --> 00:26:48,080

influencing what is going on in surface

746

00:26:51,269 --> 00:26:49,679

affected environments and it just seemed

747

00:26:53,269 --> 00:26:51,279

worth having you comment on that a

748

00:26:55,029 --> 00:26:53,279

little bit more before we go into the

749

00:26:56,630 --> 00:26:55,039

next talk

750

00:26:59,590 --> 00:26:56,640

yeah that's really good point i've

751
00:27:01,350 --> 00:26:59,600
perhaps presented it as mostly a one-way

752
00:27:03,269 --> 00:27:01,360
interaction where the surface is

753
00:27:05,029 --> 00:27:03,279
swamping or obscuring the interesting

754
00:27:07,110 --> 00:27:05,039
stuff in the subsurface but

755
00:27:08,789 --> 00:27:07,120
it's definitely can be a two-way

756
00:27:10,390 --> 00:27:08,799
interaction where

757
00:27:12,230 --> 00:27:10,400
the subsurface is influencing the

758
00:27:14,710 --> 00:27:12,240
surface and that's

759
00:27:16,390 --> 00:27:14,720
uh where a lot of interesting science is

760
00:27:17,350 --> 00:27:16,400
going on and

761
00:27:20,070 --> 00:27:17,360
um

762
00:27:21,830 --> 00:27:20,080
perhaps even by necessity that's the

763
00:27:24,149 --> 00:27:21,840

only way that we can actually understand

764

00:27:26,070 --> 00:27:24,159

what is going on in the subsurface is by

765

00:27:27,269 --> 00:27:26,080

understanding how it affects the surface

766

00:27:28,230 --> 00:27:27,279

and then

767

00:27:30,630 --> 00:27:28,240

um

768

00:27:32,549 --> 00:27:30,640

inferring what the subsurface without

769

00:27:39,510 --> 00:27:32,559

the surface might have looked like yes i

770

00:27:43,590 --> 00:27:40,549

um

771

00:27:46,070 --> 00:27:43,600

yeah so i that's another way to put my

772

00:27:47,430 --> 00:27:46,080

recommendation to our our participants

773

00:27:49,269 --> 00:27:47,440

is

774

00:27:51,909 --> 00:27:49,279

when we when we see

775

00:27:53,990 --> 00:27:51,919

uh data from field systems or perhaps

776

00:27:55,029 --> 00:27:54,000

even experimental systems it's good to

777

00:27:56,149 --> 00:27:55,039

think about

778

00:27:58,230 --> 00:27:56,159

is this

779

00:28:00,870 --> 00:27:58,240

a surface process swapping out the

780

00:28:03,269 --> 00:28:00,880

subsurface is a subsurface actually

781

00:28:05,669 --> 00:28:03,279

emerging despite the noise from the

782

00:28:07,269 --> 00:28:05,679

surface or some interesting

783

00:28:08,310 --> 00:28:07,279

synergy of the two

784

00:28:09,669 --> 00:28:08,320

i think

785

00:28:10,470 --> 00:28:09,679

that might be one way to think about

786

00:28:11,909 --> 00:28:10,480

these

787

00:28:15,029 --> 00:28:11,919

different kinds of data

788

00:28:18,710 --> 00:28:16,549

see here the schedule here we have a

789

00:28:20,950 --> 00:28:18,720

full slate of pop-up talks at the end so

790

00:28:22,870 --> 00:28:20,960

i'm really looking forward to that

791

00:28:24,310 --> 00:28:22,880

and i want to encourage everyone to ask

792

00:28:25,909 --> 00:28:24,320

questions

793

00:28:27,510 --> 00:28:25,919

probably uh

794

00:28:29,190 --> 00:28:27,520

limit the questions that labs to after

795

00:28:30,630 --> 00:28:29,200

talks but certainly if there's an

796

00:28:32,549 --> 00:28:30,640

important permanent question during the

797

00:28:34,070 --> 00:28:32,559

talk i think that may be

798

00:28:37,110 --> 00:28:34,080

possible as well but certainly after

799

00:28:38,950 --> 00:28:37,120

talks and especially any time during the

800

00:28:40,950 --> 00:28:38,960

talks in between talks in the chat

801
00:28:43,029 --> 00:28:40,960
window we are hoping that chat window

802
00:28:45,750 --> 00:28:43,039
will be a really vigorous

803
00:28:47,269 --> 00:28:45,760
field of intellectual discourse

804
00:28:48,470 --> 00:28:47,279
uh the whole purpose of this is to

805
00:28:49,750 --> 00:28:48,480
stimulate lots of really good

806
00:28:51,750 --> 00:28:49,760
discussions

807
00:28:54,070 --> 00:28:51,760
um hi billy we also had a question from

808
00:28:55,909 --> 00:28:54,080
adrian brown asking if you could comment

809
00:28:57,830 --> 00:28:55,919
on the the mineralogy you're seeing at

810
00:28:59,350 --> 00:28:57,840
the surface where where the spring the

811
00:29:00,310 --> 00:28:59,360
spring and the surface waters were

812
00:29:01,669 --> 00:29:00,320
mixing

813
00:29:03,029 --> 00:29:01,679

so that probably i think

814

00:29:05,110 --> 00:29:03,039

the white they are

815

00:29:07,590 --> 00:29:05,120

next and i know that serpentines are

816

00:29:09,669 --> 00:29:07,600

rich in serpentine and that is my

817

00:29:11,430 --> 00:29:09,679

extensive geochemical knowledge of the

818

00:29:12,870 --> 00:29:11,440

mineralogy of those rocks someone else

819

00:29:15,269 --> 00:29:12,880

could probably better answer that

820

00:29:20,389 --> 00:29:16,549

but they are really beautiful

821

00:29:20,399 --> 00:29:23,190

thank you

822

00:29:31,190 --> 00:29:25,430

[Applause]

823

00:29:35,190 --> 00:29:33,669

hi thanks billy

824

00:29:38,950 --> 00:29:35,200

um

825

00:29:41,909 --> 00:29:38,960

okay it looks like my slides are up and

826

00:29:43,990 --> 00:29:41,919

thanks for the opportunity to chat today

827

00:29:46,630 --> 00:29:44,000

so billy had asked me to talk a little

828

00:29:48,070 --> 00:29:46,640

bit about carbon and serpentinization

829

00:29:49,830 --> 00:29:48,080

environments

830

00:29:53,029 --> 00:29:49,840

and asked me

831

00:29:54,950 --> 00:29:53,039

as well to talk as much as i could

832

00:29:57,190 --> 00:29:54,960

comparing and contrasting

833

00:29:59,110 --> 00:29:57,200

some of the signatures that we see in

834

00:30:01,669 --> 00:29:59,120

oceanic versus

835

00:30:04,389 --> 00:30:01,679

continental systems

836

00:30:06,310 --> 00:30:04,399

i'll do that to the extent that i can

837

00:30:09,269 --> 00:30:06,320

but the focus is probably going to be a

838

00:30:11,750 --> 00:30:09,279

little bit more on oceanic systems

839

00:30:13,750 --> 00:30:11,760

and so the image that you see on the

840

00:30:16,789 --> 00:30:13,760

left is from

841

00:30:18,630 --> 00:30:16,799

velocity hydrothermal field and then the

842

00:30:21,110 --> 00:30:18,640

one on the right is from a continental

843

00:30:23,350 --> 00:30:21,120

system in liguria and in both cases you

844

00:30:25,510 --> 00:30:23,360

can see these large carbonate deposits

845

00:30:29,029 --> 00:30:25,520

that kind of typify

846

00:30:33,430 --> 00:30:29,039

some of these serpentization systems

847

00:30:34,789 --> 00:30:33,440

and so as billy introduced already

848

00:30:37,750 --> 00:30:34,799

one of the outcomes of the

849

00:30:40,149 --> 00:30:37,760

serpentinization reaction are these high

850

00:30:41,669 --> 00:30:40,159

hydrogen concentrations and electrons in

851
00:30:43,990 --> 00:30:41,679
this as well

852
00:30:46,389 --> 00:30:44,000
and part of the reason why i and many

853
00:30:49,190 --> 00:30:46,399
other people are very interested in that

854
00:30:52,149 --> 00:30:49,200
is because that hydrogen can go on to

855
00:30:55,269 --> 00:30:52,159
fuel both the abiotic synthesis of

856
00:30:57,590 --> 00:30:55,279
organic compounds and it can fuel

857
00:31:00,549 --> 00:30:57,600
microbial growth

858
00:31:03,509 --> 00:31:00,559
autotrophic growth in the subsurface or

859
00:31:06,630 --> 00:31:03,519
as those fluids move to the surface

860
00:31:08,630 --> 00:31:06,640
and when we think about those processes

861
00:31:10,630 --> 00:31:08,640
most of the time the reactions we're

862
00:31:13,110 --> 00:31:10,640
thinking about or the metabolisms we're

863
00:31:15,269 --> 00:31:13,120

thinking about require

864

00:31:16,950 --> 00:31:15,279

something like inorganic carbon as a

865

00:31:19,909 --> 00:31:16,960

starting material

866

00:31:22,630 --> 00:31:19,919

a lot of times we kind of default to

867

00:31:24,549 --> 00:31:22,640

thinking of it as a dissolved inorganic

868

00:31:25,990 --> 00:31:24,559

carbon so something like bicarbonate or

869

00:31:30,389 --> 00:31:26,000

co₂

870

00:31:32,789 --> 00:31:30,399

but in general it's oxidized carbon

871

00:31:34,389 --> 00:31:32,799

those processes

872

00:31:37,190 --> 00:31:34,399

both of them will

873

00:31:38,710 --> 00:31:37,200

alter carbon signatures both in fluids

874

00:31:40,470 --> 00:31:38,720

and in rocks

875

00:31:42,149 --> 00:31:40,480

and so

876
00:31:43,669 --> 00:31:42,159
as a result of this some of the research

877
00:31:45,509 --> 00:31:43,679
i'm interested in and what i wanted to

878
00:31:47,750 --> 00:31:45,519
talk a little bit about today

879
00:31:50,549 --> 00:31:47,760
is what happens to carbon in general in

880
00:31:53,029 --> 00:31:50,559
serpentinite hosted environments

881
00:31:55,509 --> 00:31:53,039
and the way i thought i would organize

882
00:31:58,230 --> 00:31:55,519
this is by those looked a little bit

883
00:32:00,549 --> 00:31:58,240
more like arrows on my uh on my version

884
00:32:01,509 --> 00:32:00,559
but i think you get the you get the

885
00:32:02,789 --> 00:32:01,519
picture

886
00:32:05,190 --> 00:32:02,799
that um

887
00:32:08,070 --> 00:32:05,200
the organization i wanted to try and go

888
00:32:10,950 --> 00:32:08,080

through is going through this as

889

00:32:13,509 --> 00:32:10,960

a fluid flow pathway and so in the ocean

890

00:32:15,590 --> 00:32:13,519

you have sea water that down wells

891

00:32:18,470 --> 00:32:15,600

in the subsurface there's some sort of

892

00:32:21,350 --> 00:32:18,480

mantle input that we can see geochemical

893

00:32:23,269 --> 00:32:21,360

signatures of there's the possibility of

894

00:32:25,830 --> 00:32:23,279

picking up material from things like

895

00:32:26,950 --> 00:32:25,840

fluid inclusion so

896

00:32:29,110 --> 00:32:26,960

small

897

00:32:32,630 --> 00:32:29,120

bubbles in the rocks that can include

898

00:32:35,350 --> 00:32:32,640

things like hydrogen or sorry methane

899

00:32:37,990 --> 00:32:35,360

and then as those fluids are heated they

900

00:32:39,590 --> 00:32:38,000

start to buoyantly rise and they exit

901
00:32:41,190 --> 00:32:39,600
out the sea floor

902
00:32:42,950 --> 00:32:41,200
in these large

903
00:32:45,190 --> 00:32:42,960
chimney structures

904
00:32:47,990 --> 00:32:45,200
you can have similar processes that go

905
00:32:50,789 --> 00:32:48,000
on in the continents and

906
00:32:52,310 --> 00:32:50,799
and people in continental systems

907
00:33:01,430 --> 00:32:52,320
have

908
00:33:02,630 --> 00:33:01,440
uh different types of fluid pathways

909
00:33:05,110 --> 00:33:02,640
first of all you're starting with

910
00:33:08,950 --> 00:33:05,120
something like meteoric water

911
00:33:10,789 --> 00:33:08,960
and if that water in well as it passes

912
00:33:13,750 --> 00:33:10,799
through the rock is in connection with

913
00:33:17,509 --> 00:33:13,760

the atmosphere and you're continuing to

914

00:33:20,310 --> 00:33:17,519

have carbon dioxide input and oxidants

915

00:33:22,470 --> 00:33:20,320

from the atmosphere it's an open system

916

00:33:24,870 --> 00:33:22,480

and you have one type of fluid chemistry

917

00:33:27,750 --> 00:33:24,880

and if you've sealed that fluid pathway

918

00:33:29,350 --> 00:33:27,760

off from interaction with the surface

919

00:33:32,310 --> 00:33:29,360

then it's a closed system and you have a

920

00:33:35,029 --> 00:33:32,320

very different type of fluid pathway

921

00:33:36,870 --> 00:33:35,039

and again you can have the potential for

922

00:33:38,389 --> 00:33:36,880

something like fluid inclusions in the

923

00:33:40,710 --> 00:33:38,399

subsurface

924

00:33:43,590 --> 00:33:40,720

and so one of the first things to think

925

00:33:45,830 --> 00:33:43,600

about is what your fluid input is

926
00:33:47,669 --> 00:33:45,840
and what happens to that material as it

927
00:33:50,230 --> 00:33:47,679
passes through the system

928
00:33:52,470 --> 00:33:50,240
and so in oceanic systems you have a

929
00:33:54,630 --> 00:33:52,480
pretty homogeneous starting material of

930
00:33:56,710 --> 00:33:54,640
ocean deep sea water where you have

931
00:33:58,710 --> 00:33:56,720
dissolved inorganic carbon present at

932
00:34:01,269 --> 00:33:58,720
about two millimolar

933
00:34:05,110 --> 00:34:01,279
and seawater dissol dissolved organic

934
00:34:08,149 --> 00:34:05,120
carbon present as about 30 to 45

935
00:34:10,230 --> 00:34:08,159
micromole of organic carbon

936
00:34:12,550 --> 00:34:10,240
in continental systems this is a number

937
00:34:13,589 --> 00:34:12,560
i picked up from oman

938
00:34:15,510 --> 00:34:13,599

and

939

00:34:17,589 --> 00:34:15,520

in open systems you have about one to

940

00:34:19,750 --> 00:34:17,599

three millimole of inorganic carbon

941

00:34:22,389 --> 00:34:19,760

that's present in those fluids and you

942

00:34:25,109 --> 00:34:22,399

also have meteoric inorganic carbon and

943

00:34:27,109 --> 00:34:25,119

dissolved organic carbon and the amounts

944

00:34:29,430 --> 00:34:27,119

that's there can probably be fairly

945

00:34:31,109 --> 00:34:29,440

dependent on whether or not the fluids

946

00:34:32,790 --> 00:34:31,119

are going through something like a soil

947

00:34:35,909 --> 00:34:32,800

layer

948

00:34:38,149 --> 00:34:35,919

and so one of the first things to think

949

00:34:39,990 --> 00:34:38,159

about is what happens in particular to

950

00:34:41,829 --> 00:34:40,000

that inorganic carbon and this is a

951
00:34:43,589 --> 00:34:41,839
picture of a serpentinite that was

952
00:34:45,510 --> 00:34:43,599
recovered from the atlantis mississippi

953
00:34:48,470 --> 00:34:45,520
and similar to the pictures that billy

954
00:34:51,589 --> 00:34:48,480
showed there's this fine um

955
00:34:53,270 --> 00:34:51,599
there's fine veins of calcium carbonate

956
00:34:55,990 --> 00:34:53,280
material

957
00:34:57,670 --> 00:34:56,000
and so we know from a lot of work from a

958
00:34:59,589 --> 00:34:57,680
lot of people that a lot of that

959
00:35:02,310 --> 00:34:59,599
inorganic carbon that's brought in with

960
00:35:04,790 --> 00:35:02,320
fluids is precipitated out as calcium

961
00:35:07,910 --> 00:35:04,800
carbonate and so just to highlight two

962
00:35:08,950 --> 00:35:07,920
examples one is um here from the iberian

963
00:35:10,150 --> 00:35:08,960

margin

964

00:35:11,990 --> 00:35:10,160

where

965

00:35:14,710 --> 00:35:12,000

esther schwarzenbach and co-workers

966

00:35:17,190 --> 00:35:14,720

looked at the amount of total inorganic

967

00:35:19,109 --> 00:35:17,200

carbon that was present in rocks and

968

00:35:20,870 --> 00:35:19,119

where you have cold shearing and you're

969

00:35:22,950 --> 00:35:20,880

starting to have fluids pass through

970

00:35:24,870 --> 00:35:22,960

those rocks you have a lot of more you

971

00:35:27,829 --> 00:35:24,880

have a lot more inorganic carbon that's

972

00:35:30,950 --> 00:35:27,839

precipitated and then a recent example

973

00:35:33,750 --> 00:35:30,960

from oman where they were looking at

974

00:35:36,069 --> 00:35:33,760

travertine veins and the c14 ages of

975

00:35:37,829 --> 00:35:36,079

those travertine veins where again you

976

00:35:40,790 --> 00:35:37,839

have a lot of inorganic carbon that's

977

00:35:44,390 --> 00:35:40,800

been precipitated in these veins

978

00:35:48,230 --> 00:35:44,400

over a pretty wide range of time frame

979

00:35:50,310 --> 00:35:48,240

and so one of the questions that's still

980

00:35:52,630 --> 00:35:50,320

being constrained is how quantitative

981

00:35:55,030 --> 00:35:52,640

and how rapid is this calcium carbonate

982

00:35:56,950 --> 00:35:55,040

precipitation and the answer to that

983

00:35:59,910 --> 00:35:56,960

will have

984

00:36:01,990 --> 00:35:59,920

an impact on both

985

00:36:04,710 --> 00:36:02,000

what material is available as a starting

986

00:36:07,910 --> 00:36:04,720

material for abiotic reactions for

987

00:36:09,510 --> 00:36:07,920

microbes for microbes in the subsurface

988

00:36:10,950 --> 00:36:09,520

and obviously a lot of people are

989

00:36:12,790 --> 00:36:10,960

interested in it

990

00:36:17,750 --> 00:36:12,800

from the standpoint of trying to

991

00:36:21,829 --> 00:36:19,510

and so once the fluids are in the

992

00:36:23,910 --> 00:36:21,839

subsurface and are in some sort of

993

00:36:25,270 --> 00:36:23,920

reaction zone

994

00:36:28,150 --> 00:36:25,280

it's a little hard to start

995

00:36:30,630 --> 00:36:28,160

distinguishing what happens in

996

00:36:32,550 --> 00:36:30,640

that area in that region versus what's

997

00:36:34,950 --> 00:36:32,560

happening in the surface which is

998

00:36:38,150 --> 00:36:34,960

something that billy also alluded to

999

00:36:40,150 --> 00:36:38,160

and so um what i thought i would do is

1000

00:36:42,710 --> 00:36:40,160

now focus a little bit more on oceanic

1001
00:36:45,270 --> 00:36:42,720
systems and look at some of the n-member

1002
00:36:47,510 --> 00:36:45,280
fluids from one particular oceanic

1003
00:36:49,910 --> 00:36:47,520
system and try and

1004
00:36:51,270 --> 00:36:49,920
use some evidence

1005
00:36:52,390 --> 00:36:51,280
to talk about

1006
00:36:54,710 --> 00:36:52,400
what might be happening in the

1007
00:36:57,190 --> 00:36:54,720
subsurface versus what's happening more

1008
00:36:58,069 --> 00:36:57,200
towards the surface but really the

1009
00:36:59,990 --> 00:36:58,079
the

1010
00:37:02,069 --> 00:37:00,000
easiest way to go about that at this

1011
00:37:03,829 --> 00:37:02,079
point is to look at some of the fluid

1012
00:37:05,030 --> 00:37:03,839
chemistry in the n member fluids

1013
00:37:06,710 --> 00:37:05,040

although

1014

00:37:09,589 --> 00:37:06,720

folks will be talking a little bit later

1015

00:37:11,349 --> 00:37:09,599

today about some other approaches to try

1016

00:37:13,109 --> 00:37:11,359

and get at what's happening in the rocks

1017

00:37:14,470 --> 00:37:13,119

versus what's happening more towards the

1018

00:37:16,470 --> 00:37:14,480

surface

1019

00:37:19,030 --> 00:37:16,480

and so the system that

1020

00:37:20,790 --> 00:37:19,040

i'm going to focus on is the lost city

1021

00:37:23,670 --> 00:37:20,800

hydrothermal system

1022

00:37:25,750 --> 00:37:23,680

the map in the upper left is um is the

1023

00:37:26,950 --> 00:37:25,760

location of the field is there in a

1024

00:37:27,829 --> 00:37:26,960

white dot

1025

00:37:30,230 --> 00:37:27,839

and

1026
00:37:32,150 --> 00:37:30,240
on the bottom left there's a cartoon of

1027
00:37:34,470 --> 00:37:32,160
the way we

1028
00:37:37,190 --> 00:37:34,480
visualize what might be happening with

1029
00:37:39,190 --> 00:37:37,200
the fluids and in general what we think

1030
00:37:41,829 --> 00:37:39,200
is happening is that there's a single

1031
00:37:42,870 --> 00:37:41,839
n-member fluid that's feeding the the

1032
00:37:47,430 --> 00:37:42,880
field

1033
00:37:48,310 --> 00:37:47,440
have higher temperatures

1034
00:37:52,230 --> 00:37:48,320
and

1035
00:37:54,790 --> 00:37:52,240
as you move to the periphery of the

1036
00:37:56,950 --> 00:37:54,800
field fluids are conductively cooled

1037
00:37:58,230 --> 00:37:56,960
they continue to undergo water rock

1038
00:38:00,390 --> 00:37:58,240

reactions

1039

00:38:02,069 --> 00:38:00,400

and you have a drawdown of hydrogen we

1040

00:38:03,349 --> 00:38:02,079

think mainly because of sulfate

1041

00:38:05,270 --> 00:38:03,359

reduction

1042

00:38:07,349 --> 00:38:05,280

and so these fluids

1043

00:38:09,750 --> 00:38:07,359

that are feeding the chimneys on the

1044

00:38:11,990 --> 00:38:09,760

edges of the field we think have been

1045

00:38:14,550 --> 00:38:12,000

more exposed to

1046

00:38:17,190 --> 00:38:14,560

microbial activity

1047

00:38:20,150 --> 00:38:17,200

i've tried to list here all the carbon

1048

00:38:22,630 --> 00:38:20,160

species that we've identified to date in

1049

00:38:24,790 --> 00:38:22,640

the lost city fluids

1050

00:38:26,470 --> 00:38:24,800

i i think it's pretty comprehensive but

1051
00:38:29,750 --> 00:38:26,480
i could be wrong

1052
00:38:32,870 --> 00:38:29,760
and i've organized it in

1053
00:38:34,230 --> 00:38:32,880
in by oxidation state so

1054
00:38:36,470 --> 00:38:34,240
we've already

1055
00:38:37,910 --> 00:38:36,480
i've already mentioned that

1056
00:38:39,750 --> 00:38:37,920
there's a lot of calcium carbonate

1057
00:38:42,790 --> 00:38:39,760
precipitation so

1058
00:38:43,829 --> 00:38:42,800
co₂ in the surface

1059
00:38:47,430 --> 00:38:43,839
is

1060
00:38:49,430 --> 00:38:47,440
precipitated out as calcium carbonate

1061
00:38:51,910 --> 00:38:49,440
and so not surprising

1062
00:38:53,750 --> 00:38:51,920
is that these n-member fluids have very

1063
00:38:57,190 --> 00:38:53,760

low inorganic carbon

1064

00:38:59,430 --> 00:38:57,200

um present in the fluids and then on the

1065

00:39:02,630 --> 00:38:59,440

other end of the

1066

00:39:04,630 --> 00:39:02,640

of this list is very reduced material so

1067

00:39:06,150 --> 00:39:04,640

things like methane

1068

00:39:07,190 --> 00:39:06,160

and there's high concentrations of

1069

00:39:09,589 --> 00:39:07,200

methane

1070

00:39:11,349 --> 00:39:09,599

but um that can be challenging to use as

1071

00:39:14,470 --> 00:39:11,359

a starting material

1072

00:39:17,270 --> 00:39:14,480

in the anaerobic end member

1073

00:39:18,630 --> 00:39:17,280

for either abiotic reactions or for

1074

00:39:20,870 --> 00:39:18,640

microbial

1075

00:39:24,630 --> 00:39:20,880

metabolism

1076

00:39:27,510 --> 00:39:24,640

because it's already so reduced and so

1077

00:39:29,589 --> 00:39:27,520

the the question as we're looking at

1078

00:39:32,230 --> 00:39:29,599

what is present in these fluids so

1079

00:39:33,829 --> 00:39:32,240

methane is the most abundant

1080

00:39:36,790 --> 00:39:33,839

carbon species that's present in the

1081

00:39:39,270 --> 00:39:36,800

fluid followed by the single carbon

1082

00:39:43,030 --> 00:39:39,280

organic acid formate which is present

1083

00:39:46,310 --> 00:39:43,040

from 34 to 140 micromole and then you

1084

00:39:47,990 --> 00:39:46,320

have things like amino acids and acetate

1085

00:39:49,750 --> 00:39:48,000

that are also present

1086

00:39:51,910 --> 00:39:49,760

and so one of the questions that we've

1087

00:39:54,710 --> 00:39:51,920

been trying to address is

1088

00:39:57,829 --> 00:39:54,720

of these what's biologically produced

1089

00:39:59,270 --> 00:39:57,839

and what's a biologically produced

1090

00:40:01,430 --> 00:39:59,280

and there's a couple ways that we go

1091

00:40:03,349 --> 00:40:01,440

about that we can use geochemical

1092

00:40:04,790 --> 00:40:03,359

evidence to try and address that

1093

00:40:07,510 --> 00:40:04,800

question so

1094

00:40:09,670 --> 00:40:07,520

with things like amino acids we can look

1095

00:40:11,670 --> 00:40:09,680

at the distribution of the amino acids

1096

00:40:14,309 --> 00:40:11,680

compare them to what we would expect a

1097

00:40:16,309 --> 00:40:14,319

biological signature to look like so

1098

00:40:18,150 --> 00:40:16,319

what's the distribution of amino acids

1099

00:40:21,190 --> 00:40:18,160

in the surface ocean what's the

1100

00:40:23,430 --> 00:40:21,200

distribution of amino acids in

1101
00:40:25,270 --> 00:40:23,440
an autotrophic culture versus a culture

1102
00:40:27,910 --> 00:40:25,280
that's been said

1103
00:40:29,750 --> 00:40:27,920
that's heterotrophic and has been fed

1104
00:40:32,230 --> 00:40:29,760
phytoplankton or something along those

1105
00:40:34,150 --> 00:40:32,240
lines and so there's

1106
00:40:36,069 --> 00:40:34,160
just pure distribution arguments that

1107
00:40:37,430 --> 00:40:36,079
you can make to try and address some of

1108
00:40:38,950 --> 00:40:37,440
these questions

1109
00:40:41,349 --> 00:40:38,960
and from that

1110
00:40:43,910 --> 00:40:41,359
we have indications that amino acids for

1111
00:40:44,950 --> 00:40:43,920
example are biologically produced

1112
00:40:47,190 --> 00:40:44,960
and

1113
00:40:48,309 --> 00:40:47,200

things like acetate

1114

00:40:50,230 --> 00:40:48,319

is also

1115

00:40:53,750 --> 00:40:50,240

most likely biologically produced and

1116

00:40:57,030 --> 00:40:53,760

that's coming mainly from the um the

1117

00:40:59,510 --> 00:40:57,040

signatures of where acetate is highest

1118

00:41:00,950 --> 00:40:59,520

and we see the most acetate where we see

1119

00:41:03,190 --> 00:41:00,960

evidence of the most

1120

00:41:04,790 --> 00:41:03,200

uh microbial activity so it's most

1121

00:41:06,550 --> 00:41:04,800

likely something like a microbial

1122

00:41:08,069 --> 00:41:06,560

byproduct

1123

00:41:11,510 --> 00:41:08,079

another way we try and address these

1124

00:41:13,510 --> 00:41:11,520

questions is using c13 data and trying

1125

00:41:15,670 --> 00:41:13,520

and since people have done some very

1126

00:41:17,750 --> 00:41:15,680

extensive testing in

1127

00:41:19,829 --> 00:41:17,760

bench top experiments to try and look at

1128

00:41:23,109 --> 00:41:19,839

fractionation factors we can start

1129

00:41:26,870 --> 00:41:23,119

trying to use c13 to create an isotope

1130

00:41:29,270 --> 00:41:26,880

budget and look at sources of carbon and

1131

00:41:31,510 --> 00:41:29,280

and synthesis pathways and so that's

1132

00:41:34,550 --> 00:41:31,520

also been a very valuable tool

1133

00:41:36,790 --> 00:41:34,560

and then the final um

1134

00:41:39,109 --> 00:41:36,800

and then the final wave or one of the

1135

00:41:41,030 --> 00:41:39,119

other ways that we are trying to

1136

00:41:43,750 --> 00:41:41,040

approach these questions is by looking

1137

00:41:46,069 --> 00:41:43,760

at c14 signatures and so that's what i

1138

00:41:51,910 --> 00:41:46,079

wanted to talk a little bit more about

1139

00:41:54,790 --> 00:41:51,920

um and so this is a graph of uh c14

1140

00:41:55,670 --> 00:41:54,800

signatures is goes from about zero and

1141

00:41:58,390 --> 00:41:55,680

that's

1142

00:42:02,390 --> 00:41:58,400

um where mantle input comes from so

1143

00:42:04,069 --> 00:42:02,400

mantle in mantle carbon is c14 free and

1144

00:42:06,630 --> 00:42:04,079

on the other end of the spectrum you

1145

00:42:09,430 --> 00:42:06,640

have modern seawater which has a c14

1146

00:42:12,950 --> 00:42:09,440

signature of approximately one

1147

00:42:14,790 --> 00:42:12,960

and so from some c14 work is

1148

00:42:16,630 --> 00:42:14,800

is very useful in this type of

1149

00:42:18,630 --> 00:42:16,640

environment where you have these

1150

00:42:21,190 --> 00:42:18,640

very large n members very large

1151

00:42:23,030 --> 00:42:21,200

differences between the n members and so

1152

00:42:25,829 --> 00:42:23,040

you can start to distinguish at least

1153

00:42:26,790 --> 00:42:25,839

where the carbon sources are coming from

1154

00:42:31,190 --> 00:42:26,800

and

1155

00:42:33,589 --> 00:42:31,200

is

1156

00:42:35,430 --> 00:42:33,599

and so based on some previous work that

1157

00:42:38,069 --> 00:42:35,440

local seawater dissolved in organic

1158

00:42:40,870 --> 00:42:38,079

carbon not surprisingly is modern

1159

00:42:43,270 --> 00:42:40,880

um the chimneys as billy mentioned come

1160

00:42:46,390 --> 00:42:43,280

from this mixing zone this mixing of

1161

00:42:49,670 --> 00:42:46,400

this high ph fluid with local

1162

00:42:52,069 --> 00:42:49,680

bicarbonate and so those those carbonate

1163

00:42:53,510 --> 00:42:52,079

chimneys are also modern

1164

00:42:56,950 --> 00:42:53,520

and then

1165

00:42:59,510 --> 00:42:56,960

the methane in the system is c14 free

1166

00:43:01,109 --> 00:42:59,520

and has a c13 signature these numbers on

1167

00:43:03,990 --> 00:43:01,119

the bottom

1168

00:43:06,069 --> 00:43:04,000

of these is the c13 signature and so

1169

00:43:10,790 --> 00:43:06,079

that methane has a c13 signature of

1170

00:43:13,990 --> 00:43:10,800

about minus 12 per ml and is c14 free

1171

00:43:16,550 --> 00:43:14,000

and i thought i would mention that um

1172

00:43:18,710 --> 00:43:16,560

and so let me first say that so in law

1173

00:43:19,829 --> 00:43:18,720

city it's thought that the methane is

1174

00:43:22,470 --> 00:43:19,839

largely

1175

00:43:24,630 --> 00:43:22,480

um abiotically produced although there's

1176

00:43:27,670 --> 00:43:24,640

methanogens present who are probably

1177

00:43:28,630 --> 00:43:27,680

making methane and so there is probably

1178

00:43:32,630 --> 00:43:28,640

a

1179

00:43:33,510 --> 00:43:32,640

well

1180

00:43:35,829 --> 00:43:33,520

and

1181

00:43:38,069 --> 00:43:35,839

there's still questions of whether that

1182

00:43:40,150 --> 00:43:38,079

methane is

1183

00:43:42,790 --> 00:43:40,160

is created kind of on the fly as the

1184

00:43:44,710 --> 00:43:42,800

fluids pass through or if it's being

1185

00:43:46,550 --> 00:43:44,720

harvested from

1186

00:43:48,390 --> 00:43:46,560

fluid inclusions

1187

00:43:50,630 --> 00:43:48,400

and i did want to mention just going

1188

00:43:53,589 --> 00:43:50,640

back to continental systems that there's

1189

00:43:55,910 --> 00:43:53,599

methane present in those fluids as well

1190

00:43:58,150 --> 00:43:55,920

i've seen a couple of numbers of c14

1191

00:43:58,950 --> 00:43:58,160

from methane both in the literature and

1192

00:44:01,190 --> 00:43:58,960

from

1193

00:44:04,630 --> 00:44:01,200

work that we've done in the lab that

1194

00:44:07,270 --> 00:44:04,640

that methane is c14 free and so again

1195

00:44:09,589 --> 00:44:07,280

you need to have a source

1196

00:44:13,109 --> 00:44:09,599

initial carbon source from that

1197

00:44:15,510 --> 00:44:13,119

from that methane of um

1198

00:44:17,750 --> 00:44:15,520

of either coming from some c14 free

1199

00:44:19,270 --> 00:44:17,760

material like bicarb like calcium

1200

00:44:21,750 --> 00:44:19,280

carbonate that's been

1201

00:44:24,630 --> 00:44:21,760

um down there for a very long time or

1202

00:44:27,030 --> 00:44:24,640

from fluid inclusions

1203

00:44:28,870 --> 00:44:27,040

and so i've also plotted on here the

1204

00:44:31,430 --> 00:44:28,880

formate which is

1205

00:44:33,670 --> 00:44:31,440

data that we generated recently and so

1206

00:44:34,790 --> 00:44:33,680

depending on what location you are in in

1207

00:44:37,510 --> 00:44:34,800

the field

1208

00:44:39,349 --> 00:44:37,520

we have these different chimneys and you

1209

00:44:41,910 --> 00:44:39,359

have different concentrations of formate

1210

00:44:43,030 --> 00:44:41,920

across the field and so depending on

1211

00:44:47,430 --> 00:44:43,040

where you are

1212

00:44:48,470 --> 00:44:47,440

this formate is largely c14 free

1213

00:44:51,430 --> 00:44:48,480

and

1214

00:44:52,550 --> 00:44:51,440

in other places where we have other kind

1215

00:44:54,470 --> 00:44:52,560

of

1216

00:44:57,030 --> 00:44:54,480

indications that there's some local

1217

00:45:00,470 --> 00:44:57,040

mixing with local seawater some of that

1218

00:45:03,670 --> 00:45:00,480

format is starting to include a

1219

00:45:04,710 --> 00:45:03,680

relatively modern seawater signature and

1220

00:45:06,550 --> 00:45:04,720

so

1221

00:45:09,030 --> 00:45:06,560

um we've

1222

00:45:11,829 --> 00:45:09,040

while we were interpreting this um the

1223

00:45:14,630 --> 00:45:11,839

interpretation that we've um

1224

00:45:17,270 --> 00:45:14,640

settled on is that the c14 free format

1225

00:45:19,829 --> 00:45:17,280

has to be coming from the subsurface

1226

00:45:22,790 --> 00:45:19,839

where you still have a mantle

1227

00:45:26,230 --> 00:45:22,800

co2 signature that's available whereas

1228

00:45:28,550 --> 00:45:26,240

these this additional input of more

1229

00:45:31,030 --> 00:45:28,560

modern formate is most likely

1230

00:45:33,030 --> 00:45:31,040

biologically derived

1231

00:45:35,430 --> 00:45:33,040

because this is happening in temperature

1232

00:45:36,710 --> 00:45:35,440

regimes um where

1233

00:45:38,870 --> 00:45:36,720

where would

1234

00:45:40,390 --> 00:45:38,880

where microbial activity is a lot more

1235

00:45:41,750 --> 00:45:40,400

favorable

1236

00:45:43,750 --> 00:45:41,760

um

1237

00:45:46,069 --> 00:45:43,760

and so if i was just going to be

1238

00:45:47,430 --> 00:45:46,079

extraordinarily simplistic and just put

1239

00:45:48,870 --> 00:45:47,440

some check marks

1240

00:45:51,190 --> 00:45:48,880

on things

1241

00:45:54,550 --> 00:45:51,200

i would say that something like methane

1242

00:45:55,990 --> 00:45:54,560

is predominantly abiotic and i haven't

1243

00:45:57,670 --> 00:45:56,000

talked at all about the short chain

1244

00:46:00,470 --> 00:45:57,680

hydrocarbons but based on some

1245

00:46:02,470 --> 00:46:00,480

geochemical and some c13 signatures

1246

00:46:05,349 --> 00:46:02,480

there's also indication that that's a

1247

00:46:08,550 --> 00:46:05,359

biological whereas amino acids and

1248

00:46:10,470 --> 00:46:08,560

acetate are most likely biological and

1249

00:46:12,550 --> 00:46:10,480

formate probably has this mixed

1250

00:46:14,470 --> 00:46:12,560

signature

1251

00:46:17,030 --> 00:46:14,480

and so now as we're moving up and

1252

00:46:18,950 --> 00:46:17,040

definitively in the chimneys there's

1253

00:46:20,309 --> 00:46:18,960

been quite some work in those

1254

00:46:21,670 --> 00:46:20,319

environments

1255

00:46:23,430 --> 00:46:21,680

to

1256

00:46:25,510 --> 00:46:23,440

first of all we know there's a lot more

1257

00:46:27,589 --> 00:46:25,520

carbonate precipitation because there's

1258

00:46:29,270 --> 00:46:27,599

large carbonate chimneys

1259

00:46:30,710 --> 00:46:29,280

but there's been quite some work by

1260

00:46:32,710 --> 00:46:30,720

people like matt shrank and billy

1261

00:46:34,150 --> 00:46:32,720

brazelton to characterize the

1262

00:46:36,470 --> 00:46:34,160

communities that are in those

1263

00:46:37,990 --> 00:46:36,480

environments and there's a fairly

1264

00:46:39,670 --> 00:46:38,000

significant difference between the

1265

00:46:42,309 --> 00:46:39,680

communities that are inhabiting the

1266

00:46:45,349 --> 00:46:42,319

interior of these chimneys where it's

1267

00:46:48,710 --> 00:46:45,359

dominated by anaerobic

1268

00:46:50,870 --> 00:46:48,720

anaerobic processes and the exterior of

1269

00:46:52,150 --> 00:46:50,880

these chimneys where you see

1270

00:46:55,670 --> 00:46:52,160

more

1271

00:46:57,670 --> 00:46:55,680

exposure to local oxidized seawater

1272

00:46:59,750 --> 00:46:57,680

and so

1273

00:47:01,510 --> 00:46:59,760

um and this is just a picture of an

1274

00:47:03,349 --> 00:47:01,520

up-close picture of some of the dense

1275

00:47:04,470 --> 00:47:03,359

biofilms that you can see in some of

1276
00:47:08,550 --> 00:47:04,480
these

1277
00:47:11,349 --> 00:47:08,560
and they're very close association with

1278
00:47:12,390 --> 00:47:11,359
things like bruce sites

1279
00:47:13,589 --> 00:47:12,400
um

1280
00:47:14,790 --> 00:47:13,599
and so

1281
00:47:18,069 --> 00:47:14,800
one

1282
00:47:19,670 --> 00:47:18,079
approach to try and get a better idea of

1283
00:47:21,270 --> 00:47:19,680
what's happening

1284
00:47:23,430 --> 00:47:21,280
with these microbial communities in

1285
00:47:25,750 --> 00:47:23,440
these chimneys is to look at things like

1286
00:47:28,309 --> 00:47:25,760
specific biomarkers that these

1287
00:47:31,829 --> 00:47:28,319
communities can form

1288
00:47:35,030 --> 00:47:31,839

and this and so if you are talking about

1289

00:47:36,950 --> 00:47:35,040

bacterial communities a lot of

1290

00:47:40,390 --> 00:47:36,960

these bacterial communities produce

1291

00:47:43,510 --> 00:47:40,400

fatty acids in particular and from some

1292

00:47:46,150 --> 00:47:43,520

c13 work of alex bradley

1293

00:47:46,950 --> 00:47:46,160

um and co-workers they've already shown

1294

00:47:49,990 --> 00:47:46,960

that

1295

00:47:53,190 --> 00:47:50,000

in the exterior chimney or they've

1296

00:47:55,589 --> 00:47:53,200

interpreted that the c16 fatty acids

1297

00:47:59,270 --> 00:47:55,599

with a single double bond in them

1298

00:48:02,309 --> 00:47:59,280

have a c13 signature of about -20 and

1299

00:48:04,790 --> 00:48:02,319

they've interpreted that as indicating

1300

00:48:06,230 --> 00:48:04,800

that there's an exterior

1301
00:48:09,349 --> 00:48:06,240
that it's coming from one of these

1302
00:48:11,030 --> 00:48:09,359
exterior exterior biolog

1303
00:48:13,510 --> 00:48:11,040
sorry

1304
00:48:17,349 --> 00:48:13,520
microbial communities that has a little

1305
00:48:19,430 --> 00:48:17,359
bit easier access to local dic

1306
00:48:22,150 --> 00:48:19,440
whereas in contrast as you get into the

1307
00:48:24,309 --> 00:48:22,160
interior of the chimney

1308
00:48:27,910 --> 00:48:24,319
the bacteria don't have as easy of an

1309
00:48:30,870 --> 00:48:27,920
access to inorganic carbon and the c13

1310
00:48:33,109 --> 00:48:30,880
signatures turn to be more

1311
00:48:35,910 --> 00:48:33,119
around minus nine

1312
00:48:37,670 --> 00:48:35,920
and so and then the other community

1313
00:48:39,829 --> 00:48:37,680

that's present in the interior of the

1314

00:48:42,870 --> 00:48:39,839

chimneys is the methanosarcinalis

1315

00:48:45,670 --> 00:48:42,880

velocity methanococci in particular tends

1316

00:48:47,750 --> 00:48:45,680

to dominate the anoxic interior of a lot

1317

00:48:52,309 --> 00:48:47,760

of these chimneys and they produce a

1318

00:48:54,390 --> 00:48:52,319

very diagnostic biomarker called pmis

1319

00:48:56,710 --> 00:48:54,400

and so these numbers that are up here

1320

00:48:59,589 --> 00:48:56,720

right now are actually the c13

1321

00:49:02,069 --> 00:48:59,599

signatures of one particular chimney in

1322

00:49:03,190 --> 00:49:02,079

the lost city field

1323

00:49:05,910 --> 00:49:03,200

that we

1324

00:49:07,990 --> 00:49:05,920

took and we analyzed the c13 signatures

1325

00:49:10,230 --> 00:49:08,000

of them and the numbers are consistent

1326
00:49:11,670 --> 00:49:10,240
with what other people have seen in the

1327
00:49:13,430 --> 00:49:11,680
past

1328
00:49:15,990 --> 00:49:13,440
and then we went on to also look at

1329
00:49:18,470 --> 00:49:16,000
their c14 signatures to try and get a

1330
00:49:21,510 --> 00:49:18,480
little bit more insight into what their

1331
00:49:24,069 --> 00:49:21,520
metabolisms were and so consistent with

1332
00:49:25,510 --> 00:49:24,079
what was suggested just based on the c13

1333
00:49:28,309 --> 00:49:25,520
data

1334
00:49:29,430 --> 00:49:28,319
the bacterial community is kind of split

1335
00:49:30,390 --> 00:49:29,440
and so

1336
00:49:34,150 --> 00:49:30,400
the

1337
00:49:36,710 --> 00:49:34,160
biomarkers that have a more negative c13

1338
00:49:39,349 --> 00:49:36,720

signature have a more modern signature

1339

00:49:40,790 --> 00:49:39,359

and whereas those that seem to be

1340

00:49:44,150 --> 00:49:40,800

undergoing some sort of carbon

1341

00:49:45,430 --> 00:49:44,160

limitation have a more c14 free

1342

00:49:47,190 --> 00:49:45,440

signature

1343

00:49:48,230 --> 00:49:47,200

and whereas the

1344

00:49:53,430 --> 00:49:48,240

the

1345

00:49:54,230 --> 00:49:53,440

this more mixed signature

1346

00:49:55,990 --> 00:49:54,240

and

1347

00:49:58,790 --> 00:49:56,000

some work that billy brazelton has done

1348

00:50:00,710 --> 00:49:58,800

has demonstrated that it's very likely

1349

00:50:02,309 --> 00:50:00,720

that these um

1350

00:50:04,710 --> 00:50:02,319

archaea may not be able to take up

1351
00:50:06,630 --> 00:50:04,720
formate directly and so it may be that

1352
00:50:08,790 --> 00:50:06,640
they're relying on some sort of

1353
00:50:10,309 --> 00:50:08,800
inorganic carbon source so the way we've

1354
00:50:12,390 --> 00:50:10,319
interpreted all this

1355
00:50:14,230 --> 00:50:12,400
is that you have some sort of formate

1356
00:50:16,069 --> 00:50:14,240
source that's coming from the subsurface

1357
00:50:19,430 --> 00:50:16,079
and abiotically produced

1358
00:50:20,710 --> 00:50:19,440
it's um it's utilized by sulfate

1359
00:50:23,109 --> 00:50:20,720
reducers and in the formate

1360
00:50:25,510 --> 00:50:23,119
dehydrogenase gene you have rapid

1361
00:50:26,470 --> 00:50:25,520
conversion between formate and inorganic

1362
00:50:33,990 --> 00:50:26,480
carbon

1363
00:50:37,030 --> 00:50:34,000

this new mixed

1364

00:50:39,030 --> 00:50:37,040

inorganic carbon pool can be used by

1365

00:50:40,790 --> 00:50:39,040

autotrophs or

1366

00:50:42,630 --> 00:50:40,800

uh the sulfate reducers could also

1367

00:50:44,710 --> 00:50:42,640

potentially produce organics that are

1368

00:50:47,510 --> 00:50:44,720

used by heterotrophs

1369

00:50:50,230 --> 00:50:47,520

and so just to wrap up some of the major

1370

00:50:51,589 --> 00:50:50,240

things that uh that we're thinking about

1371

00:50:54,309 --> 00:50:51,599

so during downwelling you have the

1372

00:50:57,030 --> 00:50:54,319

removal of inorganic carbon the question

1373

00:50:59,510 --> 00:50:57,040

as to the fate of organic carbon that's

1374

00:51:01,430 --> 00:50:59,520

present in deep sea water and hopefully

1375

00:51:04,630 --> 00:51:01,440

beth and matt will talk a little bit

1376

00:51:06,870 --> 00:51:04,640

about the biosphere in kind of these

1377

00:51:09,190 --> 00:51:06,880

really rocky locations

1378

00:51:11,910 --> 00:51:09,200

in the subsurface you have this mantle

1379

00:51:14,230 --> 00:51:11,920

input of inorganic carbon

1380

00:51:16,150 --> 00:51:14,240

probably conversion to formate there is

1381

00:51:18,470 --> 00:51:16,160

also evidence that there's precipitation

1382

00:51:20,710 --> 00:51:18,480

of this mantle CO_2 as bicarbonate you

1383

00:51:22,470 --> 00:51:20,720

can see that in some of the 180 data

1384

00:51:25,990 --> 00:51:22,480

from

1385

00:51:29,030 --> 00:51:26,000

and there's conversion or there's

1386

00:51:30,950 --> 00:51:29,040

addition of methane and alkanes

1387

00:51:34,150 --> 00:51:30,960

and then there's the C_4 expression for

1388

00:51:36,630 --> 00:51:34,160

their precipitation and microbial

1389

00:51:40,549 --> 00:51:36,640

uptake and so i will leave it there and

1390

00:51:43,910 --> 00:51:41,990

i can see there's

1391

00:51:46,309 --> 00:51:43,920

questions over here

1392

00:51:47,190 --> 00:51:46,319

yeah thanks dude

1393

00:51:48,309 --> 00:51:47,200

um

1394

00:51:53,109 --> 00:51:48,319

i

1395

00:51:54,950 --> 00:51:53,119

um

1396

00:51:57,670 --> 00:51:54,960

i don't know

1397

00:51:59,430 --> 00:51:57,680

that we've i think it would show up in

1398

00:52:02,390 --> 00:51:59,440

some of the analyses that we've done

1399

00:52:04,390 --> 00:52:02,400

particularly the short chain and alkane

1400

00:52:06,549 --> 00:52:04,400

analyses we should see acetylene

1401
00:52:08,309 --> 00:52:06,559
and so i don't think that anyone's seen

1402
00:52:11,190 --> 00:52:08,319
it or at least i've not seen any reports

1403
00:52:15,030 --> 00:52:13,030
and the c13 might be misleading if

1404
00:52:16,470 --> 00:52:15,040
examined in other settings

1405
00:52:20,150 --> 00:52:16,480
i would say

1406
00:52:22,230 --> 00:52:20,160
examined in this setting

1407
00:52:25,670 --> 00:52:22,240
um and so

1408
00:52:27,589 --> 00:52:25,680
uh yes i think c13 has

1409
00:52:30,870 --> 00:52:27,599
c13 is great

1410
00:52:33,829 --> 00:52:30,880
sorry i will reread the question um

1411
00:52:36,150 --> 00:52:33,839
c13 might be misleading if examined in

1412
00:52:38,390 --> 00:52:36,160
other settings have similar trends been

1413
00:52:40,870 --> 00:52:38,400

observed in other vent systems do fatty

1414

00:52:44,829 --> 00:52:40,880

acids have diagnostic oxygen and

1415

00:52:48,390 --> 00:52:44,839

hydrogen isotopic signatures

1416

00:52:51,430 --> 00:52:48,400

um so again i would say c13 can be

1417

00:52:52,549 --> 00:52:51,440

misleading in this setting

1418

00:52:53,510 --> 00:52:52,559

um

1419

00:52:56,870 --> 00:52:53,520

the

1420

00:52:59,190 --> 00:52:56,880

great thing about c13 is it records in

1421

00:53:01,430 --> 00:52:59,200

addition to recording

1422

00:53:04,309 --> 00:53:01,440

the source of carbon it's recording a

1423

00:53:05,829 --> 00:53:04,319

process that's happened to that carbon

1424

00:53:09,030 --> 00:53:05,839

but you

1425

00:53:11,349 --> 00:53:09,040

have to consider that the signature of

1426

00:53:12,950 --> 00:53:11,359

the source can always change based on

1427

00:53:15,670 --> 00:53:12,960

other processes that's happened with

1428

00:53:18,470 --> 00:53:15,680

that source and that the

1429

00:53:22,230 --> 00:53:18,480

signature of the process can change

1430

00:53:26,150 --> 00:53:24,150

surprisingly things like how much energy

1431

00:53:27,990 --> 00:53:26,160

is available so how much hydrogen is

1432

00:53:30,069 --> 00:53:28,000

present can change the isotope

1433

00:53:31,270 --> 00:53:30,079

signatures of

1434

00:53:34,790 --> 00:53:31,280

of the

1435

00:53:37,910 --> 00:53:34,800

newly created material and so c13 has to

1436

00:53:41,510 --> 00:53:37,920

be thought about very very carefully

1437

00:53:43,270 --> 00:53:41,520

the fatty acids look pretty the delta d

1438

00:53:45,190 --> 00:53:43,280

signatures of the fatty acids look

1439

00:53:46,150 --> 00:53:45,200

pretty similar to what you would expect

1440

00:53:51,030 --> 00:53:46,160

for

1441

00:53:52,470 --> 00:53:51,040

activity

1442

00:53:54,230 --> 00:53:52,480

and so

1443

00:53:55,829 --> 00:53:54,240

if the question is is whether or not you

1444

00:53:59,510 --> 00:53:55,839

can use that to distinguish between

1445

00:54:03,510 --> 00:54:01,190

synthesis reactions i'd have to think

1446

00:54:06,150 --> 00:54:03,520

about it a little bit more

1447

00:54:07,910 --> 00:54:06,160

the fatty acids look biological but i

1448

00:54:11,109 --> 00:54:07,920

can't think off the top of my head of

1449

00:54:12,790 --> 00:54:11,119

what the dh signature is of

1450

00:54:14,870 --> 00:54:12,800

alkanes that have been produced

1451
00:54:16,549 --> 00:54:14,880
abiotically so i don't know that off the

1452
00:54:19,190 --> 00:54:16,559
top of my head

1453
00:54:20,870 --> 00:54:19,200
susan this is susan this is alexis i

1454
00:54:23,190 --> 00:54:20,880
just want to stop you for a sec because

1455
00:54:26,150 --> 00:54:23,200
we're getting so much information

1456
00:54:27,829 --> 00:54:26,160
gonna um let oh no it's fantastic and

1457
00:54:29,589 --> 00:54:27,839
i'm just sort of trying to absorb it and

1458
00:54:30,950 --> 00:54:29,599
and i think billy has a bunch of

1459
00:54:32,549 --> 00:54:30,960
questions coming in from the audience

1460
00:54:34,230 --> 00:54:32,559
that um he can

1461
00:54:36,069 --> 00:54:34,240
walk through with you just so we all

1462
00:54:36,950 --> 00:54:36,079
have time to see them separated out a

1463
00:54:38,230 --> 00:54:36,960

little bit

1464

00:54:40,549 --> 00:54:38,240

it'd be great with the other speakers

1465

00:54:41,990 --> 00:54:40,559

too if we can have a look like take that

1466

00:54:44,150 --> 00:54:42,000

down so we have just a little time to

1467

00:54:47,750 --> 00:54:44,160

know what the the questions are too

1468

00:54:47,760 --> 00:54:52,630

thanks for addressing my question

1469

00:54:55,270 --> 00:54:53,990

um

1470

00:54:59,829 --> 00:54:55,280

so how do you

1471

00:55:03,190 --> 00:55:01,750

how would you like to proceed bill i

1472

00:55:05,270 --> 00:55:03,200

think you're muted i think you're trying

1473

00:55:07,109 --> 00:55:05,280

to just yeah sorry

1474

00:55:09,030 --> 00:55:07,119

uh

1475

00:55:11,109 --> 00:55:09,040

i'm not sure either let's i guess we can

1476

00:55:13,349 --> 00:55:11,119

move on to amy's question and the first

1477

00:55:15,270 --> 00:55:13,359

half of it i can answer for you which is

1478

00:55:18,549 --> 00:55:15,280

that we don't find any obvious acetogens

1479

00:55:22,150 --> 00:55:18,559

but acidogens are not always obviously

1480

00:55:24,150 --> 00:55:22,160

easy to detect um and then i'll

1481

00:55:25,589 --> 00:55:24,160

let you answer her second question which

1482

00:55:28,710 --> 00:55:25,599

is do you think this is being formed in

1483

00:55:33,270 --> 00:55:31,030

um i think that the

1484

00:55:35,510 --> 00:55:33,280

acetate is being i assume you're asking

1485

00:55:37,589 --> 00:55:35,520

if the acetate is being formed in the

1486

00:55:40,069 --> 00:55:37,599

downwelling location i think it's being

1487

00:55:43,589 --> 00:55:40,079

formed in the chimneys based on the c13

1488

00:55:47,589 --> 00:55:43,599

signatures that we have of the acetate

1489

00:55:49,910 --> 00:55:47,599

and so they're a little unusual given

1490

00:55:52,870 --> 00:55:49,920

what you normally see with acetate

1491

00:55:55,030 --> 00:55:52,880

and the easiest way to explain them is

1492

00:55:56,789 --> 00:55:55,040

that the biomass

1493

00:55:57,750 --> 00:55:56,799

if you just take bulk biomass in the

1494

00:55:58,870 --> 00:55:57,760

chimney

1495

00:56:00,789 --> 00:55:58,880

it's

1496

00:56:03,109 --> 00:56:00,799

more enriched in c13 than what you

1497

00:56:04,789 --> 00:56:03,119

normally expect with bulk biomass again

1498

00:56:06,309 --> 00:56:04,799

because you have such a carbon limited

1499

00:56:09,190 --> 00:56:06,319

system

1500

00:56:12,470 --> 00:56:09,200

but if you take kind of very traditional

1501
00:56:14,950 --> 00:56:12,480
values of the fractionation between bulk

1502
00:56:17,990 --> 00:56:14,960
biomass and the breakdown of that bulk

1503
00:56:19,750 --> 00:56:18,000
biomass under anaerobic conditions

1504
00:56:21,430 --> 00:56:19,760
you would produce acetate that'd be one

1505
00:56:24,870 --> 00:56:21,440
of the expected outcomes and that

1506
00:56:27,109 --> 00:56:24,880
acetate has a c13 signature that's

1507
00:56:29,190 --> 00:56:27,119
consistent with that being the process

1508
00:56:30,630 --> 00:56:29,200
that you basically have some heterotroph

1509
00:56:33,750 --> 00:56:30,640
eating out the bulk biomass and

1510
00:56:35,589 --> 00:56:33,760
producing acetate

1511
00:56:38,069 --> 00:56:35,599
then one more question from jen and then

1512
00:56:40,549 --> 00:56:38,079
we'll move on to the next talk perhaps

1513
00:56:42,309 --> 00:56:40,559

about whether dc the

1514

00:56:44,950 --> 00:56:42,319

c13 changes with the age of the

1515

00:56:47,670 --> 00:56:44,960

carbonate

1516

00:56:50,789 --> 00:56:47,680

um that's a great question i'd let me

1517

00:56:52,789 --> 00:56:50,799

think about that for a second i don't

1518

00:56:56,829 --> 00:56:52,799

think so

1519

00:57:00,069 --> 00:56:56,839

but i could be wrong i think that there

1520

00:57:03,030 --> 00:57:00,079

is um i don't remember that i don't

1521

00:57:06,549 --> 00:57:03,040

remember the c13 signatures

1522

00:57:08,870 --> 00:57:06,559

versus c14 signatures off the top of my

1523

00:57:12,069 --> 00:57:08,880

head there is a relationship

1524

00:57:15,750 --> 00:57:12,079

now that i'm thinking about it um

1525

00:57:18,710 --> 00:57:15,760

and you end up getting more negative

1526
00:57:19,750 --> 00:57:18,720
c13 signatures where the carbonate is a

1527
00:57:21,109 --> 00:57:19,760
little bit

1528
00:57:22,390 --> 00:57:21,119
older

1529
00:57:24,870 --> 00:57:22,400
um

1530
00:57:27,829 --> 00:57:24,880
and so

1531
00:57:30,309 --> 00:57:27,839
yes

1532
00:57:33,349 --> 00:57:30,319
assuming that c148 is purely reflecting

1533
00:57:37,430 --> 00:57:35,030
yes no answer awesome

1534
00:57:40,150 --> 00:57:39,030
there's some more questions probably

1535
00:57:42,470 --> 00:57:40,160
going to be some more questions for

1536
00:57:45,030 --> 00:57:42,480
susan and i'll let her and the rest of

1537
00:57:46,870 --> 00:57:45,040
us answer them in the chat window and

1538
00:57:48,470 --> 00:57:46,880

we'll move on to the next talk thank you

1539

00:58:03,109 --> 00:57:48,480

very much susan

1540

00:58:05,589 --> 00:58:04,470

okay everett i promote you to a

1541

00:58:08,390 --> 00:58:05,599

presenter if you want to start your

1542

00:58:10,710 --> 00:58:08,400

webcam and then uh mute your phone

1543

00:58:12,470 --> 00:58:10,720

well we're ready for you

1544

00:58:14,470 --> 00:58:12,480

okay i think i've done those things can

1545

00:58:16,230 --> 00:58:14,480

you hear me

1546

00:58:17,829 --> 00:58:16,240

uh yes we can hear you we can't see you

1547

00:58:19,430 --> 00:58:17,839

yet though if you want to start that uh

1548

00:58:21,589 --> 00:58:19,440

you might not have clicked start sharing

1549

00:58:23,910 --> 00:58:21,599

on your webcam

1550

00:58:28,390 --> 00:58:26,150

i can see me which is kind of disturbing

1551
00:58:32,230 --> 00:58:30,390
so in the middle of your webcam preview

1552
00:58:34,829 --> 00:58:32,240
there's a button that says start sharing

1553
00:58:39,349 --> 00:58:37,910
that tell me again where it is

1554
00:58:41,270 --> 00:58:39,359
it should be right in the middle of your

1555
00:58:44,230 --> 00:58:41,280
webcam view

1556
00:58:44,240 --> 00:58:48,309
oh sure enough start sharing

1557
00:58:51,349 --> 00:58:49,190
all right

1558
00:58:53,030 --> 00:58:51,359
take it away

1559
00:58:56,630 --> 00:58:53,040
all right well we're going to crawl uh

1560
00:58:59,670 --> 00:58:56,640
out of the ocean and on to the land uh

1561
00:59:03,030 --> 00:58:59,680
and so this image we're starting with is

1562
00:59:06,390 --> 00:59:03,040
uh from oman where the mountain range

1563
00:59:07,910 --> 00:59:06,400

back behind me there is um

1564

00:59:09,990 --> 00:59:07,920

you know a big hunk of the mantle and

1565

00:59:11,510 --> 00:59:10,000

it's an exciting place to visit because

1566

00:59:14,230 --> 00:59:11,520

you can walk around on the mantel it's

1567

00:59:17,829 --> 00:59:14,240

been studied for decades by

1568

00:59:19,510 --> 00:59:17,839

geologists and petrologists and

1569

00:59:23,109 --> 00:59:19,520

dynamics people

1570

00:59:24,230 --> 00:59:23,119

and really probably the same ophilite in

1571

00:59:28,390 --> 00:59:24,240

oman

1572

00:59:31,910 --> 00:59:28,400

is largely what we see in

1573

00:59:33,589 --> 00:59:31,920

the sort of textbook images of what the

1574

00:59:35,109 --> 00:59:33,599

earth's lithosphere is like the

1575

00:59:36,630 --> 00:59:35,119

lithosphere being

1576

00:59:39,510 --> 00:59:36,640

the um

1577

00:59:41,589 --> 00:59:39,520

rigid part of the crust and upper mantle

1578

00:59:43,829 --> 00:59:41,599

of the earth that is the parts that

1579

00:59:46,150 --> 00:59:43,839

actually getting pushed around and

1580

00:59:48,549 --> 00:59:46,160

as plates on the surface of the earth

1581

00:59:51,270 --> 00:59:48,559

now let's see somewhere here i'm sure

1582

00:59:53,109 --> 00:59:51,280

i'm supposed to see an arrow there it is

1583

00:59:56,309 --> 00:59:53,119

fantastic all right

1584

00:59:58,470 --> 00:59:56,319

so just quickly to orient ourselves oman

1585

00:59:59,750 --> 00:59:58,480

and southeastern corner of the arabian

1586

01:00:01,430 --> 00:59:59,760

peninsula

1587

01:00:03,670 --> 01:00:01,440

you can see let's see where is that

1588

01:00:05,430 --> 01:00:03,680

arrow thing

1589

01:00:07,030 --> 01:00:05,440

ah there it is

1590

01:00:11,510 --> 01:00:07,040

you can

1591

01:00:12,390 --> 01:00:11,520

mountains on even this map

1592

01:00:15,750 --> 01:00:12,400

and

1593

01:00:19,030 --> 01:00:15,760

if we look at a satellite image then

1594

01:00:20,470 --> 01:00:19,040

this mountain range here uh is

1595

01:00:23,670 --> 01:00:20,480

the um

1596

01:00:25,990 --> 01:00:23,680

these are the uh ultramafic rocks

1597

01:00:27,670 --> 01:00:26,000

uh that are the dark rocks here

1598

01:00:30,470 --> 01:00:27,680

that come from the

1599

01:00:31,990 --> 01:00:30,480

earth's upper mantle

1600

01:00:34,309 --> 01:00:32,000

as i said this has been studied for

1601
01:00:35,750 --> 01:00:34,319
decades by geologists and the general

1602
01:00:37,510 --> 01:00:35,760
story

1603
01:00:38,870 --> 01:00:37,520
is summarized here

1604
01:00:40,630 --> 01:00:38,880
and let me move that arrow out of the

1605
01:00:42,390 --> 01:00:40,640
way in a

1606
01:00:45,190 --> 01:00:42,400
nice cartoon view you have mantle

1607
01:00:46,950 --> 01:00:45,200
peridotite ocean crust

1608
01:00:50,309 --> 01:00:46,960
and then thrust faulting

1609
01:00:53,190 --> 01:00:50,319
that managed to slice down into the

1610
01:00:56,390 --> 01:00:53,200
mantle peridotite and send that

1611
01:00:59,190 --> 01:00:56,400
material up onto the continent which is

1612
01:01:01,589 --> 01:00:59,200
you know rather unusual it misbehaved

1613
01:01:03,589 --> 01:01:01,599

and didn't go down the subduction

1614

01:01:05,349 --> 01:01:03,599

uh zone like

1615

01:01:07,190 --> 01:01:05,359

would be expected so

1616

01:01:09,190 --> 01:01:07,200

the the fabulous thing is that it's

1617

01:01:10,870 --> 01:01:09,200

exposed to the surface you can walk

1618

01:01:12,710 --> 01:01:10,880

around have a view

1619

01:01:16,870 --> 01:01:12,720

eat lunch on the mantel various things

1620

01:01:21,829 --> 01:01:19,510

here's a zooming in on the area the

1621

01:01:25,430 --> 01:01:21,839

point here is not so much the details

1622

01:01:28,309 --> 01:01:25,440

but that these various locations

1623

01:01:30,950 --> 01:01:28,319

are places where

1624

01:01:32,230 --> 01:01:30,960

water appears at the surface as an arid

1625

01:01:33,750 --> 01:01:32,240

climate as you can tell from the

1626
01:01:35,270 --> 01:01:33,760
satellite image

1627
01:01:36,069 --> 01:01:35,280
and the first picture

1628
01:01:38,470 --> 01:01:36,079
but

1629
01:01:40,630 --> 01:01:38,480
there is an active hydrologic system and

1630
01:01:42,789 --> 01:01:40,640
when the water that infiltrates and

1631
01:01:44,950 --> 01:01:42,799
reacts with these ultramafic rocks

1632
01:01:48,789 --> 01:01:44,960
returns to the surface it has this

1633
01:01:51,270 --> 01:01:48,799
fantastic properties of very high ph

1634
01:01:53,670 --> 01:01:51,280
pushing up towards 12 in what we've

1635
01:01:56,870 --> 01:01:53,680
measured and

1636
01:01:59,349 --> 01:01:56,880
very reduced such that it contains

1637
01:02:08,150 --> 01:01:59,359
abundant dissolved methane

1638
01:02:10,309 --> 01:02:09,029

okay

1639

01:02:12,710 --> 01:02:10,319

um

1640

01:02:15,349 --> 01:02:12,720

and the point being that that has been

1641

01:02:17,430 --> 01:02:15,359

made at the beginning of this uh

1642

01:02:20,069 --> 01:02:17,440

meeting that you know we it seems rather

1643

01:02:22,230 --> 01:02:20,079

rare to find serpentine you know split

1644

01:02:24,390 --> 01:02:22,240

in a circinazation seems rare at the

1645

01:02:26,230 --> 01:02:24,400

surface because you have to have these

1646

01:02:27,910 --> 01:02:26,240

ultramafic rocks exposed especially on

1647

01:02:30,069 --> 01:02:27,920

the surface of the continents much more

1648

01:02:32,069 --> 01:02:30,079

common on the seafloor

1649

01:02:34,069 --> 01:02:32,079

but it's probably extraordinarily

1650

01:02:36,069 --> 01:02:34,079

ordinary kind of process in our solar

1651
01:02:37,829 --> 01:02:36,079
system because this sort of rock type

1652
01:02:40,309 --> 01:02:37,839
which after all makes up the majority of

1653
01:02:43,349 --> 01:02:40,319
the earth's upper mantle

1654
01:02:45,750 --> 01:02:43,359
is probably very common in in a you know

1655
01:02:47,750 --> 01:02:45,760
simplistic way it's sort of

1656
01:02:50,390 --> 01:02:47,760
similar to a lot of meteorite

1657
01:02:53,029 --> 01:02:50,400
compositions so the process of water

1658
01:02:55,430 --> 01:02:53,039
reacting with this type of material

1659
01:02:57,349 --> 01:02:55,440
leading to the alteration of culture

1660
01:02:59,190 --> 01:02:57,359
pensionization so so i'll move this

1661
01:03:00,829 --> 01:02:59,200
pointer around a little bit this dark

1662
01:03:02,630 --> 01:03:00,839
stuff is the less

1663
01:03:04,230 --> 01:03:02,640

altered

1664

01:03:07,270 --> 01:03:04,240

peridotite

1665

01:03:09,270 --> 01:03:07,280

ultramafic rock from the mantle and this

1666

01:03:11,349 --> 01:03:09,280

more the stuff in the veins is the

1667

01:03:13,029 --> 01:03:11,359

serpentine and carbonate

1668

01:03:16,710 --> 01:03:13,039

minerals that we've been

1669

01:03:21,109 --> 01:03:18,630

in thin section you see something like

1670

01:03:23,829 --> 01:03:21,119

this this is a transmitted light image

1671

01:03:25,270 --> 01:03:23,839

and i'll click to a polarized light

1672

01:03:27,430 --> 01:03:25,280

image

1673

01:03:28,789 --> 01:03:27,440

well maybe i'll go back there

1674

01:03:31,430 --> 01:03:28,799

so you see these

1675

01:03:33,589 --> 01:03:31,440

large open spaces here and then these

1676

01:03:36,549 --> 01:03:33,599

you know veins cross-cutting in this

1677

01:03:38,549 --> 01:03:36,559

incredibly complicated uh sort of system

1678

01:03:41,029 --> 01:03:38,559

if we go to the polarized light you can

1679

01:03:43,270 --> 01:03:41,039

see that these are large let me move the

1680

01:03:46,309 --> 01:03:43,280

arrow down here this is like a large

1681

01:03:49,109 --> 01:03:46,319

grain of olivine here crisp crossed by

1682

01:03:51,750 --> 01:03:49,119

these um

1683

01:03:54,069 --> 01:03:51,760

veinlets of serpentine

1684

01:03:57,270 --> 01:03:54,079

and then if we zoom in

1685

01:03:59,990 --> 01:03:57,280

um we see here here are these

1686

01:04:01,910 --> 01:04:00,000

veinlets of serpentine here and here and

1687

01:04:03,750 --> 01:04:01,920

so forth and that this stuff in the

1688

01:04:05,990 --> 01:04:03,760

background then being

1689

01:04:08,789 --> 01:04:06,000

the unaltered or certainly a lot less

1690

01:04:11,829 --> 01:04:08,799

altered uh rock from the mantle and then

1691

01:04:14,309 --> 01:04:11,839

then if we look in

1692

01:04:16,630 --> 01:04:14,319

reflected light in that same image you

1693

01:04:19,829 --> 01:04:16,640

can see these little shiny bits here

1694

01:04:21,670 --> 01:04:19,839

these white specks and those are the

1695

01:04:23,190 --> 01:04:21,680

bits in this case of magnetite

1696

01:04:26,470 --> 01:04:23,200

reflecting

1697

01:04:29,750 --> 01:04:26,480

light back to back to the camera so

1698

01:04:31,349 --> 01:04:29,760

you have a sequence of reactions and

1699

01:04:33,109 --> 01:04:31,359

we

1700

01:04:35,029 --> 01:04:33,119

can delve into this and

1701

01:04:38,230 --> 01:04:35,039

whatever detail anyone wants to in terms

1702

01:04:40,390 --> 01:04:38,240

of the overall process you don't always

1703

01:04:42,309 --> 01:04:40,400

have to have magnetite

1704

01:04:44,150 --> 01:04:42,319

you can still have hydrogen production

1705

01:04:47,109 --> 01:04:44,160

the magnet the connection here is that

1706

01:04:49,990 --> 01:04:47,119

the iron is being oxidized water is

1707

01:04:52,470 --> 01:04:50,000

being reduced to hydrogen

1708

01:04:54,710 --> 01:04:52,480

magnetite is just a screaming example of

1709

01:04:56,789 --> 01:04:54,720

that oxidized iron

1710

01:04:58,150 --> 01:04:56,799

going from a mixture of ferrous plus two

1711

01:05:02,630 --> 01:04:58,160

iron

1712

01:05:04,870 --> 01:05:02,640

a mixture of ferrous and ferric plus two

1713

01:05:07,750 --> 01:05:04,880

and plus three in the magnetite but you

1714

01:05:08,950 --> 01:05:07,760

can have ferric iron in the serpentine

1715

01:05:13,829 --> 01:05:08,960

and

1716

01:05:15,670 --> 01:05:13,839

lots of opportunities for hydrogen

1717

01:05:17,190 --> 01:05:15,680

production during the entire

1718

01:05:18,950 --> 01:05:17,200

process

1719

01:05:21,190 --> 01:05:18,960

all right so if we viewed this from

1720

01:05:24,309 --> 01:05:21,200

petrology let me move this arrow again

1721

01:05:26,950 --> 01:05:24,319

we have olivine in pyroxene the the

1722

01:05:29,430 --> 01:05:26,960

rocks are the minerals in the

1723

01:05:31,270 --> 01:05:29,440

unaltered rocks reacting with water and

1724

01:05:32,950 --> 01:05:31,280

carbon dioxide and we get serpentine

1725

01:05:34,630 --> 01:05:32,960

with maybe some brucite magnetic

1726

01:05:36,950 --> 01:05:34,640

carbonate minerals

1727

01:05:39,910 --> 01:05:36,960

when we look at this

1728

01:05:41,670 --> 01:05:39,920

from a geochemical process we still we

1729

01:05:44,789 --> 01:05:41,680

have the olivine and pyroxene reacting

1730

01:05:46,549 --> 01:05:44,799

with surface waters and air um giving us

1731

01:05:49,510 --> 01:05:46,559

serpentine blue site magnified carbonate

1732

01:05:52,150 --> 01:05:49,520

and these hyper alkaline solutions

1733

01:05:53,589 --> 01:05:52,160

that feature reduced gases and of course

1734

01:05:57,190 --> 01:05:53,599

the question that

1735

01:06:00,150 --> 01:05:57,200

we're also asking is how much of this

1736

01:06:01,910 --> 01:06:00,160

whole process is populated where and by

1737

01:06:03,670 --> 01:06:01,920

whom and those kind of questions are

1738

01:06:05,910 --> 01:06:03,680

being addressed by other people today in

1739

01:06:08,470 --> 01:06:05,920

more detail than me

1740

01:06:10,789 --> 01:06:08,480

so i'm going to focus in here on what

1741

01:06:12,710 --> 01:06:10,799

can happen here is a very simplified

1742

01:06:15,270 --> 01:06:12,720

cross-sectional view of again a

1743

01:06:18,549 --> 01:06:15,280

continentally exposed

1744

01:06:21,190 --> 01:06:18,559

ultramafic rocks oh my there we go

1745

01:06:22,630 --> 01:06:21,200

nearly lost my computer all right so you

1746

01:06:25,589 --> 01:06:22,640

have uh

1747

01:06:28,950 --> 01:06:25,599

let me get the arrow hey it's raining

1748

01:06:31,270 --> 01:06:28,960

shallow groundwater surface water tends

1749

01:06:32,710 --> 01:06:31,280

to be this magnesium

1750

01:06:35,349 --> 01:06:32,720

bicarbonate

1751
01:06:37,430 --> 01:06:35,359
enriched enriched composition and the

1752
01:06:39,670 --> 01:06:37,440
deeper water that's water that

1753
01:06:41,109 --> 01:06:39,680
circulates more deeply and

1754
01:06:43,190 --> 01:06:41,119
hydrates the

1755
01:06:45,829 --> 01:06:43,200
minerals more extensively

1756
01:06:47,589 --> 01:06:45,839
reappears at the surface is basically a

1757
01:06:49,910 --> 01:06:47,599
calcium hydroxide solution with a very

1758
01:06:51,910 --> 01:06:49,920
high ph and this is where

1759
01:06:54,390 --> 01:06:51,920
the um

1760
01:06:56,549 --> 01:06:54,400
and picks up the hydrogen

1761
01:06:59,990 --> 01:06:56,559
and brings the hydrogen and methane to

1762
01:07:02,710 --> 01:07:00,000
the surface as well

1763
01:07:04,069 --> 01:07:02,720

here's an example um right

1764

01:07:06,950 --> 01:07:04,079

of a

1765

01:07:10,390 --> 01:07:06,960

stream system with springs in it in oman

1766

01:07:11,670 --> 01:07:10,400

so this clearer greenish water up here

1767

01:07:14,230 --> 01:07:11,680

is that

1768

01:07:16,470 --> 01:07:14,240

surface water and right around in here

1769

01:07:19,190 --> 01:07:16,480

suddenly everything turns white as you

1770

01:07:22,150 --> 01:07:19,200

can see and what's happening is that

1771

01:07:25,029 --> 01:07:22,160

the calcium hydroxide solution is oozing

1772

01:07:27,109 --> 01:07:25,039

in here into the stream and can

1773

01:07:29,910 --> 01:07:27,119

the reactions are happening very rapidly

1774

01:07:32,630 --> 01:07:29,920

we have bicarbonate back here in the

1775

01:07:34,950 --> 01:07:32,640

water and you have calcium coming in

1776

01:07:36,470 --> 01:07:34,960

here and suddenly you get calcium

1777

01:07:38,630 --> 01:07:36,480

carbonate precipitation it's all that

1778

01:07:40,390 --> 01:07:38,640

white stuff you can even see bits of it

1779

01:07:42,390 --> 01:07:40,400

back here where there's a little bit of

1780

01:07:44,309 --> 01:07:42,400

steep coming in under the

1781

01:07:46,069 --> 01:07:44,319

under the pressure water so this is an

1782

01:07:49,029 --> 01:07:46,079

example of seeing both of those systems

1783

01:07:51,750 --> 01:07:49,039

here we are looking down there is my the

1784

01:07:54,069 --> 01:07:51,760

toe of my boot for scale here's that

1785

01:07:55,910 --> 01:07:54,079

calcium hydroxide solution

1786

01:07:58,870 --> 01:07:55,920

who's coming out of that crack right

1787

01:08:01,029 --> 01:07:58,880

there flowing down along this path

1788

01:08:04,470 --> 01:08:01,039

falls off the edge of the rock into the

1789

01:08:06,549 --> 01:08:04,480

stream and instantly there's a bunch of

1790

01:08:08,870 --> 01:08:06,559

calcium carbonate precipitation this is

1791

01:08:11,910 --> 01:08:08,880

a telltale sign that we've got the high

1792

01:08:14,950 --> 01:08:11,920

ph fluid interacting with the surface

1793

01:08:17,269 --> 01:08:14,960

fluid and then looking on downstream

1794

01:08:19,189 --> 01:08:17,279

it's pretty dramatic in many cases

1795

01:08:22,070 --> 01:08:19,199

where there's a lot of calcium carbonate

1796

01:08:24,870 --> 01:08:22,080

precipitation that sets up

1797

01:08:27,590 --> 01:08:24,880

these kind of stunning views

1798

01:08:30,309 --> 01:08:27,600

at least in omaha

1799

01:08:33,349 --> 01:08:30,319

all right so here here's what here's a

1800

01:08:35,510 --> 01:08:33,359

plot of magnesium as a function of ph

1801
01:08:37,749 --> 01:08:35,520
and you'll notice that at the very high

1802
01:08:39,430 --> 01:08:37,759
ph over here

1803
01:08:41,749 --> 01:08:39,440
there's very little

1804
01:08:44,390 --> 01:08:41,759
magnesium dissolved in the water those

1805
01:08:46,309 --> 01:08:44,400
spots that are clustered along the zero

1806
01:08:48,149 --> 01:08:46,319
axis there are

1807
01:08:50,630 --> 01:08:48,159
indeed there are values associated with

1808
01:08:52,789 --> 01:08:50,640
those but this is a linear scale over

1809
01:08:55,590 --> 01:08:52,799
here so it's very hard to see those

1810
01:08:57,990 --> 01:08:55,600
and then the fresher water the surface

1811
01:08:59,269 --> 01:08:58,000
water is represented by these things

1812
01:09:01,669 --> 01:08:59,279
over here

1813
01:09:03,829 --> 01:09:01,679

ph starting around eight here and

1814

01:09:06,390 --> 01:09:03,839

considerably more enriched magnesium and

1815

01:09:07,349 --> 01:09:06,400

in between in this zone is where you

1816

01:09:09,269 --> 01:09:07,359

would have

1817

01:09:12,149 --> 01:09:09,279

you have mixing between the two

1818

01:09:14,870 --> 01:09:12,159

in-members of the fresh water over here

1819

01:09:17,269 --> 01:09:14,880

the serpentinized fluid over there and

1820

01:09:19,829 --> 01:09:17,279

lo and behold you get things plotting in

1821

01:09:23,189 --> 01:09:19,839

between so this the serpentinization

1822

01:09:25,669 --> 01:09:23,199

process then is removing the magnesium

1823

01:09:28,070 --> 01:09:25,679

it removes silica sulfate dissolved in

1824

01:09:29,990 --> 01:09:28,080

organic carbon the plots look more or

1825

01:09:32,630 --> 01:09:30,000

less like this for these other

1826
01:09:35,349 --> 01:09:32,640
constituents of the system

1827
01:09:36,149 --> 01:09:35,359
contrast here's a plot of hydrogen so

1828
01:09:42,950 --> 01:09:36,159
here

1829
01:09:45,910 --> 01:09:42,960
ph the subpentanized fluids can be

1830
01:09:47,990 --> 01:09:45,920
enormously enriched in hydrogen relative

1831
01:09:51,430 --> 01:09:48,000
to these surface fluids again these are

1832
01:09:52,390 --> 01:09:51,440
measurements but they're way down in the

1833
01:09:54,709 --> 01:09:52,400
animal

1834
01:09:56,550 --> 01:09:54,719
level of dissolved hydrogen it's just

1835
01:09:59,350 --> 01:09:56,560
still kind of remarkable that even this

1836
01:10:01,590 --> 01:09:59,360
fresh water has this hydrogen wafting up

1837
01:10:03,990 --> 01:10:01,600
through it from below

1838
01:10:06,390 --> 01:10:04,000

you can see that although the

1839

01:10:08,790 --> 01:10:06,400

serpentinized fluid can be massively

1840

01:10:12,870 --> 01:10:08,800

enriched in hydrogen it can also have

1841

01:10:15,510 --> 01:10:12,880

very low hydrogen and this is probably

1842

01:10:17,750 --> 01:10:15,520

evidence of biological consumption of

1843

01:10:19,990 --> 01:10:17,760

that hydrogen that's being delivered

1844

01:10:23,030 --> 01:10:20,000

a plot of methane and a plot or a plot

1845

01:10:25,910 --> 01:10:23,040

of ammonia or sulfide look very much

1846

01:10:28,390 --> 01:10:25,920

like this and also calcium which of

1847

01:10:30,870 --> 01:10:28,400

course is not directly involved in the

1848

01:10:33,590 --> 01:10:30,880

oxidation reduction reaction but it's an

1849

01:10:36,310 --> 01:10:33,600

indication of why the ph is going up and

1850

01:10:39,189 --> 01:10:36,320

what's happening in the in the

1851

01:10:42,149 --> 01:10:39,199

non-redox part of the system

1852

01:10:44,550 --> 01:10:42,159

there is calcium in the pyroxenes

1853

01:10:46,149 --> 01:10:44,560

that weathers into solution and then

1854

01:10:48,550 --> 01:10:46,159

when the new minerals form the

1855

01:10:49,910 --> 01:10:48,560

serpentine minerals calcium does not fit

1856

01:10:51,990 --> 01:10:49,920

into those serpentine minerals it

1857

01:10:53,830 --> 01:10:52,000

accumulates in solution and of course

1858

01:10:56,630 --> 01:10:53,840

you can't just add charge to the

1859

01:10:58,390 --> 01:10:56,640

solution without balancing it and so the

1860

01:11:00,229 --> 01:10:58,400

way that charge is balanced is by an

1861

01:11:01,990 --> 01:11:00,239

increase in hydroxide

1862

01:11:03,590 --> 01:11:02,000

so you end up with a calcium hydroxide

1863

01:11:05,510 --> 01:11:03,600

solution because there aren't any other

1864

01:11:07,590 --> 01:11:05,520

anions in the system the

1865

01:11:09,990 --> 01:11:07,600

typical anion something like bicarbonate

1866

01:11:11,750 --> 01:11:10,000

has been consumed on the way in

1867

01:11:14,070 --> 01:11:11,760

as the water is infiltrated in by the

1868

01:11:15,510 --> 01:11:14,080

precipitation of calcium carbonate all

1869

01:11:19,270 --> 01:11:15,520

right

1870

01:11:20,310 --> 01:11:19,280

well here's a list of that we've made of

1871

01:11:22,070 --> 01:11:20,320

um

1872

01:11:24,390 --> 01:11:22,080

what that we i'm calling here the

1873

01:11:25,990 --> 01:11:24,400

demonstrated chemolithotrophic reactions

1874

01:11:27,750 --> 01:11:26,000

in serpentinizing system and you'll

1875

01:11:29,350 --> 01:11:27,760

notice i have these different classes in

1876

01:11:30,950 --> 01:11:29,360

fact there's even something that's

1877

01:11:33,510 --> 01:11:30,960

fallen off the bottom of the picture

1878

01:11:36,550 --> 01:11:33,520

that's pretty good anyway so

1879

01:11:39,590 --> 01:11:36,560

i've ranked these here uh with um peter

1880

01:11:41,990 --> 01:11:39,600

canovis in terms of you know the quality

1881

01:11:45,189 --> 01:11:42,000

of the information the molecular and

1882

01:11:45,990 --> 01:11:45,199

micro microbiological information so the

1883

01:11:47,550 --> 01:11:46,000

um

1884

01:11:50,550 --> 01:11:47,560

the best case we have for

1885

01:11:53,350 --> 01:11:50,560

chemolithotropic uh reaction is hydrogen

1886

01:11:55,270 --> 01:11:53,360

oxidation and that that we that's

1887

01:11:57,750 --> 01:11:55,280

because there are there's at least an

1888

01:11:59,830 --> 01:11:57,760

isolate and culture of uh known

1889

01:12:02,229 --> 01:11:59,840

physiology and genomic data that goes

1890

01:12:04,310 --> 01:12:02,239

with that and so we're pretty sure we

1891

01:12:06,550 --> 01:12:04,320

know something about this reaction what

1892

01:12:07,750 --> 01:12:06,560

i'm trying to do here is use what's

1893

01:12:09,910 --> 01:12:07,760

known

1894

01:12:11,750 --> 01:12:09,920

coming from molecular biology and

1895

01:12:14,630 --> 01:12:11,760

microbiology to identify what kinds of

1896

01:12:17,189 --> 01:12:14,640

reactions are supporting life

1897

01:12:21,350 --> 01:12:19,270

what we're calling class 2 type data is

1898

01:12:23,430 --> 01:12:21,360

where they're something like rate data

1899

01:12:24,870 --> 01:12:23,440

on redox reaction and isotopically

1900

01:12:26,550 --> 01:12:24,880

labeled experiments that really show

1901

01:12:29,189 --> 01:12:26,560

that the reaction seems to be happening

1902

01:12:30,950 --> 01:12:29,199

and is my microbially mediated and here

1903

01:12:33,750 --> 01:12:30,960

we have several reactions

1904

01:12:34,830 --> 01:12:33,760

carbon monoxide oxidation

1905

01:12:37,270 --> 01:12:34,840

the

1906

01:12:39,350 --> 01:12:37,280

methanogenesis reaction so making

1907

01:12:40,790 --> 01:12:39,360

methane from this from co2 and there's

1908

01:12:42,149 --> 01:12:40,800

that hydrogen

1909

01:12:43,830 --> 01:12:42,159

coming from the

1910

01:12:45,189 --> 01:12:43,840

point at it it will be working better

1911

01:12:47,669 --> 01:12:45,199

there's that hydrogen coming from the

1912

01:12:49,430 --> 01:12:47,679

water rock reaction and then

1913

01:12:51,910 --> 01:12:49,440

various

1914

01:12:54,550 --> 01:12:51,920

anaerobic methanotrophy

1915

01:12:56,630 --> 01:12:54,560

simply because it often in the

1916

01:12:58,950 --> 01:12:56,640

literature it's not specified what the

1917

01:13:01,510 --> 01:12:58,960

oxidant is and so we're using the three

1918

01:13:04,229 --> 01:13:01,520

that we have measured here sulfate uh

1919

01:13:06,229 --> 01:13:04,239

nitrate and nitrite

1920

01:13:10,149 --> 01:13:06,239

somewhat

1921

01:13:11,990 --> 01:13:10,159

useful information and it's what we're

1922

01:13:14,070 --> 01:13:12,000

calling class three information where

1923

01:13:16,630 --> 01:13:14,080

you actually have gene expression it's

1924

01:13:18,709 --> 01:13:16,640

not uh and then or transcrip

1925

01:13:20,149 --> 01:13:18,719

transcriptomic proteomic or biomarker

1926

01:13:21,830 --> 01:13:20,159

data that indicates the reaction is

1927

01:13:24,470 --> 01:13:21,840

happening it's not like watching the

1928

01:13:26,310 --> 01:13:24,480

reaction happen but it's very suggestive

1929

01:13:28,630 --> 01:13:26,320

of that kind of reaction happening and

1930

01:13:30,229 --> 01:13:28,640

what fits in here is ammonia oxidation

1931

01:13:33,030 --> 01:13:30,239

sulfate reduction

1932

01:13:35,510 --> 01:13:33,040

we also have um

1933

01:13:38,229 --> 01:13:35,520

reactions that can be identified based

1934

01:13:40,229 --> 01:13:38,239

on uh genes that have been

1935

01:13:41,990 --> 01:13:40,239

actual gene hunting and looking for

1936

01:13:44,470 --> 01:13:42,000

genes involved in these sorts of

1937

01:13:46,870 --> 01:13:44,480

processes that adds sulfide oxidation

1938

01:13:48,870 --> 01:13:46,880

and nitrogen reduction to the list and

1939

01:13:51,990 --> 01:13:48,880

then what you can't read down here are

1940

01:13:53,990 --> 01:13:52,000

what we consider the type of information

1941

01:13:55,830 --> 01:13:54,000

that is least indicative of something

1942

01:13:57,830 --> 01:13:55,840

actually happening which is what's

1943

01:14:00,229 --> 01:13:57,840

inferred from 16s

1944

01:14:02,310 --> 01:14:00,239

ribosomal rna data which is about like

1945

01:14:03,669 --> 01:14:02,320

saying your brother is a lawyer so you

1946

01:14:06,550 --> 01:14:03,679

must be a lawyer

1947

01:14:08,630 --> 01:14:06,560

um you know great uh and

1948

01:14:10,229 --> 01:14:08,640

you know helpfully perhaps those

1949

01:14:12,310 --> 01:14:10,239

reactions are sliced off the bottom of

1950

01:14:14,630 --> 01:14:12,320

the image we can't even see them anyway

1951

01:14:16,790 --> 01:14:14,640

so there you have it um but there's a

1952

01:14:18,310 --> 01:14:16,800

couple more reactions on this on this

1953

01:14:20,229 --> 01:14:18,320

list and they'll show up here in just a

1954

01:14:22,070 --> 01:14:20,239

moment the one thing we can do with all

1955

01:14:23,590 --> 01:14:22,080

of this is try to figure out how much

1956

01:14:25,910 --> 01:14:23,600

energy are we talking about these are

1957

01:14:27,510 --> 01:14:25,920

reactions that um

1958

01:14:30,310 --> 01:14:27,520

are

1959

01:14:31,910 --> 01:14:30,320

identified uh have been identified

1960

01:14:34,950 --> 01:14:31,920

through microbiology or molecular

1961

01:14:36,630 --> 01:14:34,960

biology and so what is what what's the

1962

01:14:39,030 --> 01:14:36,640

energy supply so there must be some

1963

01:14:40,790 --> 01:14:39,040

energy that supports these things

1964

01:14:43,110 --> 01:14:40,800

we do this by calculating this term

1965

01:14:44,390 --> 01:14:43,120

called the chemical affinity right here

1966

01:14:46,870 --> 01:14:44,400

and whatever

1967

01:14:49,030 --> 01:14:46,880

the way you do that is uh combining of

1968

01:14:50,950 --> 01:14:49,040

course is the ideal gas constant

1969

01:14:53,750 --> 01:14:50,960

temperature but the important parts over

1970

01:14:55,910 --> 01:14:53,760

here are the equilibrium constant and

1971

01:14:57,110 --> 01:14:55,920

the reaction quotient or the activity

1972

01:14:59,350 --> 01:14:57,120

product

1973

01:15:00,950 --> 01:14:59,360

and essentially the the

1974

01:15:04,310 --> 01:15:00,960

equilibrium constant tells you where

1975

01:15:06,470 --> 01:15:04,320

equilibrium is for the reaction and the

1976

01:15:07,830 --> 01:15:06,480

x the activity product the reaction

1977

01:15:10,070 --> 01:15:07,840

quotient is kind of hard to point at

1978

01:15:11,350 --> 01:15:10,080

that q there is what you actually

1979

01:15:13,990 --> 01:15:11,360

measure

1980

01:15:16,229 --> 01:15:14,000

out in the field and in samples that you

1981

01:15:18,630 --> 01:15:16,239

bring back to the lab and you can see

1982

01:15:20,070 --> 01:15:18,640

that here if those two things are equal

1983

01:15:21,830 --> 01:15:20,080

to each other

1984

01:15:24,390 --> 01:15:21,840

take the natural log hey the natural log

1985

01:15:26,149 --> 01:15:24,400

of one is zero presto affinity will be

1986

01:15:28,390 --> 01:15:26,159

zero when the system's completely at

1987

01:15:29,189 --> 01:15:28,400

equilibrium and what we're looking for

1988

01:15:31,430 --> 01:15:29,199

are

1989

01:15:33,430 --> 01:15:31,440

places where the affinity is positive

1990

01:15:35,430 --> 01:15:33,440

because that tells us

1991

01:15:37,830 --> 01:15:35,440

that there's more

1992

01:15:39,910 --> 01:15:37,840

there's energy that could be

1993

01:15:42,229 --> 01:15:39,920

that is available for that reaction to

1994

01:15:44,310 --> 01:15:42,239

proceed from left to right as we're

1995

01:15:47,270 --> 01:15:44,320

writing it so just to show you a few

1996

01:15:49,750 --> 01:15:47,280

examples here from peter canovis's work

1997

01:15:51,030 --> 01:15:49,760

here are affinities

1998

01:15:53,510 --> 01:15:51,040

now

1999

01:15:55,750 --> 01:15:53,520

the units here are kilocalories per mole

2000

01:15:57,510 --> 01:15:55,760

of electrons involved in the reaction

2001
01:15:59,510 --> 01:15:57,520
and we do this so that we can compare

2002
01:16:00,950 --> 01:15:59,520
everything on a similar basis since

2003
01:16:03,669 --> 01:16:00,960
there's different numbers of electrons

2004
01:16:05,910 --> 01:16:03,679
used in the reaction so here's energy

2005
01:16:07,110 --> 01:16:05,920
available from hydrogen oxidation across

2006
01:16:07,910 --> 01:16:07,120
this

2007
01:16:10,149 --> 01:16:07,920
uh

2008
01:16:11,189 --> 01:16:10,159
these samples from from oman and you can

2009
01:16:12,310 --> 01:16:11,199
see

2010
01:16:13,830 --> 01:16:12,320
these

2011
01:16:14,709 --> 01:16:13,840
you wouldn't know this unless you've

2012
01:16:16,149 --> 01:16:14,719
been

2013
01:16:17,830 --> 01:16:16,159

doing these sorts of calculations but

2014

01:16:21,270 --> 01:16:17,840

these are very large

2015

01:16:23,350 --> 01:16:21,280

positive values of infinity so ample

2016

01:16:24,870 --> 01:16:23,360

energy availability for hydrogen

2017

01:16:26,790 --> 01:16:24,880

oxidation

2018

01:16:30,229 --> 01:16:26,800

another example is

2019

01:16:31,990 --> 01:16:30,239

methane oxidation aerobic methanotrophy

2020

01:16:33,270 --> 01:16:32,000

abundant information

2021

01:16:34,790 --> 01:16:33,280

information

2022

01:16:37,030 --> 01:16:34,800

energy available for that reaction you

2023

01:16:39,350 --> 01:16:37,040

can see sort of a trend of increasing

2024

01:16:41,189 --> 01:16:39,360

energy as you go up into higher ph where

2025

01:16:43,590 --> 01:16:41,199

the fluids are dominated by the

2026

01:16:45,030 --> 01:16:43,600

surfacing fluid that's even more

2027

01:16:47,830 --> 01:16:45,040

dramatic when you look at carbon

2028

01:16:50,149 --> 01:16:47,840

monoxide oxidation so all these reduced

2029

01:16:52,950 --> 01:16:50,159

constituents the hydrogen and carbon

2030

01:16:53,990 --> 01:16:52,960

monoxide methane coming up

2031

01:16:56,310 --> 01:16:54,000

from

2032

01:16:58,870 --> 01:16:56,320

with the serpentinized fluid

2033

01:17:00,709 --> 01:16:58,880

all represent wonderful sources of

2034

01:17:02,870 --> 01:17:00,719

energy when they can be combined with

2035

01:17:04,630 --> 01:17:02,880

something like oxygen energy of course

2036

01:17:07,270 --> 01:17:04,640

coming from a reaction and not from an

2037

01:17:09,510 --> 01:17:07,280

individual constituent

2038

01:17:13,350 --> 01:17:09,520

much lower amounts of energy are

2039

01:17:15,189 --> 01:17:13,360

available for things like methanogenesis

2040

01:17:17,110 --> 01:17:15,199

zero here look at that hey hey there's

2041

01:17:19,350 --> 01:17:17,120

equilibrium and there's the distribution

2042

01:17:21,990 --> 01:17:19,360

of points which is slightly above that

2043

01:17:24,149 --> 01:17:22,000

equilibrium value which means there's a

2044

01:17:26,470 --> 01:17:24,159

little bit of energy available and the

2045

01:17:28,950 --> 01:17:26,480

question you might be asking is well is

2046

01:17:31,189 --> 01:17:28,960

that the best that the system can do to

2047

01:17:33,189 --> 01:17:31,199

support methanogens or is this

2048

01:17:35,750 --> 01:17:33,199

everything that's left

2049

01:17:36,950 --> 01:17:35,760

after the methanogens have uh done what

2050

01:17:38,790 --> 01:17:36,960

they can

2051
01:17:40,950 --> 01:17:38,800
with the system and what we're finding

2052
01:17:42,550 --> 01:17:40,960
is that there are methanogens present in

2053
01:17:45,030 --> 01:17:42,560
the sediments associated with a lot of

2054
01:17:47,750 --> 01:17:45,040
these springs so we're thinking that

2055
01:17:50,390 --> 01:17:47,760
this might be what's left after they've

2056
01:17:51,510 --> 01:17:50,400
worked over the system another example

2057
01:17:55,189 --> 01:17:51,520
like that

2058
01:17:57,590 --> 01:17:55,199
is the anaerobic methanotrophy here with

2059
01:17:59,910 --> 01:17:57,600
balance in the reaction of sulfate again

2060
01:18:02,630 --> 01:17:59,920
a very small and positive amount of

2061
01:18:05,669 --> 01:18:02,640
energy and the question remains whether

2062
01:18:08,950 --> 01:18:05,679
this is just the remnant energy that's

2063
01:18:13,430 --> 01:18:08,960

left after uh biology has worked the

2064

01:18:15,669 --> 01:18:13,440
system so if we go out to a ph of 11

2065

01:18:19,270 --> 01:18:15,679
for just as an example to get something

2066

01:18:21,189 --> 01:18:19,280
out close to the serpentinized fluid we

2067

01:18:23,189 --> 01:18:21,199
can get this sort of thing

2068

01:18:25,750 --> 01:18:23,199
this is a ranked

2069

01:18:29,110 --> 01:18:25,760
diagram of affinities

2070

01:18:31,590 --> 01:18:29,120
with the carbon monoxide oxidation uh

2071

01:18:34,310 --> 01:18:31,600
at least in the oman system being

2072

01:18:36,149 --> 01:18:34,320
a nice big source of energy

2073

01:18:37,990 --> 01:18:36,159
followed by these various other

2074

01:18:40,630 --> 01:18:38,000
oxidation reactions

2075

01:18:42,229 --> 01:18:40,640
on down through um

2076

01:18:45,430 --> 01:18:42,239

reactions that we consider based on

2077

01:18:47,830 --> 01:18:45,440

geochemistry and on down into the really

2078

01:18:50,470 --> 01:18:47,840

sad pathetic leftovers of sulfate

2079

01:18:53,270 --> 01:18:50,480

reduction methanogenesis and anaerobic

2080

01:18:55,510 --> 01:18:53,280

methanotrophy with sulfate so

2081

01:18:59,270 --> 01:18:55,520

we can generate these sorts of

2082

01:19:01,590 --> 01:18:59,280

images of the supply of energy

2083

01:19:04,229 --> 01:19:01,600

based this way by comparing things on an

2084

01:19:06,070 --> 01:19:04,239

electron basis or

2085

01:19:08,790 --> 01:19:06,080

going to individual samples and

2086

01:19:11,830 --> 01:19:08,800

evaluating the energy supply in each one

2087

01:19:13,750 --> 01:19:11,840

and what we see is a wide spread and

2088

01:19:15,990 --> 01:19:13,760

what of energy

2089

01:19:18,310 --> 01:19:16,000

availability and what re remains to be

2090

01:19:20,070 --> 01:19:18,320

seen is exactly

2091

01:19:22,550 --> 01:19:20,080

what all is controlling that these

2092

01:19:23,910 --> 01:19:22,560

reactions are predominantly

2093

01:19:26,550 --> 01:19:23,920

the this list of reactions is

2094

01:19:28,790 --> 01:19:26,560

predominantly things that we know that

2095

01:19:30,790 --> 01:19:28,800

there are microorganisms in

2096

01:19:32,550 --> 01:19:30,800

serpentinizing systems that do these

2097

01:19:35,350 --> 01:19:32,560

we've added a few reactions that we

2098

01:19:37,189 --> 01:19:35,360

think are likely based on what we've

2099

01:19:38,390 --> 01:19:37,199

based on the geochemistry of the system

2100

01:19:41,030 --> 01:19:38,400

like the

2101
01:19:43,510 --> 01:19:41,040
amminox reaction the animox reaction

2102
01:19:45,430 --> 01:19:43,520
here ammonia oxidation the water gas

2103
01:19:47,830 --> 01:19:45,440
shift reaction and so forth that we

2104
01:19:48,830 --> 01:19:47,840
think are plausible and that

2105
01:19:49,750 --> 01:19:48,840
those

2106
01:19:52,070 --> 01:19:49,760
metabolisms be

2107
01:19:54,390 --> 01:19:52,080
explored i think

2108
01:19:55,990 --> 01:19:54,400
with some you know it'd be worth doing

2109
01:19:58,709 --> 01:19:56,000
so what i've tried to do real quickly

2110
01:20:00,149 --> 01:19:58,719
here is show you how you can go from

2111
01:20:02,149 --> 01:20:00,159
collecting

2112
01:20:04,149 --> 01:20:02,159
analytical data

2113
01:20:07,430 --> 01:20:04,159

geochemical data on these systems doing

2114

01:20:09,110 --> 01:20:07,440

some calculations and having now a menu

2115

01:20:10,790 --> 01:20:09,120

this is you know this is the menu this

2116

01:20:13,590 --> 01:20:10,800

is what's on the menu here for these

2117

01:20:16,870 --> 01:20:13,600

reactions in terms of their relative uh

2118

01:20:19,510 --> 01:20:16,880

energy supply more positive being more

2119

01:20:21,990 --> 01:20:19,520

energy and that gives it gets us one

2120

01:20:24,550 --> 01:20:22,000

step closer to trying to

2121

01:20:26,629 --> 01:20:24,560

having an image of how geochemistry of

2122

01:20:28,950 --> 01:20:26,639

the system is supporting the

2123

01:20:32,310 --> 01:20:28,960

microbiology of its presence and i'll

2124

01:20:34,629 --> 01:20:32,320

leave you with that

2125

01:20:36,229 --> 01:20:34,639

hey thank you

2126

01:20:38,629 --> 01:20:36,239

so we've got some specific questions in

2127

01:20:40,390 --> 01:20:38,639

the chat window that i might have time

2128

01:20:42,149 --> 01:20:40,400

for and i'd start i'd like to start

2129

01:20:45,830 --> 01:20:42,159

though with the general

2130

01:20:47,830 --> 01:20:45,840

question which is to ask you if um i can

2131

01:20:49,830 --> 01:20:47,840

summarize your your final conclusion

2132

01:20:51,590 --> 01:20:49,840

there accurately which is that

2133

01:20:53,590 --> 01:20:51,600

because you're measuring things at the

2134

01:20:54,550 --> 01:20:53,600

surface that are that are mixed with the

2135

01:20:57,270 --> 01:20:54,560

surface

2136

01:20:59,510 --> 01:20:57,280

if your energetic calculations show a

2137

01:21:01,350 --> 01:20:59,520

very small amount of energy that might

2138

01:21:03,510 --> 01:21:01,360

actually be an indication of something

2139

01:21:05,750 --> 01:21:03,520

that is most likely to actually be

2140

01:21:07,350 --> 01:21:05,760

occurring in the subsurface

2141

01:21:08,629 --> 01:21:07,360

when you have additional information of

2142

01:21:10,950 --> 01:21:08,639

course that you can use to interpret

2143

01:21:12,870 --> 01:21:10,960

that information is that totally

2144

01:21:20,550 --> 01:21:12,880

uh

2145

01:21:21,590 --> 01:21:20,560

things that we we think of as you know

2146

01:21:23,270 --> 01:21:21,600

something like

2147

01:21:24,709 --> 01:21:23,280

methanogenesis and autotrophic

2148

01:21:27,350 --> 01:21:24,719

methanogenesis

2149

01:21:28,870 --> 01:21:27,360

where we um

2150

01:21:30,629 --> 01:21:28,880

we think of that as sort of i think of

2151

01:21:33,430 --> 01:21:30,639

that as sort of a reductive process i

2152

01:21:36,310 --> 01:21:33,440

guess i'm obsessed with the carbon um

2153

01:21:38,950 --> 01:21:36,320

that i think that's much more uh likely

2154

01:21:42,550 --> 01:21:38,960

in the subsurface as long as the co2 can

2155

01:21:45,030 --> 01:21:42,560

infiltrate um in into the subsurface uh

2156

01:21:47,830 --> 01:21:45,040

and and it's broad or

2157

01:21:49,830 --> 01:21:47,840

uh is present as uh carbonate minerals

2158

01:21:52,229 --> 01:21:49,840

so there there could be a complex

2159

01:21:53,830 --> 01:21:52,239

history which i i don't doubt

2160

01:21:56,070 --> 01:21:53,840

in these systems where

2161

01:21:57,910 --> 01:21:56,080

at when you have fluids infiltrating

2162

01:22:00,070 --> 01:21:57,920

bringing

2163

01:22:02,629 --> 01:22:00,080

dissolved carbonate into the system that

2164

01:22:05,189 --> 01:22:02,639

precipitates as carbonate minerals and

2165

01:22:07,510 --> 01:22:05,199

then things change later and there's a

2166

01:22:10,070 --> 01:22:07,520

supply of say hydrogen into where those

2167

01:22:12,070 --> 01:22:10,080

carbonate minerals are and suddenly that

2168

01:22:13,669 --> 01:22:12,080

those carbonates look pretty pretty much

2169

01:22:15,510 --> 01:22:13,679

like pretty delicious with all that

2170

01:22:17,990 --> 01:22:15,520

hydrogen around and so i think there are

2171

01:22:19,510 --> 01:22:18,000

probably microbes you know using solid

2172

01:22:21,189 --> 01:22:19,520

carbonate as

2173

01:22:22,470 --> 01:22:21,199

their

2174

01:22:23,830 --> 01:22:22,480

carbon source and i think people are

2175

01:22:25,350 --> 01:22:23,840

having success showing that sort of

2176

01:22:26,550 --> 01:22:25,360

thing

2177

01:22:28,149 --> 01:22:26,560

okay thanks

2178

01:22:29,830 --> 01:22:28,159

and then uh before we move on to the

2179

01:22:32,790 --> 01:22:29,840

break let's get to at least one of these

2180

01:22:34,550 --> 01:22:32,800

questions uh darcy asks

2181

01:22:37,270 --> 01:22:34,560

uh have you looked at the transformation

2182

01:22:38,870 --> 01:22:37,280

of iron or are those reactions

2183

01:22:40,709 --> 01:22:38,880

do they suck so much they're not worth

2184

01:22:41,910 --> 01:22:40,719

mentioning on the platform

2185

01:22:44,629 --> 01:22:41,920

it's very

2186

01:22:48,790 --> 01:22:44,639

well we're in the ph range where

2187

01:22:52,470 --> 01:22:48,800

uh iron oxidation is definitely

2188

01:22:54,870 --> 01:22:52,480

fe2 to fe3 in solution is so fast

2189

01:22:56,629 --> 01:22:54,880

abiotically that there it's definitely

2190

01:22:59,590 --> 01:22:56,639

an example of something that is bursting

2191

01:23:02,629 --> 01:22:59,600

into flame and is not good to eat um it

2192

01:23:03,590 --> 01:23:02,639

is just simply uh you know we can't

2193

01:23:05,430 --> 01:23:03,600

measure

2194

01:23:07,590 --> 01:23:05,440

the reduced iron in the water in the

2195

01:23:09,910 --> 01:23:07,600

field it's below our detection limit and

2196

01:23:12,629 --> 01:23:09,920

the rate would be so outrageous for the

2197

01:23:14,790 --> 01:23:12,639

abiotic oxidation in these systems that

2198

01:23:17,350 --> 01:23:14,800

i don't think there's the oxidation of

2199

01:23:18,390 --> 01:23:17,360

iron is uh is

2200

01:23:20,790 --> 01:23:18,400

something that

2201

01:23:23,189 --> 01:23:20,800

is supporting life at least in the

2202

01:23:24,629 --> 01:23:23,199

solution um now that could be very

2203

01:23:26,629 --> 01:23:24,639

different in the minerals because you're

2204

01:23:29,189 --> 01:23:26,639

going to have the kinetic inhibitions

2205

01:23:32,870 --> 01:23:29,199

for the reactions and and allow the

2206

01:23:34,629 --> 01:23:32,880

ferrous iron to stick around but we

2207

01:23:36,950 --> 01:23:34,639

have not included

2208

01:23:38,550 --> 01:23:36,960

those in this particular analysis but we

2209

01:23:41,270 --> 01:23:38,560

certainly can for

2210

01:23:42,629 --> 01:23:41,280

writing reactions for the various

2211

01:23:45,110 --> 01:23:42,639

ferrous iron

2212

01:23:47,510 --> 01:23:45,120

minerals and the ferric iron mineral

2213

01:23:49,990 --> 01:23:47,520

products

2214

01:23:53,110 --> 01:23:50,000

but they're not as dramatic as

2215

01:24:02,310 --> 01:23:55,910

and then alexis asks what is the source

2216

01:24:08,310 --> 01:24:05,669

sure uh i don't know it uh it increases

2217

01:24:11,430 --> 01:24:08,320

much higher in the serpentinized fluid

2218

01:24:13,590 --> 01:24:11,440

than it is in the surface water um

2219

01:24:16,550 --> 01:24:13,600

so

2220

01:24:18,790 --> 01:24:16,560

i i don't i don't know why

2221

01:24:21,030 --> 01:24:18,800

that is in terms of like the nitrogen

2222

01:24:23,510 --> 01:24:21,040

cycle but it certainly seems that

2223

01:24:26,070 --> 01:24:23,520

nitrogen going into the system is coming

2224

01:24:28,870 --> 01:24:26,080

back out as ammonia but it's also

2225

01:24:32,870 --> 01:24:28,880

enhanced in its concentration relative

2226

01:24:35,669 --> 01:24:34,229

cool thanks

2227

01:24:37,430 --> 01:24:35,679

uh i think the

2228

01:24:39,830 --> 01:24:37,440

discussion will continue in the chat

2229

01:24:42,709 --> 01:24:39,840

window and now i think maybe we should

2230

01:24:44,149 --> 01:24:42,719

have our coffee break

2231

01:24:46,229 --> 01:24:44,159

all right well wonderful well thank you

2232

01:24:48,070 --> 01:24:46,239

billy uh and everyone for organizing

2233

01:24:49,270 --> 01:24:48,080

this this is really interesting session

2234

01:24:50,950 --> 01:24:49,280

so far

2235

01:24:52,790 --> 01:24:50,960

um we've

2236

01:24:56,229 --> 01:24:52,800

covered some interesting material going

2237

01:25:00,070 --> 01:24:56,239

from the sea floor uh to oman

2238

01:25:01,990 --> 01:25:00,080

um what i uh am trying to cover here is

2239

01:25:04,070 --> 01:25:02,000

uh telling you a bit about what we found

2240

01:25:06,390 --> 01:25:04,080

out about the microbiology

2241

01:25:08,390 --> 01:25:06,400

of serpentinizing systems particularly

2242

01:25:11,510 --> 01:25:08,400

in continental environments

2243

01:25:12,390 --> 01:25:11,520

um and so this is uh

2244

01:25:15,510 --> 01:25:12,400

some

2245

01:25:17,669 --> 01:25:15,520

various

2246

01:25:19,990 --> 01:25:17,679

settings uh throughout the world

2247

01:25:22,229 --> 01:25:20,000

now am i moving the slide okay there in

2248

01:25:24,229 --> 01:25:22,239

terms of what you're seeing

2249

01:25:27,910 --> 01:25:24,239

yeah matt i um i recommend you use the

2250

01:25:31,510 --> 01:25:30,310

and then it'll page more like a slide

2251

01:25:32,870 --> 01:25:31,520

all right now i'm clicking through

2252

01:25:34,390 --> 01:25:32,880

everything all at once

2253

01:25:36,070 --> 01:25:34,400

wonderful

2254

01:25:38,550 --> 01:25:36,080

all right so um you've already heard

2255

01:25:40,470 --> 01:25:38,560

something of of the lost city uh and

2256

01:25:42,550 --> 01:25:40,480

it's really been the hallmark site for

2257

01:25:43,350 --> 01:25:42,560

surprisation over the last decade or

2258

01:25:46,149 --> 01:25:43,360

more

2259

01:25:47,990 --> 01:25:46,159

uh in terms of the exciting uh you know

2260

01:25:50,550 --> 01:25:48,000

contrast to high temperature black

2261

01:25:53,189 --> 01:25:50,560

smoker types of hydrothermal systems

2262

01:25:55,350 --> 01:25:53,199

uh the high high ph fluids relatively

2263

01:25:57,189 --> 01:25:55,360

high temperatures copious amounts of

2264

01:26:00,149 --> 01:25:57,199

methane and hydrogen

2265

01:26:02,870 --> 01:26:00,159

and associated

2266

01:26:05,030 --> 01:26:02,880

associated uh potentially a biogenic

2267

01:26:06,870 --> 01:26:05,040

organic molecule so there's been a ton

2268

01:26:08,709 --> 01:26:06,880

of study at the lost city we've really

2269

01:26:10,550 --> 01:26:08,719

advanced our understanding of the

2270

01:26:13,189 --> 01:26:10,560

microbiology of

2271

01:26:15,189 --> 01:26:13,199

sea floor serpentinizing systems anyway

2272

01:26:18,870 --> 01:26:15,199

uh through the through the study of that

2273

01:26:20,870 --> 01:26:18,880

site but uh the fact of the matter is uh

2274

01:26:22,709 --> 01:26:20,880

beyond lost city there haven't really

2275

01:26:25,910 --> 01:26:22,719

been that many studies

2276

01:26:27,270 --> 01:26:25,920

of c4 surpatinizing systems in recent

2277

01:26:28,229 --> 01:26:27,280

years there have been

2278

01:26:29,350 --> 01:26:28,239

um

2279

01:26:31,110 --> 01:26:29,360

you know

2280

01:26:34,149 --> 01:26:31,120

analog systems discovered in new

2281

01:26:36,470 --> 01:26:34,159

caledonia region and the western pacific

2282

01:26:38,390 --> 01:26:36,480

but by and large there's this is a

2283

01:26:40,950 --> 01:26:38,400

relatively uh a new

2284

01:26:43,830 --> 01:26:40,960

area of study and there's relatively few

2285

01:26:45,270 --> 01:26:43,840

of these systems that have been explored

2286

01:26:47,430 --> 01:26:45,280

uh and so

2287

01:26:49,110 --> 01:26:47,440

given this uh you know gap in our

2288

01:26:52,070 --> 01:26:49,120

knowledge over the years and uh of

2289

01:26:54,229 --> 01:26:52,080

cipretinizing sites and the fact

2290

01:26:56,149 --> 01:26:54,239

that eventually much of the seafloor

2291

01:26:58,149 --> 01:26:56,159

material ends up on land through plate

2292

01:27:00,070 --> 01:26:58,159

tectonics we

2293

01:27:02,790 --> 01:27:00,080

we and others went about studying uh

2294

01:27:05,189 --> 01:27:02,800

continental surface regenizing systems

2295

01:27:08,070 --> 01:27:05,199

so ophiolite complexes so one of the

2296

01:27:09,590 --> 01:27:08,080

most beautiful examples of this uh in my

2297

01:27:12,629 --> 01:27:09,600

opinion uh

2298

01:27:14,149 --> 01:27:12,639

is the table lanzophilite this is a

2299

01:27:16,790 --> 01:27:14,159

picture of the tablelands in

2300

01:27:18,790 --> 01:27:16,800

newfoundland canada i believe billy

2301

01:27:21,990 --> 01:27:18,800

mentioned this briefly earlier so this

2302

01:27:25,030 --> 01:27:22,000

is a nearly half a billion year old uh

2303

01:27:28,310 --> 01:27:25,040

sterpetinizing opioids

2304

01:27:31,510 --> 01:27:28,320

which is still seeping high ph gas-rich

2305

01:27:32,390 --> 01:27:31,520

fluids and and is a continental analog

2306

01:27:34,790 --> 01:27:32,400

to

2307

01:27:39,910 --> 01:27:34,800

uh some of what we've seen in in

2308

01:27:45,990 --> 01:27:42,790

so um so as i mentioned uh you know

2309

01:27:48,470 --> 01:27:46,000

following the work at the law city uh

2310

01:27:50,390 --> 01:27:48,480

before more cruz has been out there we

2311

01:27:52,550 --> 01:27:50,400

and others

2312

01:27:55,830 --> 01:27:52,560

including many of the people on on this

2313

01:27:58,390 --> 01:27:55,840

uh telecon have studied uh surprising

2314

01:27:59,669 --> 01:27:58,400

sites in ophiolites uh

2315

01:28:01,669 --> 01:27:59,679

continental settings throughout the

2316

01:28:02,950 --> 01:28:01,679

globe and so places like

2317

01:28:05,669 --> 01:28:02,960

uh

2318

01:28:10,229 --> 01:28:05,679

you know in california in newfoundland

2319

01:28:12,470 --> 01:28:10,239

in liguria in italy in oman and so on so

2320

01:28:15,030 --> 01:28:12,480

uh you know it racked up a lot of

2321

01:28:16,870 --> 01:28:15,040

frequent flyer miles and and spent a lot

2322

01:28:18,550 --> 01:28:16,880

of money on field gear

2323

01:28:21,350 --> 01:28:18,560

for sampling and analysis of these

2324

01:28:24,149 --> 01:28:21,360

various sites um i recently came across

2325

01:28:25,830 --> 01:28:24,159

a paper from 2007 by os

2326

01:28:28,629 --> 01:28:25,840

i know there's about serpentinites

2327

01:28:30,629 --> 01:28:28,639

separate and isingophilites and that map

2328

01:28:32,870 --> 01:28:30,639

is shown in the lower left here

2329

01:28:34,950 --> 01:28:32,880

they were looking at uh

2330

01:28:36,550 --> 01:28:34,960

geochemistry of serpentine soils but

2331

01:28:39,110 --> 01:28:36,560

this just shows

2332

01:28:40,709 --> 01:28:39,120

in addition to the the dots on our

2333

01:28:42,229 --> 01:28:40,719

google earth map

2334

01:28:44,550 --> 01:28:42,239

how many hundreds of other

2335

01:28:47,189 --> 01:28:44,560

serpentinizing settings there are

2336

01:28:49,030 --> 01:28:47,199

throughout the globe particularly

2337

01:28:53,110 --> 01:28:49,040

in continental margin

2338

01:28:57,830 --> 01:28:56,229

all right

2339

01:28:59,669 --> 01:28:57,840

so um

2340

01:29:01,189 --> 01:28:59,679

so what i think is exciting about this

2341

01:29:03,830 --> 01:29:01,199

in addition to the fact that there are

2342

01:29:05,750 --> 01:29:03,840

so many sites to investigate is that

2343

01:29:08,390 --> 01:29:05,760

these continental stripetonites cover a

2344

01:29:10,229 --> 01:29:08,400

broad range of different conditions

2345

01:29:12,229 --> 01:29:10,239

it's sure they have some things in

2346

01:29:14,229 --> 01:29:12,239

common like the high ph and and the

2347

01:29:16,390 --> 01:29:14,239

presence of the gases and the generally

2348

01:29:19,430 --> 01:29:16,400

reducing conditions but they cover a

2349

01:29:21,590 --> 01:29:19,440

great spectrum of conditions in terms of

2350

01:29:23,110 --> 01:29:21,600

climate uh in terms of hydrology

2351
01:29:26,229 --> 01:29:23,120
groundwater

2352
01:29:27,350 --> 01:29:26,239
recharge and discharge and residence

2353
01:29:29,110 --> 01:29:27,360
times

2354
01:29:30,470 --> 01:29:29,120
things like the geochemistry of this

2355
01:29:32,790 --> 01:29:30,480
these systems

2356
01:29:35,270 --> 01:29:32,800
the geologic setting some of which was

2357
01:29:36,830 --> 01:29:35,280
alluded to on that earlier slide about

2358
01:29:39,270 --> 01:29:36,840
when exactly these

2359
01:29:40,470 --> 01:29:39,280
opioids arrived on the continental

2360
01:29:42,550 --> 01:29:40,480
margins

2361
01:29:44,550 --> 01:29:42,560
and then consequently microbiological

2362
01:29:47,030 --> 01:29:44,560
processes so

2363
01:29:48,629 --> 01:29:47,040

in the context of astrobiology i think

2364

01:29:50,070 --> 01:29:48,639

this provides us with a tremendous

2365

01:29:52,149 --> 01:29:50,080

opportunity to

2366

01:29:53,590 --> 01:29:52,159

to look at some different settings some

2367

01:29:56,470 --> 01:29:53,600

different occurrences which may be

2368

01:29:59,030 --> 01:29:56,480

analogs to things we may observe on mars

2369

01:30:01,830 --> 01:29:59,040

or or elsewhere in the solar system

2370

01:30:03,270 --> 01:30:01,840

uh so i just wanted to point out a few

2371

01:30:05,910 --> 01:30:03,280

of these uh

2372

01:30:07,830 --> 01:30:05,920

examples from our travels to to various

2373

01:30:08,629 --> 01:30:07,840

surpet nights uh in the course of this

2374

01:30:10,629 --> 01:30:08,639

talk

2375

01:30:13,030 --> 01:30:10,639

uh further they're also significantly

2376

01:30:15,270 --> 01:30:13,040

easier to access and cheaper to access

2377

01:30:17,030 --> 01:30:15,280

than seafloor systems and so

2378

01:30:19,110 --> 01:30:17,040

uh some of what we've been able to do in

2379

01:30:20,950 --> 01:30:19,120

these continental surpatonites is to go

2380

01:30:23,030 --> 01:30:20,960

about and conduct

2381

01:30:24,629 --> 01:30:23,040

time series studies

2382

01:30:26,550 --> 01:30:24,639

or to

2383

01:30:31,189 --> 01:30:26,560

develop new methods to apply to some

2384

01:30:34,709 --> 01:30:32,870

all right so um

2385

01:30:36,470 --> 01:30:34,719

one of the uh

2386

01:30:38,229 --> 01:30:36,480

one of the major sites for uh

2387

01:30:40,229 --> 01:30:38,239

continental serpentinization that's been

2388

01:30:42,310 --> 01:30:40,239

studied over the past several years has

2389

01:30:44,229 --> 01:30:42,320

been the cedars in sonoma county

2390

01:30:45,990 --> 01:30:44,239

california this is a place where ken

2391

01:30:48,709 --> 01:30:46,000

nielsen's lab

2392

01:30:50,629 --> 01:30:48,719

as well as shino suzuki and penny morel

2393

01:30:53,350 --> 01:30:50,639

have all done some work

2394

01:30:54,870 --> 01:30:53,360

so this is a very uh extreme environment

2395

01:30:57,510 --> 01:30:54,880

characterized by

2396

01:30:59,830 --> 01:30:57,520

uh copious amounts of gases particularly

2397

01:31:02,310 --> 01:30:59,840

hydrogen methane very reducing

2398

01:31:04,149 --> 01:31:02,320

conditions

2399

01:31:04,870 --> 01:31:04,159

high ph groundwater

2400

01:31:07,030 --> 01:31:04,880

and

2401
01:31:09,669 --> 01:31:07,040
extensive travertine deposits shown in

2402
01:31:11,830 --> 01:31:09,679
the left-hand side of the slide so

2403
01:31:13,510 --> 01:31:11,840
really impressive carbonate deposits

2404
01:31:15,430 --> 01:31:13,520
associated with

2405
01:31:16,790 --> 01:31:15,440
circulation of sterpenizing fluids

2406
01:31:19,590 --> 01:31:16,800
through the system

2407
01:31:22,470 --> 01:31:19,600
and so uh shino and ken and others have

2408
01:31:24,149 --> 01:31:22,480
explored the microbiology of this system

2409
01:31:26,229 --> 01:31:24,159
and found that

2410
01:31:28,870 --> 01:31:26,239
the communities that inhabit relatively

2411
01:31:30,870 --> 01:31:28,880
shallow portions of the system perhaps

2412
01:31:32,229 --> 01:31:30,880
more influenced by mixing and shallow

2413
01:31:34,470 --> 01:31:32,239

groundwater

2414

01:31:37,030 --> 01:31:34,480
are of different communities than

2415

01:31:38,390 --> 01:31:37,040
those in deeper groundwater so

2416

01:31:40,950 --> 01:31:38,400
they see organisms like beta

2417

01:31:44,070 --> 01:31:40,960
proteobacteria commonly in the shallower

2418

01:31:47,430 --> 01:31:44,080
parts of the system at high ph and

2419

01:31:50,629 --> 01:31:47,440
organisms like chloroplaxy and candidate

2420

01:31:53,350 --> 01:31:50,639
division od1 in deeper groundwater uh

2421

01:31:56,950 --> 01:31:53,360
perhaps more representative of n member

2422

01:32:01,750 --> 01:31:59,510
my group and others uh including people

2423

01:32:04,790 --> 01:32:01,760
like don cartis uh torrey holler and tom

2424

01:32:06,709 --> 01:32:04,800
mccullum has done a lot of work uh at

2425

01:32:09,910 --> 01:32:06,719
what's known as the coast range ophillite

2426
01:32:10,950 --> 01:32:09,920
microbial observatory uh this is located

2427
01:32:12,709 --> 01:32:10,960
uh

2428
01:32:15,350 --> 01:32:12,719
you know a relatively short distance

2429
01:32:18,229 --> 01:32:15,360
away from the cedars uh in reality but

2430
01:32:20,629 --> 01:32:18,239
uh it's near lower lake california at

2431
01:32:23,189 --> 01:32:20,639
the mclaughlin natural reserve

2432
01:32:25,030 --> 01:32:23,199
and uh what's been great about this site

2433
01:32:26,870 --> 01:32:25,040
and in addition to it being at a field

2434
01:32:29,669 --> 01:32:26,880
station where we have access to a lab

2435
01:32:33,189 --> 01:32:29,679
and facilities is that we were able to

2436
01:32:36,950 --> 01:32:33,199
recover drill core from this location in

2437
01:32:39,750 --> 01:32:36,960
uh 2011 with support from the nei

2438
01:32:41,830 --> 01:32:39,760

and subsequently establish eight new

2439

01:32:44,709 --> 01:32:41,840

monitoring wells in the system to

2440

01:32:47,350 --> 01:32:44,719

conduct uh comparative experiments or

2441

01:32:49,430 --> 01:32:47,360

conduct experiments to compare

2442

01:32:51,590 --> 01:32:49,440

microbiology and geochemistry

2443

01:32:53,750 --> 01:32:51,600

geochemistry and hydrology within the

2444

01:32:55,510 --> 01:32:53,760

system and to learn something more about

2445

01:32:57,270 --> 01:32:55,520

the native populations in the

2446

01:32:59,590 --> 01:32:57,280

serpentinizing groundwater

2447

01:33:01,910 --> 01:32:59,600

so some of this work was published uh as

2448

01:33:05,030 --> 01:33:01,920

far as the operations was published in

2449

01:33:07,350 --> 01:33:05,040

2013 by don cardis in scientific

2450

01:33:09,510 --> 01:33:07,360

drilling

2451

01:33:10,310 --> 01:33:09,520

so here's an example of uh

2452

01:33:12,790 --> 01:33:10,320

of

2453

01:33:13,910 --> 01:33:12,800

mike kubo and katrina twing uh a couple

2454

01:33:16,629 --> 01:33:13,920

others uh

2455

01:33:18,390 --> 01:33:16,639

uh putting experiments down into one of

2456

01:33:19,189 --> 01:33:18,400

the wells at chromo

2457

01:33:21,030 --> 01:33:19,199

to

2458

01:33:24,070 --> 01:33:21,040

look at colonization of different

2459

01:33:25,350 --> 01:33:24,080

minerals within the groundwater as a

2460

01:33:27,830 --> 01:33:25,360

function of time

2461

01:33:29,910 --> 01:33:27,840

but just shows an example of the fact

2462

01:33:33,430 --> 01:33:29,920

that you can go out and manipulate these

2463

01:33:35,189 --> 01:33:33,440

systems and do experimental work

2464

01:33:36,709 --> 01:33:35,199

so there are challenges to these systems

2465

01:33:39,030 --> 01:33:36,719

as you may have already gained through

2466

01:33:39,990 --> 01:33:39,040

the last couple of talks so we have high

2467

01:33:42,470 --> 01:33:40,000

ph

2468

01:33:45,110 --> 01:33:42,480

uh low ea so

2469

01:33:46,390 --> 01:33:45,120

very oxidant poor environments uh in in

2470

01:33:47,990 --> 01:33:46,400

many cases

2471

01:33:50,950 --> 01:33:48,000

and the possibility for nutrient

2472

01:33:53,830 --> 01:33:50,960

limitation um so things like nitrogen

2473

01:33:55,910 --> 01:33:53,840

and phosphorus perhaps but also

2474

01:33:58,790 --> 01:33:55,920

the availability of dissolved inorganic

2475

01:34:00,629 --> 01:33:58,800

carbon and the possibility that

2476

01:34:02,149 --> 01:34:00,639

different carbon sources are necessary

2477

01:34:05,590 --> 01:34:02,159

for organisms

2478

01:34:07,189 --> 01:34:05,600

to be sustained in these environments

2479

01:34:10,149 --> 01:34:07,199

uh one of the

2480

01:34:12,229 --> 01:34:10,159

things that has been uh seen in both the

2481

01:34:13,270 --> 01:34:12,239

systems i described as well as elsewhere

2482

01:34:15,189 --> 01:34:13,280

is the

2483

01:34:18,229 --> 01:34:15,199

ubiquity of certain types of

2484

01:34:20,229 --> 01:34:18,239

microorganisms in these environments so

2485

01:34:22,950 --> 01:34:20,239

sheena suzuki published a really nice

2486

01:34:25,510 --> 01:34:22,960

paper uh isolating a new type of

2487

01:34:27,910 --> 01:34:25,520

organism called cerpenomonas

2488

01:34:29,590 --> 01:34:27,920

from the cedars she published this back

2489

01:34:32,470 --> 01:34:29,600

in 2014

2490

01:34:34,870 --> 01:34:32,480

but very similar

2491

01:34:37,750 --> 01:34:34,880

strains or similar sequences related to

2492

01:34:38,950 --> 01:34:37,760

streptomonomas have been observed in

2493

01:34:40,790 --> 01:34:38,960

high ph

2494

01:34:43,030 --> 01:34:40,800

environments around the world places

2495

01:34:45,510 --> 01:34:43,040

like the tablelands in canada

2496

01:34:46,790 --> 01:34:45,520

like deep

2497

01:34:50,149 --> 01:34:46,800

groundwater is influenced by

2498

01:34:53,350 --> 01:34:50,159

serpentinization in finland at odocompo

2499

01:34:55,669 --> 01:34:53,360

uh even in places like uh like a

2500

01:34:58,950 --> 01:34:55,679

contaminated steel slag

2501

01:35:02,070 --> 01:34:58,960

site uh industrial waste location in in

2502

01:35:04,229 --> 01:35:02,080

the midwest uh work that uh was swingly

2503

01:35:06,790 --> 01:35:04,239

and others are doing so this this is a

2504

01:35:09,030 --> 01:35:06,800

very ubiquitous uh species of organism

2505

01:35:11,189 --> 01:35:09,040

uh in the beta pretty bacteria that's

2506

01:35:12,950 --> 01:35:11,199

been found at all these sites

2507

01:35:16,070 --> 01:35:12,960

and uh what's really interesting about

2508

01:35:17,910 --> 01:35:16,080

this is is not only its ability to stand

2509

01:35:19,669 --> 01:35:17,920

some of these extreme conditions but its

2510

01:35:21,990 --> 01:35:19,679

ability to utilize diverse carbon

2511

01:35:23,910 --> 01:35:22,000

sources uh so one of the one of the

2512

01:35:25,990 --> 01:35:23,920

fascinating aspects of this organism is

2513

01:35:26,790 --> 01:35:26,000

that connect it's actually been shown to

2514

01:35:28,790 --> 01:35:26,800

use

2515

01:35:35,270 --> 01:35:28,800

solid calcium carbonate as a source of

2516

01:35:40,790 --> 01:35:38,229

others including my laboratory and

2517

01:35:42,790 --> 01:35:40,800

billy brazelton and several other groups

2518

01:35:45,030 --> 01:35:42,800

have taken meta genomics approaches to

2519

01:35:46,950 --> 01:35:45,040

surprise hosted communities

2520

01:35:49,030 --> 01:35:46,960

so

2521

01:35:51,350 --> 01:35:49,040

in other words what this means is going

2522

01:35:53,990 --> 01:35:51,360

about extracting the genomic dna from

2523

01:35:56,870 --> 01:35:54,000

the natural communities in these systems

2524

01:36:00,070 --> 01:35:56,880

and studying the genetic content of of

2525

01:36:01,590 --> 01:36:00,080

their genomes to try to infer uh aspects

2526

01:36:03,669 --> 01:36:01,600

of their function and their functional

2527

01:36:05,990 --> 01:36:03,679

potential so some of this first work we

2528

01:36:09,590 --> 01:36:06,000

did in this regard was at the tablelands

2529

01:36:11,750 --> 01:36:09,600

published in 2012 by braceleton

2530

01:36:13,990 --> 01:36:11,760

identifying genes involved in hydrogen

2531

01:36:16,870 --> 01:36:14,000

oxidation and carbon monoxide

2532

01:36:18,149 --> 01:36:16,880

utilization from the metagenome in that

2533

01:36:19,430 --> 01:36:18,159

context

2534

01:36:22,149 --> 01:36:19,440

and then

2535

01:36:23,750 --> 01:36:22,159

recently we've looked at a series of

2536

01:36:25,189 --> 01:36:23,760

metagenomes that we have from the

2537

01:36:28,790 --> 01:36:25,199

chromosite

2538

01:36:30,629 --> 01:36:28,800

and various types of catabolic

2539

01:36:31,750 --> 01:36:30,639

or genes related to various catabolic

2540

01:36:34,229 --> 01:36:31,760

reactions

2541

01:36:36,470 --> 01:36:34,239

including hydrogen oxidation

2542

01:36:39,750 --> 01:36:36,480

carbon carbon monoxide

2543

01:36:42,390 --> 01:36:39,760

oxidation assimilation and sulfur uh

2544

01:36:44,390 --> 01:36:42,400

metabolisms and and map those out uh

2545

01:36:46,390 --> 01:36:44,400

versus ph at the chromo wells and so

2546

01:36:48,709 --> 01:36:46,400

that's what you see in the lower right

2547

01:36:51,590 --> 01:36:48,719

hand of this figure is is the diversity

2548

01:36:55,189 --> 01:36:51,600

of of genes and functions uh in some of

2549

01:36:57,270 --> 01:36:55,199

the wells uh at very high ph so uh

2550

01:36:59,750 --> 01:36:57,280

supporting this idea that hydrogen

2551
01:37:02,229 --> 01:36:59,760
carbon monoxide are are important and

2552
01:37:04,149 --> 01:37:02,239
even potentially acetogenesis which is

2553
01:37:09,109 --> 01:37:04,159
why i was asking everett about this uh

2554
01:37:12,790 --> 01:37:11,030
all right but uh

2555
01:37:15,030 --> 01:37:12,800
but so again these are these are just a

2556
01:37:17,590 --> 01:37:15,040
few examples of ophiolites that are out

2557
01:37:19,990 --> 01:37:17,600
there uh everett's mentioned uh the

2558
01:37:22,470 --> 01:37:20,000
samael ophelite in oman this world's

2559
01:37:24,470 --> 01:37:22,480
largest ophelia exposure where you have

2560
01:37:26,950 --> 01:37:24,480
exposed sections of oceanic crust and

2561
01:37:29,750 --> 01:37:26,960
upper mantle and there's ongoing

2562
01:37:32,390 --> 01:37:29,760
drilling project in oman including many

2563
01:37:34,550 --> 01:37:32,400

members of the nai rpl team

2564

01:37:36,470 --> 01:37:34,560

like alexis's group

2565

01:37:39,350 --> 01:37:36,480

to take part and participate in this

2566

01:37:40,830 --> 01:37:39,360

project and study both the organisms in

2567

01:37:43,109 --> 01:37:40,840

the groundwater as well as the

2568

01:37:44,550 --> 01:37:43,119

biogeochemistry of core samples coming

2569

01:37:46,950 --> 01:37:44,560

up from very deep

2570

01:37:48,470 --> 01:37:46,960

within the system

2571

01:37:51,350 --> 01:37:48,480

there's also a really interesting site

2572

01:37:54,070 --> 01:37:51,360

that's been studied lately in the santa

2573

01:37:56,149 --> 01:37:54,080

elena ophelia in costa rica which is a

2574

01:37:58,470 --> 01:37:56,159

tropical stratifying environment

2575

01:38:01,270 --> 01:37:58,480

characterized by very extreme seasonal

2576

01:38:02,790 --> 01:38:01,280

wet dry cycles so short residence times

2577

01:38:04,310 --> 01:38:02,800

rapid recharge

2578

01:38:06,790 --> 01:38:04,320

and one of the things that we've

2579

01:38:09,109 --> 01:38:06,800

observed through sequence based studies

2580

01:38:11,350 --> 01:38:09,119

of this system are that there are

2581

01:38:13,830 --> 01:38:11,360

relatively abundant methanogens uh in

2582

01:38:17,270 --> 01:38:13,840

that environment and so perhaps there's

2583

01:38:19,669 --> 01:38:17,280

a link between these shorts recharge

2584

01:38:21,430 --> 01:38:19,679

events and the possibility for

2585

01:38:22,790 --> 01:38:21,440

biological methanogenesis in these

2586

01:38:24,229 --> 01:38:22,800

systems so it's

2587

01:38:25,590 --> 01:38:24,239

in the context of what we've talked

2588

01:38:27,590 --> 01:38:25,600

about over the past couple of

2589

01:38:30,629 --> 01:38:27,600

presentations that that's a really

2590

01:38:36,470 --> 01:38:30,639

interesting uh variation on on this

2591

01:38:39,590 --> 01:38:37,350

so

2592

01:38:41,750 --> 01:38:39,600

you know in terms of astrobiology what's

2593

01:38:43,350 --> 01:38:41,760

what are some of the interesting things

2594

01:38:45,270 --> 01:38:43,360

that have come out of this work well

2595

01:38:47,510 --> 01:38:45,280

we've we've

2596

01:38:49,510 --> 01:38:47,520

learned something about adaptations to

2597

01:38:52,390 --> 01:38:49,520

high ph environments to surpatinizing

2598

01:38:54,070 --> 01:38:52,400

environments uh high ph in itself does

2599

01:38:55,990 --> 01:38:54,080

not appear to be an impediment to life

2600

01:38:57,669 --> 01:38:56,000

in these systems

2601

01:38:59,590 --> 01:38:57,679

but they're because

2602

01:39:02,310 --> 01:38:59,600

but there is a relatively few tax that

2603

01:39:03,990 --> 01:39:02,320

we see relatively low diversity uh that

2604

01:39:06,310 --> 01:39:04,000

are common in global strapatinizing

2605

01:39:07,590 --> 01:39:06,320

systems at least from the reports that

2606

01:39:10,149 --> 01:39:07,600

we're aware of

2607

01:39:11,990 --> 01:39:10,159

uh it also seems that uh growth of some

2608

01:39:14,070 --> 01:39:12,000

of these organisms is stimulated by

2609

01:39:16,470 --> 01:39:14,080

fluid flow and mixing that

2610

01:39:20,709 --> 01:39:16,480

perhaps this brings in the nutrients or

2611

01:39:22,950 --> 01:39:20,719

the chemical disease that's necessary to

2612

01:39:25,109 --> 01:39:22,960

really cause uh

2613

01:39:28,070 --> 01:39:25,119

sustained growth and blooms of organisms

2614

01:39:29,590 --> 01:39:28,080

in the serpentinizing systems

2615

01:39:31,750 --> 01:39:29,600

second point is that methanogenic

2616

01:39:33,910 --> 01:39:31,760

archaea are surprisingly absent in many

2617

01:39:36,790 --> 01:39:33,920

of these continental circanites does

2618

01:39:39,189 --> 01:39:36,800

this mean that there's a ph limitation

2619

01:39:41,030 --> 01:39:39,199

competition with acetogens or other

2620

01:39:42,149 --> 01:39:41,040

factors limiting their growth i think

2621

01:39:43,910 --> 01:39:42,159

that's still

2622

01:39:45,030 --> 01:39:43,920

a work in progress until we get more

2623

01:39:47,030 --> 01:39:45,040

information

2624

01:39:50,310 --> 01:39:47,040

about uh the physiology of these

2625

01:39:52,390 --> 01:39:50,320

organisms but uh but it's it's really

2626

01:39:54,229 --> 01:39:52,400

been hit or miss in terms of seeing

2627

01:39:55,669 --> 01:39:54,239

archaea in many of these types of

2628

01:39:57,270 --> 01:39:55,679

systems

2629

01:39:59,830 --> 01:39:57,280

and then what sort of strategies do

2630

01:40:03,030 --> 01:39:59,840

organisms have to to gain nutrients

2631

01:40:04,950 --> 01:40:03,040

toxins particularly carbon uh

2632

01:40:06,950 --> 01:40:04,960

species in some of these systems there's

2633

01:40:08,790 --> 01:40:06,960

some evidence that organisms are

2634

01:40:10,790 --> 01:40:08,800

fermenting organic acids in some of

2635

01:40:13,030 --> 01:40:10,800

these environments and again are those

2636

01:40:15,590 --> 01:40:13,040

organic acids derived from

2637

01:40:17,750 --> 01:40:15,600

sedimentary inputs from from preformed

2638

01:40:20,149 --> 01:40:17,760

organic matter or from a biogenic

2639

01:40:22,870 --> 01:40:20,159

organic matter these are all questions

2640

01:40:25,030 --> 01:40:22,880

that are still out there

2641

01:40:26,950 --> 01:40:25,040

um a second interesting thing that's

2642

01:40:29,189 --> 01:40:26,960

come about is for many years people have

2643

01:40:31,750 --> 01:40:29,199

talked about serpentinites and spreading

2644

01:40:33,669 --> 01:40:31,760

icing systems as places that were

2645

01:40:35,350 --> 01:40:33,679

likely quite common geologically on the

2646

01:40:38,550 --> 01:40:35,360

early earth

2647

01:40:40,870 --> 01:40:38,560

and that perhaps sustained some of the

2648

01:40:42,870 --> 01:40:40,880

chemical reactions and important in

2649

01:40:45,109 --> 01:40:42,880

prebiotic chemistry

2650

01:40:47,270 --> 01:40:45,119

places like the lost city type of system

2651
01:40:48,790 --> 01:40:47,280
where you have thermal and chemical

2652
01:40:51,189 --> 01:40:48,800
gradients

2653
01:40:54,070 --> 01:40:51,199
and compartments uh facilitating the

2654
01:40:56,070 --> 01:40:54,080
origins in the early evolution of life

2655
01:40:58,629 --> 01:40:56,080
at the same time there was a a paper

2656
01:40:59,510 --> 01:40:58,639
recently uh this past summer that looked

2657
01:41:00,229 --> 01:40:59,520
at

2658
01:41:02,310 --> 01:41:00,239
the

2659
01:41:04,470 --> 01:41:02,320
phylogenetic analyses of published

2660
01:41:06,910 --> 01:41:04,480
genomes and microorganisms not just

2661
01:41:08,709 --> 01:41:06,920
extremophiles not just

2662
01:41:10,950 --> 01:41:08,719
serpentinite-derived organisms but

2663
01:41:12,790 --> 01:41:10,960

published genomes in general to try to

2664

01:41:14,990 --> 01:41:12,800

boil down what some of the

2665

01:41:17,430 --> 01:41:15,000

common

2666

01:41:19,109 --> 01:41:17,440

physiological functions were of these

2667

01:41:21,189 --> 01:41:19,119

organisms and a lot of the genes that

2668

01:41:23,109 --> 01:41:21,199

came out of this analysis by bill

2669

01:41:25,030 --> 01:41:23,119

martin's group

2670

01:41:26,790 --> 01:41:25,040

showed that

2671

01:41:29,030 --> 01:41:26,800

many of the genes that were observed

2672

01:41:31,030 --> 01:41:29,040

were also very parallel to sorts of

2673

01:41:33,669 --> 01:41:31,040

things we're seeing in modern

2674

01:41:35,750 --> 01:41:33,679

serpentinizing systems so i think from

2675

01:41:37,510 --> 01:41:35,760

both the bottom-up and top-down

2676

01:41:39,830 --> 01:41:37,520

sorts of approaches it's it's kind of

2677

01:41:44,629 --> 01:41:39,840

converging upon these stropatinizing

2678

01:41:49,350 --> 01:41:47,350

uh and then thirdly uh

2679

01:41:51,510 --> 01:41:49,360

just pointing out that biosignature

2680

01:41:53,030 --> 01:41:51,520

detection is both uh

2681

01:41:55,590 --> 01:41:53,040

is both very challenging in these

2682

01:41:57,189 --> 01:41:55,600

systems but also uh could be very

2683

01:42:00,149 --> 01:41:57,199

informative and particularly in

2684

01:42:01,990 --> 01:42:00,159

relationship to how we might conduct the

2685

01:42:03,030 --> 01:42:02,000

same sort of analyses on other planets

2686

01:42:05,030 --> 01:42:03,040

and moons

2687

01:42:07,109 --> 01:42:05,040

so generally you have very low cell

2688

01:42:09,030 --> 01:42:07,119

numbers in a lot of serpentinites uh

2689

01:42:12,709 --> 01:42:09,040

places like the theaters have

2690

01:42:14,870 --> 01:42:12,719

are very very low cell numbers in them

2691

01:42:16,470 --> 01:42:14,880

sometimes in the range of 10 or 100

2692

01:42:18,149 --> 01:42:16,480

cells per milliliter

2693

01:42:20,390 --> 01:42:18,159

you have overlapping microbial

2694

01:42:22,950 --> 01:42:20,400

thermogenic and abiogenic sources of

2695

01:42:25,510 --> 01:42:22,960

some of the compounds including methane

2696

01:42:28,790 --> 01:42:25,520

so to figure out how to decipher those

2697

01:42:30,390 --> 01:42:28,800

various sources how to how to tell uh

2698

01:42:32,229 --> 01:42:30,400

different sources apart from one another

2699

01:42:34,950 --> 01:42:32,239

and what uh

2700

01:42:36,550 --> 01:42:34,960

what mechanisms are being used

2701

01:42:39,189 --> 01:42:36,560

um

2702

01:42:41,750 --> 01:42:39,199

on the left here uh

2703

01:42:44,149 --> 01:42:41,760

is some work recently out of shuheiono's

2704

01:42:45,590 --> 01:42:44,159

lab at mit this is david

2705

01:42:47,669 --> 01:42:45,600

wang's paper

2706

01:42:49,510 --> 01:42:47,679

and showing some of the different

2707

01:42:52,550 --> 01:42:49,520

methane topolog values that were

2708

01:42:54,550 --> 01:42:52,560

obtained from methane samples at both

2709

01:42:58,310 --> 01:42:54,560

the chromosite and the cedars showing

2710

01:43:00,229 --> 01:42:58,320

quite different uh values depending upon

2711

01:43:02,070 --> 01:43:00,239

yeah let me figure out where the arrow

2712

01:43:03,430 --> 01:43:02,080

is here

2713

01:43:04,390 --> 01:43:03,440

okay

2714

01:43:05,430 --> 01:43:04,400

so the

2715

01:43:07,750 --> 01:43:05,440

the

2716

01:43:09,430 --> 01:43:07,760

cedars is right here

2717

01:43:11,270 --> 01:43:09,440

but i'm moving this around maybe that's

2718

01:43:12,709 --> 01:43:11,280

not worthwhile

2719

01:43:14,709 --> 01:43:12,719

well in any case

2720

01:43:15,990 --> 01:43:14,719

uh you're seeing a system

2721

01:43:17,270 --> 01:43:16,000

sorry to interrupt if you want to just

2722

01:43:19,510 --> 01:43:17,280

click on the slide where you want the

2723

01:43:21,430 --> 01:43:19,520

error to go it'll behave a little nicer

2724

01:43:23,510 --> 01:43:21,440

i see okay

2725

01:43:25,590 --> 01:43:23,520

well any case the the methane isotope

2726

01:43:27,430 --> 01:43:25,600

log values of the seeders which is where

2727

01:43:30,149 --> 01:43:27,440

my arrow currently is

2728

01:43:32,470 --> 01:43:30,159

versus chromo uh

2729

01:43:33,510 --> 01:43:32,480

and i switched slides

2730

01:43:35,270 --> 01:43:33,520

uh

2731

01:43:37,669 --> 01:43:35,280

any case um

2732

01:43:39,750 --> 01:43:37,679

are quite different uh

2733

01:43:41,030 --> 01:43:39,760

suggesting different contributions of

2734

01:43:43,990 --> 01:43:41,040

either

2735

01:43:46,950 --> 01:43:44,000

microbial thermogenic or abiogenic

2736

01:43:48,709 --> 01:43:46,960

sources are of methane

2737

01:43:51,109 --> 01:43:48,719

thank you xuhay for piping in there with

2738

01:43:52,629 --> 01:43:51,119

some information about which is which

2739

01:43:55,189 --> 01:43:52,639

i appreciate it

2740

01:43:57,590 --> 01:43:55,199

um so various sources of methane

2741

01:43:59,510 --> 01:43:57,600

contributing to the the isotope log

2742

01:44:01,590 --> 01:43:59,520

signatures in these settings

2743

01:44:03,350 --> 01:44:01,600

also there's a potential look at some

2744

01:44:05,109 --> 01:44:03,360

different dissolved organic compounds or

2745

01:44:07,990 --> 01:44:05,119

metabolites in these systems perhaps

2746

01:44:09,030 --> 01:44:08,000

things like organic sulfur compounds or

2747

01:44:11,270 --> 01:44:09,040

other

2748

01:44:13,510 --> 01:44:11,280

organic acids would be worthwhile to

2749

01:44:15,510 --> 01:44:13,520

investigate in terms of biosignature

2750

01:44:17,830 --> 01:44:15,520

detection and continental

2751
01:44:19,189 --> 01:44:17,840
uh serpentinites provide another

2752
01:44:20,709 --> 01:44:19,199
environment that we could look at these

2753
01:44:22,310 --> 01:44:20,719
sorts of effects

2754
01:44:24,149 --> 01:44:22,320
and then finally i would say that

2755
01:44:25,910 --> 01:44:24,159
consideration of seasonal or episodic

2756
01:44:27,109 --> 01:44:25,920
effects are also important so to

2757
01:44:29,189 --> 01:44:27,119
understand

2758
01:44:30,709 --> 01:44:29,199
uh issues related to

2759
01:44:33,270 --> 01:44:30,719
uh you know

2760
01:44:35,430 --> 01:44:33,280
fluid recharge fluid

2761
01:44:37,750 --> 01:44:35,440
efflux from these continental springs

2762
01:44:40,149 --> 01:44:37,760
and how does my parallel things we

2763
01:44:41,830 --> 01:44:40,159

observe on places like mars

2764

01:44:44,709 --> 01:44:41,840

would also be an interesting area of

2765

01:44:46,390 --> 01:44:44,719

study the temporal aspect

2766

01:44:48,790 --> 01:44:46,400

and then finally i just wanted to point

2767

01:44:50,870 --> 01:44:48,800

out that serpent that surprising

2768

01:44:52,950 --> 01:44:50,880

ophiolites are not the only sites of

2769

01:44:53,910 --> 01:44:52,960

ongoing serpentinization that there are

2770

01:44:56,149 --> 01:44:53,920

actually

2771

01:44:58,470 --> 01:44:56,159

um ultramafic intrusions in various

2772

01:45:00,070 --> 01:44:58,480

settings that may provide an interesting

2773

01:45:02,870 --> 01:45:00,080

uh comparison

2774

01:45:05,189 --> 01:45:02,880

to some of these uh paleo seafloor

2775

01:45:08,229 --> 01:45:05,199

that's being serpentinized so places

2776

01:45:09,669 --> 01:45:08,239

like the quebec david uh

2777

01:45:11,669 --> 01:45:09,679

serpentinite

2778

01:45:14,870 --> 01:45:11,679

influence wells in portugal that igor

2779

01:45:17,510 --> 01:45:14,880

thiago in portugal is looking at

2780

01:45:19,990 --> 01:45:17,520

have in some cases very similar

2781

01:45:22,550 --> 01:45:20,000

uh characteristics uh microbiologically

2782

01:45:25,270 --> 01:45:22,560

to what we observe in the ophelites so

2783

01:45:27,669 --> 01:45:25,280

uh abundant clostridium beta pretty

2784

01:45:29,910 --> 01:45:27,679

bacteria in other cases these can be

2785

01:45:32,470 --> 01:45:29,920

very stagnant uh sorts of environments

2786

01:45:34,790 --> 01:45:32,480

so so less influence of surface

2787

01:45:36,149 --> 01:45:34,800

groundwater and recharge

2788

01:45:37,189 --> 01:45:36,159

another site that's been looked at

2789

01:45:38,629 --> 01:45:37,199

recently

2790

01:45:41,109 --> 01:45:38,639

in collaboration

2791

01:45:43,430 --> 01:45:41,119

uh between my lab and barb sherwood

2792

01:45:45,030 --> 01:45:43,440

lawler up in toronto is looking at

2793

01:45:46,310 --> 01:45:45,040

serpentinizing kimber lights up in

2794

01:45:48,390 --> 01:45:46,320

kirkland lake

2795

01:45:49,830 --> 01:45:48,400

in ontario and

2796

01:45:52,149 --> 01:45:49,840

where you have

2797

01:45:54,470 --> 01:45:52,159

these deep ultramafic rocks coming near

2798

01:45:57,830 --> 01:45:54,480

the surface completely in a different

2799

01:46:00,070 --> 01:45:57,840

geographic setting from the

2800

01:46:02,229 --> 01:46:00,080

with uh some interesting parallels and

2801
01:46:03,270 --> 01:46:02,239
some interesting contrast to what's been

2802
01:46:05,270 --> 01:46:03,280
observed

2803
01:46:06,950 --> 01:46:05,280
so i think i'll leave it at that and

2804
01:46:08,790 --> 01:46:06,960
hopefully have a chance to answer some

2805
01:46:11,270 --> 01:46:08,800
questions related to this and i hope

2806
01:46:12,790 --> 01:46:11,280
it's given you a flavor of

2807
01:46:14,629 --> 01:46:12,800
what we've seen in some of these systems

2808
01:46:17,830 --> 01:46:14,639
and leads well into what beth will be

2809
01:46:22,070 --> 01:46:20,629
great thanks matt i think uh ava asked a

2810
01:46:24,310 --> 01:46:22,080
good question that would be good to

2811
01:46:25,430 --> 01:46:24,320
start with which is that alkaline lakes

2812
01:46:26,870 --> 01:46:25,440
are some of the most productive

2813
01:46:28,790 --> 01:46:26,880

ecosystems on earth why are

2814

01:46:29,830 --> 01:46:28,800

serpentinizing settings so much less

2815

01:46:31,510 --> 01:46:29,840

productive

2816

01:46:32,790 --> 01:46:31,520

and perhaps as part of your answer you

2817

01:46:36,390 --> 01:46:32,800

could give us

2818

01:46:39,430 --> 01:46:36,400

a brief explanation for why high ph is a

2819

01:46:42,070 --> 01:46:39,440

challenge to biology

2820

01:46:43,750 --> 01:46:42,080

yeah i mean i i think this is still a

2821

01:46:45,669 --> 01:46:43,760

work in progress but

2822

01:46:47,750 --> 01:46:45,679

uh high ph uh

2823

01:46:50,070 --> 01:46:47,760

is a challenge to bio biology at least

2824

01:46:53,270 --> 01:46:50,080

uh from what we know in the literature

2825

01:46:55,590 --> 01:46:53,280

um because many organisms require proton

2826

01:46:58,310 --> 01:46:55,600

motive force to generate energy

2827

01:47:00,310 --> 01:46:58,320

to generate atp and so the fact that you

2828

01:47:02,709 --> 01:47:00,320

have uh

2829

01:47:04,709 --> 01:47:02,719

protons being extremely unstable in the

2830

01:47:06,870 --> 01:47:04,719

extracellular environment

2831

01:47:10,870 --> 01:47:06,880

is probably a first order challenge to

2832

01:47:13,910 --> 01:47:10,880

this whole uh situation um and so they

2833

01:47:16,550 --> 01:47:13,920

need to go to great efforts to to

2834

01:47:19,109 --> 01:47:16,560

generate some sort of force and

2835

01:47:21,030 --> 01:47:19,119

at least in alkaline light lakes in many

2836

01:47:23,510 --> 01:47:21,040

cases there is the potential to use

2837

01:47:26,950 --> 01:47:23,520

other ions as a source of uh generating

2838

01:47:28,629 --> 01:47:26,960

this this gradient whereas uh in many of

2839

01:47:30,950 --> 01:47:28,639

these tripenizing systems you're dealing

2840

01:47:33,109 --> 01:47:30,960

with very fresh water conditions

2841

01:47:37,430 --> 01:47:33,119

that are not

2842

01:47:39,350 --> 01:47:37,440

providing those ions for for uh

2843

01:47:40,390 --> 01:47:39,360

generation of the

2844

01:47:41,350 --> 01:47:40,400

those

2845

01:47:43,910 --> 01:47:41,360

gradients

2846

01:47:45,830 --> 01:47:43,920

but i also think just thinking back to

2847

01:47:46,950 --> 01:47:45,840

what i think it was everett was talking

2848

01:47:48,550 --> 01:47:46,960

about is

2849

01:47:50,790 --> 01:47:48,560

perhaps some of the chemistry we're

2850

01:47:52,870 --> 01:47:50,800

seeing is not so much because of some

2851
01:47:56,229 --> 01:47:52,880
active metabolism but it's because of

2852
01:47:57,270 --> 01:47:56,239
what's not being consumed perhaps

2853
01:48:00,629 --> 01:47:57,280
the

2854
01:48:01,990 --> 01:48:00,639
systems is leaving compounds like

2855
01:48:05,030 --> 01:48:02,000
ammonium

2856
01:48:07,990 --> 01:48:05,040
behind and so we also need to consider

2857
01:48:11,750 --> 01:48:08,000
that in terms of the context of

2858
01:48:14,310 --> 01:48:13,189
yeah thanks

2859
01:48:17,109 --> 01:48:14,320
for the answer

2860
01:48:18,950 --> 01:48:17,119
uh earlier beth orkut asked whether you

2861
01:48:20,950 --> 01:48:18,960
could elaborate on the mechanisms that

2862
01:48:23,990 --> 01:48:20,960
are being used to access carbon from

2863
01:48:27,350 --> 01:48:25,590

uh you know i

2864

01:48:29,350 --> 01:48:27,360

don't know much more about it than what

2865

01:48:32,550 --> 01:48:29,360

was published in shino's paper that they

2866

01:48:35,430 --> 01:48:32,560

provided some sort of uh fine-grained

2867

01:48:37,590 --> 01:48:35,440

suspension of calcium carbonate that

2868

01:48:38,950 --> 01:48:37,600

these organisms were able to

2869

01:48:40,550 --> 01:48:38,960

utilize

2870

01:48:42,629 --> 01:48:40,560

and it seemed like they were attached to

2871

01:48:43,830 --> 01:48:42,639

the particles from what i recall

2872

01:48:46,149 --> 01:48:43,840

uh so that there's some sort of

2873

01:48:47,430 --> 01:48:46,159

interaction between the solid surfaces

2874

01:48:50,629 --> 01:48:47,440

with the organisms and the solid

2875

01:48:52,310 --> 01:48:50,639

surfaces but in terms of the

2876

01:48:53,910 --> 01:48:52,320

you know fine scale mechanisms i'm not

2877

01:48:54,790 --> 01:48:53,920

entirely sure

2878

01:48:58,550 --> 01:48:54,800

although

2879

01:49:00,709 --> 01:48:58,560

annie typed in it looks like and uh

2880

01:49:04,229 --> 01:49:00,719

perhaps she has more insight into into

2881

01:49:09,430 --> 01:49:07,510

thanks and john asks whether we have a

2882

01:49:11,350 --> 01:49:09,440

sense as to what the bias signature

2883

01:49:13,109 --> 01:49:11,360

preservation potential of the carbonates

2884

01:49:16,629 --> 01:49:13,119

are do they preserve organics or

2885

01:49:19,350 --> 01:49:16,639

biogenic textures or structures

2886

01:49:20,950 --> 01:49:19,360

i mean i think even dating back to

2887

01:49:22,950 --> 01:49:20,960

what we saw in the lost city chimneys

2888

01:49:26,709 --> 01:49:22,960

many years ago

2889

01:49:29,030 --> 01:49:26,719

it certainly looks like the

2890

01:49:31,750 --> 01:49:29,040

the filaments and and the biofilm serve

2891

01:49:33,830 --> 01:49:31,760

as uh as a template for precipitation of

2892

01:49:36,709 --> 01:49:33,840

some of these uh

2893

01:49:38,709 --> 01:49:36,719

carbonate phases so uh that in itself

2894

01:49:41,030 --> 01:49:38,719

could be an interesting avenue to

2895

01:49:42,870 --> 01:49:41,040

explore in terms of uh biosignatures and

2896

01:49:44,870 --> 01:49:42,880

streptonizing systems

2897

01:49:48,229 --> 01:49:44,880

uh in terms of the

2898

01:49:49,430 --> 01:49:48,239

ability to preserve organics or biogenic

2899

01:49:52,149 --> 01:49:49,440

i guess

2900

01:49:53,430 --> 01:49:52,159

by organics is the main thing uh

2901

01:49:55,750 --> 01:49:53,440

um

2902

01:49:57,750 --> 01:49:55,760

i i don't know for sure whether whether

2903

01:49:59,669 --> 01:49:57,760

circanizing systems are more or less

2904

01:50:02,790 --> 01:49:59,679

prone to preserving organics than other

2905

01:50:04,550 --> 01:50:02,800

types of systems i would think that

2906

01:50:06,790 --> 01:50:04,560

organisms in these systems living

2907

01:50:09,109 --> 01:50:06,800

organisms because they're so

2908

01:50:12,070 --> 01:50:09,119

desperate for carbon

2909

01:50:13,750 --> 01:50:12,080

might have strategies to extract any

2910

01:50:14,790 --> 01:50:13,760

edible carbon out of some of these

2911

01:50:17,030 --> 01:50:14,800

organic

2912

01:50:22,229 --> 01:50:17,040

structures that are available but that's

2913

01:50:26,629 --> 01:50:24,390

and thank you annie for elaborating on

2914

01:50:27,990 --> 01:50:26,639

these issues in the chat window

2915

01:50:29,750 --> 01:50:28,000

that's what we want to use the chat one

2916

01:50:31,830 --> 01:50:29,760

before so cool

2917

01:50:33,990 --> 01:50:31,840

um maybe that's a good time to move on

2918

01:50:35,189 --> 01:50:34,000

to our fourth invited talk thank you

2919

01:50:41,030 --> 01:50:35,199

very much matt

2920

01:50:45,750 --> 01:50:44,229

so fourth invited talk of the day is

2921

01:50:48,310 --> 01:50:45,760

from benton workout

2922

01:50:51,270 --> 01:50:48,320

about drilling industrial nights go

2923

01:50:54,790 --> 01:50:52,870

okay beth you're the presenter now so if

2924

01:51:07,589 --> 01:50:54,800

you could start your webcam and take it

2925

01:51:07,599 --> 01:51:26,950

beth looks like you're still muted

2926

01:51:31,109 --> 01:51:28,870

beth you need the instructions for to

2927

01:51:32,390 --> 01:51:31,119

call

2928

01:51:35,430 --> 01:51:32,400

i'm gonna pull those up for you real

2929

01:51:37,430 --> 01:51:35,440

quick um so just follow the top set of

2930

01:51:39,189 --> 01:51:37,440

instructions so mute adobe connect and

2931

01:51:50,629 --> 01:51:39,199

then call the number you'll see on your

2932

01:51:53,430 --> 01:51:52,149

okay uh in the meantime bill are there

2933

01:51:54,870 --> 01:51:53,440

any other questions we didn't get to

2934

01:51:57,270 --> 01:51:54,880

maybe we could uh

2935

01:51:59,189 --> 01:51:57,280

address

2936

01:52:00,870 --> 01:51:59,199

uh no specific questions yet there's

2937

01:52:02,870 --> 01:52:00,880

still an ongoing discussion on the chat

2938

01:52:04,470 --> 01:52:02,880

window which is great

2939

01:52:06,790 --> 01:52:04,480

maybe now is a

2940

01:52:10,229 --> 01:52:06,800

good time to put out another call for

2941

01:52:11,990 --> 01:52:10,239

pop-up talks we're full for today but we

2942

01:52:14,310 --> 01:52:12,000

i believe we have openings for pop-up

2943

01:52:16,390 --> 01:52:14,320

talks tomorrow and the third day so

2944

01:52:17,589 --> 01:52:16,400

please send those slides

2945

01:52:19,350 --> 01:52:17,599

to mike

2946

01:52:26,470 --> 01:52:19,360

if you'd like to give a

2947

01:52:26,480 --> 01:52:30,870

hey everybody can you hear me

2948

01:52:40,229 --> 01:52:33,350

sorry i tried to unmute my phone and i

2949

01:52:44,149 --> 01:52:41,669

okay about these slides are coming back

2950

01:52:45,589 --> 01:52:44,159

up take it away whenever you're ready

2951
01:52:48,310 --> 01:52:45,599
okay great

2952
01:52:50,709 --> 01:52:48,320
uh well thank you to the organizers of

2953
01:52:52,310 --> 01:52:50,719
this workshop for inviting me um it's

2954
01:52:53,589 --> 01:52:52,320
been really fun to listen in on these

2955
01:52:55,830 --> 01:52:53,599
talks

2956
01:52:58,550 --> 01:52:55,840
and i'm excited to talk with you all

2957
01:53:00,550 --> 01:52:58,560
about some of the recent work we're

2958
01:53:02,629 --> 01:53:00,560
involved in trying to explore this

2959
01:53:04,950 --> 01:53:02,639
repetition that may or may not be

2960
01:53:06,470 --> 01:53:04,960
occurring in the subsurface in the area

2961
01:53:07,910 --> 01:53:06,480
of lost city

2962
01:53:09,270 --> 01:53:07,920
so for those of you who don't know me

2963
01:53:11,669 --> 01:53:09,280

i'm beth workout

2964

01:53:13,270 --> 01:53:11,679

scientist at the bigelow laboratory

2965

01:53:14,550 --> 01:53:13,280

and the work that i'll be talking about

2966

01:53:16,790 --> 01:53:14,560

is

2967

01:53:19,669 --> 01:53:16,800

related to an ocean drilling expedition

2968

01:53:21,270 --> 01:53:19,679

um so iodp is the logo up there

2969

01:53:22,629 --> 01:53:21,280

but there's also several partners

2970

01:53:24,310 --> 01:53:22,639

involved in this work

2971

01:53:27,270 --> 01:53:24,320

including

2972

01:53:29,189 --> 01:53:27,280

our nasa nai life underground project um

2973

01:53:30,790 --> 01:53:29,199

funding from cw and the urban

2974

01:53:31,830 --> 01:53:30,800

observatory

2975

01:53:33,430 --> 01:53:31,840

and so

2976

01:53:35,750 --> 01:53:33,440

um i want to talk to you today about

2977

01:53:38,709 --> 01:53:35,760

some of the challenges and fun things

2978

01:53:40,950 --> 01:53:38,719

that we're learning from this system so

2979

01:53:44,149 --> 01:53:40,960

let's see how this works okay

2980

01:53:45,589 --> 01:53:44,159

um so this is probably no surprise to

2981

01:53:47,270 --> 01:53:45,599

everybody um

2982

01:53:49,109 --> 01:53:47,280

participating in this workshop but i

2983

01:53:49,990 --> 01:53:49,119

just like to put it here to

2984

01:53:52,149 --> 01:53:50,000

um

2985

01:53:54,470 --> 01:53:52,159

remind myself why we're so excited about

2986

01:53:57,189 --> 01:53:54,480

this um and thinking about energy

2987

01:53:59,750 --> 01:53:57,199

sources or life that we could be looking

2988

01:54:01,990 --> 01:53:59,760

for in other environments um

2989

01:54:03,430 --> 01:54:02,000

that's kind of what got me excited about

2990

01:54:06,550 --> 01:54:03,440

this field way back when i was a student

2991

01:54:08,950 --> 01:54:06,560

and i'm still excited about it now

2992

01:54:11,510 --> 01:54:08,960

and as several others have already shown

2993

01:54:12,550 --> 01:54:11,520

and just to reiterate here to the team

2994

01:54:15,270 --> 01:54:12,560

um

2995

01:54:17,669 --> 01:54:15,280

you know we're looking at how the fluid

2996

01:54:19,430 --> 01:54:17,679

rock reactions occurring with these

2997

01:54:21,030 --> 01:54:19,440

minerals in the mantle

2998

01:54:24,390 --> 01:54:21,040

on mantle rocks

2999

01:54:26,790 --> 01:54:24,400

can lead to the formation of chemistry

3000

01:54:29,990 --> 01:54:26,800

and conditions that could support life

3001
01:54:32,310 --> 01:54:30,000
independent of photosynthesis

3002
01:54:34,629 --> 01:54:32,320
and

3003
01:54:37,189 --> 01:54:34,639
but also some of those the chemistry of

3004
01:54:38,790 --> 01:54:37,199
some of those reactions also leads to

3005
01:54:41,030 --> 01:54:38,800
challenges for life so we're trying to

3006
01:54:42,790 --> 01:54:41,040
tease that apart um and we really want

3007
01:54:44,870 --> 01:54:42,800
to get into the rocks where this

3008
01:54:47,510 --> 01:54:44,880
reactions may be occurring and not just

3009
01:54:50,070 --> 01:54:47,520
looking at the surface expression

3010
01:54:52,870 --> 01:54:50,080
of those processes and so as billy has

3011
01:54:54,709 --> 01:54:52,880
talked about and matt and susan um you

3012
01:54:56,709 --> 01:54:54,719
know the lost city vents the beautiful

3013
01:54:59,350 --> 01:54:56,719

vents there um where you have these

3014

01:55:00,950 --> 01:54:59,360

carbonate chimneys are giving us a mixed

3015

01:55:04,550 --> 01:55:00,960

signal of what's happening in the

3016

01:55:06,550 --> 01:55:04,560

subsurface and what's happening um

3017

01:55:09,350 --> 01:55:06,560

influenced by the seawater that's around

3018

01:55:10,870 --> 01:55:09,360

it but the motivation for the project

3019

01:55:12,550 --> 01:55:10,880

that i'll be talking about is to try to

3020

01:55:14,550 --> 01:55:12,560

get into the rocks where these reactions

3021

01:55:16,070 --> 01:55:14,560

may be occurring in the modern day

3022

01:55:18,149 --> 01:55:16,080

to see

3023

01:55:20,229 --> 01:55:18,159

what microbiology may look like in this

3024

01:55:21,669 --> 01:55:20,239

environment and how microbiology may

3025

01:55:25,430 --> 01:55:21,679

affect

3026

01:55:30,149 --> 01:55:28,390

so just to reorient you in case you um

3027

01:55:32,470 --> 01:55:30,159

are not familiar with where the atlantis

3028

01:55:35,350 --> 01:55:32,480

masses is or where bigelow is which is

3029

01:55:37,830 --> 01:55:35,360

where i'm located um we're working on

3030

01:55:39,990 --> 01:55:37,840

the western side of the mid-atlantic

3031

01:55:41,669 --> 01:55:40,000

bridge and to zoom in on that

3032

01:55:43,990 --> 01:55:41,679

environment and talk a little bit more

3033

01:55:46,070 --> 01:55:44,000

about how it was formed i'm not sure

3034

01:55:48,550 --> 01:55:46,080

where this black square came from up

3035

01:55:50,950 --> 01:55:48,560

here in the top left that's okay

3036

01:55:53,189 --> 01:55:50,960

to orient you in this bottom image north

3037

01:55:55,350 --> 01:55:53,199

is pointing towards the bottom right

3038

01:55:57,510 --> 01:55:55,360

hand corner

3039

01:55:58,950 --> 01:55:57,520

and the idea here is that as the plates

3040

01:55:59,750 --> 01:55:58,960

are pulling apart

3041

01:56:01,669 --> 01:55:59,760

you

3042

01:56:05,270 --> 01:56:01,679

process these tectonic processes that

3043

01:56:07,510 --> 01:56:05,280

led to the uplift of mantle rock

3044

01:56:09,510 --> 01:56:07,520

in this mountain that forms the atlantis

3045

01:56:11,270 --> 01:56:09,520

massive and there has been drilling

3046

01:56:16,070 --> 01:56:11,280

previously in the central dome of the

3047

01:56:17,830 --> 01:56:16,080

atlantis masses mainly recovering gabros

3048

01:56:19,990 --> 01:56:17,840

and the motivation for this recent

3049

01:56:21,589 --> 01:56:20,000

drilling expedition was to really go

3050

01:56:23,189 --> 01:56:21,599

into

3051

01:56:25,589 --> 01:56:23,199

yes this

3052

01:56:27,669 --> 01:56:25,599

southern end of the rift

3053

01:56:30,390 --> 01:56:27,679

the lost city vents are basically just

3054

01:56:32,790 --> 01:56:30,400

on the back side of this to get into

3055

01:56:35,430 --> 01:56:32,800

these rocks and to drill a transect

3056

01:56:38,229 --> 01:56:35,440

across this environment where

3057

01:56:40,950 --> 01:56:38,239

rocks on this end um were potentially

3058

01:56:42,629 --> 01:56:40,960

deeper in the crust but haven't been

3059

01:56:45,430 --> 01:56:42,639

exposed for the

3060

01:56:47,669 --> 01:56:45,440

shortest length of time at the sea floor

3061

01:56:49,109 --> 01:56:47,679

as opposed to rocks over here which

3062

01:56:51,109 --> 01:56:49,119

were shallower

3063

01:56:53,350 --> 01:56:51,119

and have been exposed for longer periods

3064

01:56:56,709 --> 01:56:53,360

of time and to go across this gradient

3065

01:56:59,510 --> 01:56:56,719

and collect rocks to see um

3066

01:57:01,669 --> 01:56:59,520

what processes may be occurring um

3067

01:57:03,350 --> 01:57:01,679

related to feminization

3068

01:57:05,350 --> 01:57:03,360

and so we went out and drilled this

3069

01:57:06,709 --> 01:57:05,360

expedition um

3070

01:57:10,229 --> 01:57:06,719

in

3071

01:57:11,830 --> 01:57:10,239

october 2015 through december 2015. and

3072

01:57:13,750 --> 01:57:11,840

typically with a drilling expedition you

3073

01:57:15,510 --> 01:57:13,760

would go out with a drill ship

3074

01:57:17,510 --> 01:57:15,520

and lower a giant drill pipe into the

3075

01:57:19,350 --> 01:57:17,520

seafloor and core into your

3076
01:57:21,510 --> 01:57:19,360
environment but that was not going to

3077
01:57:23,430 --> 01:57:21,520
work for the atlantis masses for

3078
01:57:25,109 --> 01:57:23,440
multiple reasons

3079
01:57:27,189 --> 01:57:25,119
it's relatively challenging to drill

3080
01:57:29,350 --> 01:57:27,199
right into rock at the sea floor which

3081
01:57:32,390 --> 01:57:29,360
we knew the environment would be like

3082
01:57:35,589 --> 01:57:32,400
based on submersible diets

3083
01:57:37,270 --> 01:57:35,599
but also there was a strong desire to

3084
01:57:39,990 --> 01:57:37,280
recover

3085
01:57:42,390 --> 01:57:40,000
this these shallow sequences um at the

3086
01:57:44,229 --> 01:57:42,400
very top of the atlantis massif where

3087
01:57:46,790 --> 01:57:44,239
these processes are going to occur and

3088
01:57:48,870 --> 01:57:46,800

with traditional drilling um

3089

01:57:50,550 --> 01:57:48,880

uh

3090

01:57:52,950 --> 01:57:50,560

like done with an ocean drilling vessel

3091

01:57:54,950 --> 01:57:52,960

you would usually get 10 to 20 recovery

3092

01:57:56,310 --> 01:57:54,960

if you're lucky and often the rocks are

3093

01:57:59,510 --> 01:57:56,320

very broken up

3094

01:58:01,750 --> 01:57:59,520

um and fractured and we wanted to use a

3095

01:58:04,229 --> 01:58:01,760

drilling platform that would allow us to

3096

01:58:07,189 --> 01:58:04,239

get very high recovery in these upper

3097

01:58:09,109 --> 01:58:07,199

carbonate cap sequences

3098

01:58:10,550 --> 01:58:09,119

and so

3099

01:58:14,310 --> 01:58:10,560

the

3100

01:58:17,189 --> 01:58:14,320

massey expedition was to use what's

3101
01:58:18,950 --> 01:58:17,199
called a seabed drill and so the idea

3102
01:58:21,750 --> 01:58:18,960
here is that you have a self-contained

3103
01:58:23,910 --> 01:58:21,760
drilling system here's a cartoon of a

3104
01:58:25,910 --> 01:58:23,920
person for scale

3105
01:58:27,910 --> 01:58:25,920
and this system would be

3106
01:58:29,270 --> 01:58:27,920
lowered down from a research vessel to

3107
01:58:31,510 --> 01:58:29,280
the sea floor

3108
01:58:32,950 --> 01:58:31,520
connected by an umbilical that runs

3109
01:58:34,709 --> 01:58:32,960
power

3110
01:58:36,550 --> 01:58:34,719
video etc

3111
01:58:39,830 --> 01:58:36,560
all the drilling is done in place all

3112
01:58:41,669 --> 01:58:39,840
the cores are collected into a magazine

3113
01:58:44,390 --> 01:58:41,679

and then the entire drill rig is brought

3114

01:58:45,669 --> 01:58:44,400

back onto the ship and just to show you

3115

01:58:48,310 --> 01:58:45,679

what this kind of looks like it's all

3116

01:58:51,030 --> 01:58:48,320

controlled from the little van um kind

3117

01:58:53,350 --> 01:58:51,040

of like driving a video game and

3118

01:58:55,350 --> 01:58:53,360

you can also see what the c4 looks like

3119

01:58:56,950 --> 01:58:55,360

which is actually very helpful in our

3120

01:58:59,350 --> 01:58:56,960

case because in some cases we could see

3121

01:59:02,390 --> 01:58:59,360

bubbles coming out of the sea floor as

3122

01:59:05,589 --> 01:59:02,400

our operations were occurring

3123

01:59:07,189 --> 01:59:05,599

um so there are several c drills that

3124

01:59:08,950 --> 01:59:07,199

exist that are used in industry and

3125

01:59:10,790 --> 01:59:08,960

there's also some that are more specific

3126
01:59:14,870 --> 01:59:10,800
for scientific research

3127
01:59:16,629 --> 01:59:14,880
um and so the two that we used um one is

3128
01:59:17,910 --> 01:59:16,639
for the called the amiibo drill it's

3129
01:59:19,350 --> 01:59:17,920
from germany

3130
01:59:21,510 --> 01:59:19,360
um from

3131
01:59:23,189 --> 01:59:21,520
bremen and the maram team and then

3132
01:59:25,589 --> 01:59:23,199
there's another rock drill that we used

3133
01:59:28,950 --> 01:59:25,599
called the rock drill 2 that's operated

3134
01:59:30,790 --> 01:59:28,960
by the british geological survey

3135
01:59:33,270 --> 01:59:30,800
and again the motivation for this was to

3136
01:59:35,109 --> 01:59:33,280
use these systems so that we could

3137
01:59:37,430 --> 01:59:35,119
get higher core recovery than would

3138
01:59:41,750 --> 01:59:37,440

traditionally be possible

3139

01:59:46,709 --> 01:59:45,109

we also wanted to soup up these systems

3140

01:59:48,310 --> 01:59:46,719

to do more than they had ever done

3141

01:59:49,430 --> 01:59:48,320

before so that we could really

3142

01:59:52,470 --> 01:59:49,440

understand

3143

01:59:54,790 --> 01:59:52,480

if surprising was occurring

3144

01:59:56,870 --> 01:59:54,800

and generating methane and hydrogen and

3145

01:59:58,950 --> 01:59:56,880

changes in redux chemistry

3146

02:00:00,790 --> 01:59:58,960

and so as part of this expedition there

3147

02:00:03,270 --> 02:00:00,800

were several technology developments

3148

02:00:05,750 --> 02:00:03,280

that our team was involved in to make

3149

02:00:07,910 --> 02:00:05,760

these drills um even more capable than

3150

02:00:09,350 --> 02:00:07,920

they already were in collecting courses

3151

02:00:11,189 --> 02:00:09,360

so one of those

3152

02:00:13,589 --> 02:00:11,199

was that we wanted to add the capacity

3153

02:00:15,990 --> 02:00:13,599

for collecting bottom water as well as

3154

02:00:17,990 --> 02:00:16,000

water that would be coming out of the

3155

02:00:21,589 --> 02:00:18,000

borehole as we're drilling so that we

3156

02:00:24,470 --> 02:00:21,599

could see changes in fluid chemistry

3157

02:00:26,790 --> 02:00:24,480

we added on several in-situ sensors that

3158

02:00:30,390 --> 02:00:26,800

would also be sampling

3159

02:00:32,709 --> 02:00:30,400

this environment as we're drilling

3160

02:00:34,070 --> 02:00:32,719

and allow us to sense things like

3161

02:00:36,550 --> 02:00:34,080

methane

3162

02:00:39,510 --> 02:00:36,560

redox conditions ph

3163

02:00:41,030 --> 02:00:39,520

and also dissolved oxygen conductivity

3164

02:00:42,709 --> 02:00:41,040

etc

3165

02:00:44,390 --> 02:00:42,719

so we designed a system that could

3166

02:00:46,790 --> 02:00:44,400

enable us to do that

3167

02:00:50,550 --> 02:00:46,800

we also designed a system that we could

3168

02:00:52,229 --> 02:00:50,560

mount onto the drills where

3169

02:00:54,070 --> 02:00:52,239

unlike a traditional drilling vessel

3170

02:00:55,830 --> 02:00:54,080

where as you're drilling you're pumping

3171

02:00:58,390 --> 02:00:55,840

down muds and things help with the

3172

02:01:00,550 --> 02:00:58,400

drilling process

3173

02:01:02,950 --> 02:01:00,560

since all of the drilling is done on the

3174

02:01:05,189 --> 02:01:02,960

seafloor self-contained we needed to

3175

02:01:07,270 --> 02:01:05,199

come up with a system for delivering

3176

02:01:08,629 --> 02:01:07,280

synthetic tracers

3177

02:01:10,790 --> 02:01:08,639

as we were drilling so that we could

3178

02:01:13,350 --> 02:01:10,800

assess the quality of the core material

3179

02:01:15,510 --> 02:01:13,360

we brought back for doing microbiome

3180

02:01:18,229 --> 02:01:15,520

biological analysis so we came up with a

3181

02:01:20,550 --> 02:01:18,239

small pump system to inject a synthetic

3182

02:01:23,430 --> 02:01:20,560

tracer during drilling

3183

02:01:25,750 --> 02:01:23,440

and showed that that worked quite well

3184

02:01:27,910 --> 02:01:25,760

and then finally one of the things that

3185

02:01:30,550 --> 02:01:27,920

we wanted to do was not just drill a

3186

02:01:33,189 --> 02:01:30,560

hole and collect core material and then

3187

02:01:35,830 --> 02:01:33,199

leave we wanted to be able to seal off

3188

02:01:37,669 --> 02:01:35,840

the holes that we drilled

3189

02:01:41,270 --> 02:01:37,679

instrumentation that would allow us to

3190

02:01:43,510 --> 02:01:41,280

come back with an rov or a submersible

3191

02:01:45,430 --> 02:01:43,520

and directly sample the fluids in these

3192

02:01:47,350 --> 02:01:45,440

boreholes because that fluid would give

3193

02:01:49,350 --> 02:01:47,360

us the best indication

3194

02:01:51,430 --> 02:01:49,360

of what the fluid chemistry is like in

3195

02:01:53,189 --> 02:01:51,440

these environments

3196

02:01:55,270 --> 02:01:53,199

whereas the water coming out during

3197

02:01:57,189 --> 02:01:55,280

drilling is highly mixed with seawater

3198

02:01:58,790 --> 02:01:57,199

during the drilling process so we also

3199

02:01:59,750 --> 02:01:58,800

came up with a system for these borehole

3200

02:02:01,270 --> 02:01:59,760

plugs

3201

02:02:04,229 --> 02:02:01,280

so i'm going to show you a little bit of

3202

02:02:06,070 --> 02:02:04,239

some of the data that came from

3203

02:02:07,830 --> 02:02:06,080

some of these

3204

02:02:09,830 --> 02:02:07,840

technology developments but there's more

3205

02:02:12,070 --> 02:02:09,840

information available in the preliminary

3206

02:02:14,310 --> 02:02:12,080

report about this expedition if you are

3207

02:02:15,830 --> 02:02:14,320

interested

3208

02:02:17,669 --> 02:02:15,840

just to kind of show you what this looks

3209

02:02:19,990 --> 02:02:17,679

like instead of just a cartoon version

3210

02:02:22,310 --> 02:02:20,000

this is an image from taken from some of

3211

02:02:23,750 --> 02:02:22,320

the cameras on the rock drill

3212

02:02:24,709 --> 02:02:23,760

one of the rock drills while we were

3213

02:02:27,189 --> 02:02:24,719

drilling

3214

02:02:28,870 --> 02:02:27,199

and it's showing here kind of in a

3215

02:02:31,430 --> 02:02:28,880

snapshot but if you can imagine this is

3216

02:02:34,310 --> 02:02:31,440

a video of

3217

02:02:37,350 --> 02:02:34,320

fluid coming out of the open borehole as

3218

02:02:39,270 --> 02:02:37,360

we're changing around drill pipe

3219

02:02:41,350 --> 02:02:39,280

showing that there was a advection

3220

02:02:43,750 --> 02:02:41,360

coming out of the system and so in

3221

02:02:46,470 --> 02:02:43,760

system boreholes like these is where we

3222

02:02:49,510 --> 02:02:46,480

would install these borehole plugs and

3223

02:02:51,350 --> 02:02:49,520

aim to go back in 2018 to collect

3224

02:02:54,950 --> 02:02:51,360

samples

3225

02:03:00,709 --> 02:02:56,149

so

3226
02:03:02,229 --> 02:03:00,719
drilled they have these wonderful site

3227
02:03:04,870 --> 02:03:02,239
names based on the ocean drilling

3228
02:03:05,830 --> 02:03:04,880
program naming system

3229
02:03:08,550 --> 02:03:05,840
and

3230
02:03:10,070 --> 02:03:08,560
one of the exciting things for us

3231
02:03:12,470 --> 02:03:10,080
is that

3232
02:03:14,390 --> 02:03:12,480
the team of scientists involved in doing

3233
02:03:16,629 --> 02:03:14,400
both the fluid chemistry as well as

3234
02:03:19,669 --> 02:03:16,639
collecting samples

3235
02:03:22,070 --> 02:03:19,679
of rocks from drilling we're able to see

3236
02:03:24,470 --> 02:03:22,080
that in some of the sites there were

3237
02:03:27,030 --> 02:03:24,480
elevated concentrations of methane and

3238
02:03:29,910 --> 02:03:27,040

also hydrogen in the waters that were

3239

02:03:31,510 --> 02:03:29,920

collected during the drilling process

3240

02:03:33,830 --> 02:03:31,520

and also in some of the rock samples

3241

02:03:36,550 --> 02:03:33,840

themselves so this indicates that there

3242

02:03:39,350 --> 02:03:36,560

are hot spots of methane and hydrogen

3243

02:03:41,669 --> 02:03:39,360

leaking out of the atlantis masses and

3244

02:03:43,430 --> 02:03:41,679

giving us an indication of

3245

02:03:45,750 --> 02:03:43,440

where hot spots of stabilization

3246

02:03:47,750 --> 02:03:45,760

processes may be

3247

02:03:49,589 --> 02:03:47,760

this is relatively new data there's a

3248

02:03:51,669 --> 02:03:49,599

lot more work to be done looking at

3249

02:03:54,470 --> 02:03:51,679

isotopes and things like that to figure

3250

02:03:56,790 --> 02:03:54,480

out where this methane and hydrogen may

3251
02:03:58,629 --> 02:03:56,800
be coming from but i just want to give

3252
02:04:01,030 --> 02:03:58,639
you a little taste of what we've found

3253
02:04:02,870 --> 02:04:01,040
so far

3254
02:04:04,870 --> 02:04:02,880
so some of the other outcomes and i'm

3255
02:04:07,510 --> 02:04:04,880
sorry it looks like the picture i had of

3256
02:04:08,709 --> 02:04:07,520
yuki morono doing cell counts didn't

3257
02:04:10,149 --> 02:04:08,719
show up

3258
02:04:12,149 --> 02:04:10,159
but some of our outcomes from the

3259
02:04:14,709 --> 02:04:12,159
expedition so far and again this is less

3260
02:04:16,950 --> 02:04:14,719
than a year old is that we got really

3261
02:04:20,069 --> 02:04:16,960
excellent recovery um although we didn't

3262
02:04:22,950 --> 02:04:20,079
get as deep as we would like of um

3263
02:04:25,189 --> 02:04:22,960

these carbonate cap uh sequences on the

3264

02:04:27,030 --> 02:04:25,199

top of the redness masses and so the

3265

02:04:28,709 --> 02:04:27,040

petrologists that are part of our team

3266

02:04:30,629 --> 02:04:28,719

are very excited to

3267

02:04:31,750 --> 02:04:30,639

piece this all apart and

3268

02:04:33,510 --> 02:04:31,760

um

3269

02:04:35,750 --> 02:04:33,520

learn about the processes of

3270

02:04:38,629 --> 02:04:35,760

surfatization and fluid rock reactions

3271

02:04:40,470 --> 02:04:38,639

and alteration so stay tuned for that

3272

02:04:42,950 --> 02:04:40,480

we were able to demonstrate on this

3273

02:04:44,950 --> 02:04:42,960

expedition

3274

02:04:47,350 --> 02:04:44,960

that these new technologies for

3275

02:04:48,870 --> 02:04:47,360

assessing the quality of our samples

3276

02:04:50,390 --> 02:04:48,880

seem to work really well and i think

3277

02:04:53,030 --> 02:04:50,400

these are important

3278

02:04:55,830 --> 02:04:53,040

topics to consider for designing systems

3279

02:04:57,430 --> 02:04:55,840

to go to other planets and how we assess

3280

02:04:58,550 --> 02:04:57,440

the quality of those materials that are

3281

02:05:01,270 --> 02:04:58,560

brought back

3282

02:05:04,310 --> 02:05:01,280

um because of doing all this work to

3283

02:05:06,069 --> 02:05:04,320

show that we can limit contamination um

3284

02:05:07,669 --> 02:05:06,079

we also can show that we really

3285

02:05:10,229 --> 02:05:07,679

collected some great samples for doing

3286

02:05:12,069 --> 02:05:10,239

microbiological analyses and several of

3287

02:05:14,550 --> 02:05:12,079

the scientists participating in this

3288

02:05:16,229 --> 02:05:14,560

workshop um are involved in doing some

3289

02:05:19,830 --> 02:05:16,239

of those experiments to look at which

3290

02:05:21,830 --> 02:05:19,840

microbial processes are occurring

3291

02:05:23,830 --> 02:05:21,840

and

3292

02:05:25,109 --> 02:05:23,840

how they might be affecting fluid rock

3293

02:05:27,189 --> 02:05:25,119

reactions

3294

02:05:28,950 --> 02:05:27,199

and as i mentioned before we also see

3295

02:05:29,990 --> 02:05:28,960

this evidence of methane and hydrogen

3296

02:05:31,510 --> 02:05:30,000

leakage

3297

02:05:34,550 --> 02:05:31,520

across the massif

3298

02:05:37,030 --> 02:05:34,560

um and that needs to be connected with

3299

02:05:37,990 --> 02:05:37,040

these um

3300

02:05:39,750 --> 02:05:38,000

uh

3301

02:05:41,189 --> 02:05:39,760

more detailed analyses of the rock cores

3302

02:05:42,950 --> 02:05:41,199

to try to figure out if the

3303

02:05:44,550 --> 02:05:42,960

serpentinization processes are occurring

3304

02:05:48,550 --> 02:05:44,560

in the modern environment or if there

3305

02:05:50,790 --> 02:05:48,560

are indications of past activity

3306

02:05:52,790 --> 02:05:50,800

and so as i've alluded to there are many

3307

02:05:55,189 --> 02:05:52,800

many many scientists involved in this

3308

02:05:56,950 --> 02:05:55,199

expedition all of this work is ongoing

3309

02:05:59,910 --> 02:05:56,960

we're actually still in the moratorium

3310

02:06:02,310 --> 02:05:59,920

phase for this expedition um but the

3311

02:06:04,629 --> 02:06:02,320

expedition reports will be coming out um

3312

02:06:06,470 --> 02:06:04,639

within the next few weeks so there'll be

3313

02:06:09,189 --> 02:06:06,480

lots of material about

3314

02:06:11,270 --> 02:06:09,199

all of the rocks that we collected um uh

3315

02:06:13,109 --> 02:06:11,280

in the offshore phase and then started

3316

02:06:14,550 --> 02:06:13,119

examining in the onshore phase so i just

3317

02:06:16,550 --> 02:06:14,560

want to say thank you to all the

3318

02:06:18,709 --> 02:06:16,560

scientists that were involved

3319

02:06:21,270 --> 02:06:18,719

and just to wrap up kind of the big

3320

02:06:23,990 --> 02:06:21,280

motivations for this expedition is kind

3321

02:06:25,669 --> 02:06:24,000

of taking what matt and billy and susan

3322

02:06:28,310 --> 02:06:25,679

and everett have talked about you know

3323

02:06:30,550 --> 02:06:28,320

what is the life like on these rocks is

3324

02:06:32,390 --> 02:06:30,560

it a relatively unique is it going to

3325

02:06:34,950 --> 02:06:32,400

look like what we find in table lands

3326

02:06:36,390 --> 02:06:34,960

and chromo and other continental systems

3327

02:06:37,510 --> 02:06:36,400

or is it going to look more like last

3328

02:06:39,189 --> 02:06:37,520

city or is it going to look like

3329

02:06:40,390 --> 02:06:39,199

something totally different

3330

02:06:41,430 --> 02:06:40,400

how does that

3331

02:06:44,069 --> 02:06:41,440

life

3332

02:06:45,830 --> 02:06:44,079

there and where it is um

3333

02:06:47,109 --> 02:06:45,840

indicate what's going on in the rocks

3334

02:06:49,589 --> 02:06:47,119

themselves

3335

02:06:51,109 --> 02:06:49,599

so there's a lot more work to go on here

3336

02:06:53,750 --> 02:06:51,119

and i encourage you to stay tuned and

3337

02:06:55,669 --> 02:06:53,760

this is our expedition website

3338

02:06:57,430 --> 02:06:55,679

where information will be presented as

3339

02:06:58,870 --> 02:06:57,440

it's available

3340

02:07:00,069 --> 02:06:58,880

so i try to keep it short and sweet

3341

02:07:01,990 --> 02:07:00,079

because i want to see some of these

3342

02:07:05,109 --> 02:07:02,000

pop-up talks and save time for them so

3343

02:07:06,709 --> 02:07:05,119

i'm happy to take your question

3344

02:07:09,270 --> 02:07:06,719

thank you very much beth

3345

02:07:11,830 --> 02:07:09,280

uh we have one question so far

3346

02:07:14,629 --> 02:07:11,840

uh any plans for a long-term observatory

3347

02:07:18,550 --> 02:07:15,910

um

3348

02:07:20,950 --> 02:07:18,560

so thanks for that question during the

3349

02:07:22,149 --> 02:07:20,960

expedition we were able to successfully

3350

02:07:24,069 --> 02:07:22,159

install

3351

02:07:26,950 --> 02:07:24,079

two of these four whole

3352

02:07:29,189 --> 02:07:26,960

observatories um in two of the holes

3353

02:07:31,030 --> 02:07:29,199

um we there may be two other ones that

3354

02:07:32,870 --> 02:07:31,040

are installed we're not sure of the

3355

02:07:34,470 --> 02:07:32,880

quality of those installations because

3356

02:07:36,310 --> 02:07:34,480

it was really like you pull off the

3357

02:07:38,310 --> 02:07:36,320

drill rig as you're installing it and

3358

02:07:40,790 --> 02:07:38,320

kind of leave it blind but we won't know

3359

02:07:43,589 --> 02:07:40,800

until 2018 when we go back

3360

02:07:45,510 --> 02:07:43,599

how well they worked um

3361

02:07:47,109 --> 02:07:45,520

but the idea is that this infrastructure

3362

02:07:49,270 --> 02:07:47,119

is there and in place

3363

02:07:50,870 --> 02:07:49,280

it could be used as an observatory

3364

02:07:52,790 --> 02:07:50,880

should there be interest in doing it and

3365

02:07:55,189 --> 02:07:52,800

should the infrastructure

3366

02:07:56,870 --> 02:07:55,199

work the way that we designed it

3367

02:07:58,470 --> 02:07:56,880

and uh if you have more questions about

3368

02:08:00,550 --> 02:07:58,480

that susan and billy would be good

3369

02:08:03,669 --> 02:08:00,560

people to ask because they're

3370

02:08:05,510 --> 02:08:03,679

part of the expedition to go back there

3371

02:08:07,669 --> 02:08:05,520

yeah stay tuned

3372

02:08:09,830 --> 02:08:07,679

uh don cartas asks if there's any chance

3373

02:08:11,669 --> 02:08:09,840

of using the methane probe technology at

3374

02:08:13,589 --> 02:08:11,679

other sites

3375

02:08:15,589 --> 02:08:13,599

yeah thanks john for that question so

3376

02:08:18,149 --> 02:08:15,599

the methane sensor that we use is

3377

02:08:20,310 --> 02:08:18,159

actually a commercial project product

3378

02:08:23,350 --> 02:08:20,320

available from brenetech

3379

02:08:25,350 --> 02:08:23,360

it was designed for use in other systems

3380

02:08:27,589 --> 02:08:25,360

oil field type work

3381

02:08:31,990 --> 02:08:27,599

and we basically incorporated that

3382

02:08:32,870 --> 02:08:32,000

methane probe into a seabird ctd package

3383

02:08:34,550 --> 02:08:32,880

to

3384

02:08:36,709 --> 02:08:34,560

measure the concentrations and i should

3385

02:08:38,310 --> 02:08:36,719

say that my ability really led a lot of

3386

02:08:41,430 --> 02:08:38,320

that work um that's his field of

3387

02:08:44,149 --> 02:08:41,440

expertise um so that sensor exists

3388

02:08:46,470 --> 02:08:44,159

people can buy it um the one that we use

3389

02:08:48,470 --> 02:08:46,480

is um currently at the british

3390

02:08:51,189 --> 02:08:48,480

geological survey and with the amiibo

3391

02:08:52,950 --> 02:08:51,199

team and it could be part of the kit

3392

02:08:55,510 --> 02:08:52,960

for those rock drills should people want

3393

02:08:59,109 --> 02:08:55,520

to use those rock drills for

3394

02:09:02,229 --> 02:09:00,149

thanks

3395

02:09:05,510 --> 02:09:02,239

i have one more question and while i ask

3396

02:09:07,589 --> 02:09:05,520

i can say that people are

3397

02:09:09,350 --> 02:09:07,599

welcome to ask questions for any of the

3398

02:09:11,750 --> 02:09:09,360

talks today before we move on to the

3399

02:09:14,390 --> 02:09:11,760

pop-up talks pretty soon so my question

3400

02:09:15,510 --> 02:09:14,400

is um continuing with my proposed theme

3401

02:09:17,109 --> 02:09:15,520

of

3402

02:09:18,550 --> 02:09:17,119

uh how to make measurements at the

3403

02:09:20,629 --> 02:09:18,560

surface in order to understand what's

3404

02:09:23,030 --> 02:09:20,639

going on in the subsurface would you say

3405

02:09:25,350 --> 02:09:23,040

the rocks that we recovered with this

3406

02:09:27,589 --> 02:09:25,360

expedition are more or less

3407

02:09:31,430 --> 02:09:27,599

representative of the subsurface than

3408

02:09:34,629 --> 02:09:32,790

yeah that's a fun question to think

3409

02:09:35,350 --> 02:09:34,639

about so um

3410

02:09:36,709 --> 02:09:35,360

and

3411

02:09:38,229 --> 02:09:36,719

for people that are interested in this i

3412

02:09:40,709 --> 02:09:38,239

think the expedition reports will help

3413

02:09:44,830 --> 02:09:40,719

tease us apart some of the sites that we

3414

02:09:48,069 --> 02:09:44,840

drilled if i can go back here in my

3415

02:09:50,550 --> 02:09:48,079

slides one more

3416

02:09:53,910 --> 02:09:50,560

so some of the sites that we drilled we

3417

02:09:56,149 --> 02:09:53,920

can see from the assemblage of rocks

3418

02:09:56,950 --> 02:09:56,159

that we probably are not we didn't core

3419

02:09:58,709 --> 02:09:56,960

into

3420

02:10:01,750 --> 02:09:58,719

an in-situ sequence but are actually

3421

02:10:03,109 --> 02:10:01,760

looking at more of

3422

02:10:23,350 --> 02:10:03,119

a

3423

02:10:25,830 --> 02:10:23,360

of those rocks

3424

02:10:27,990 --> 02:10:25,840

lisa and others on the phone may be able

3425

02:10:30,149 --> 02:10:28,000

to get even more indication of that we

3426

02:10:32,149 --> 02:10:30,159

can give an indication of

3427

02:10:33,830 --> 02:10:32,159

probably both

3428

02:10:35,589 --> 02:10:33,840

this down rolling process seawater

3429

02:10:37,430 --> 02:10:35,599

coming into the system and reacting and

3430

02:10:39,350 --> 02:10:37,440

precipitating carbonate

3431

02:10:41,350 --> 02:10:39,360

things like susan talked about

3432

02:10:43,350 --> 02:10:41,360

but also deeper processes are occurring

3433

02:10:45,750 --> 02:10:43,360

so i think even in the atlantis massif

3434

02:10:48,390 --> 02:10:45,760

where our deepest site is 16 meters

3435

02:10:49,430 --> 02:10:48,400

we're still looking at mixing processes

3436

02:10:52,310 --> 02:10:49,440

between

3437

02:10:54,310 --> 02:10:52,320

seawater infiltration into these systems

3438

02:10:55,669 --> 02:10:54,320

as well as processes that are coming up

3439

02:10:56,709 --> 02:10:55,679

from below

3440

02:10:58,310 --> 02:10:56,719

so

3441

02:11:00,390 --> 02:10:58,320

it's lost city

3442

02:11:02,790 --> 02:11:00,400

but a little bit deeper

3443

02:11:03,589 --> 02:11:02,800

in my opinion

3444

02:11:05,990 --> 02:11:03,599

yeah

3445

02:11:08,069 --> 02:11:06,000

it's a tough question in all of our

3446

02:11:11,270 --> 02:11:08,079

minds certainly the bubbles and the flow

3447

02:11:12,550 --> 02:11:11,280

coming up are really encouraging

3448

02:11:15,669 --> 02:11:12,560

um

3449

02:11:19,109 --> 02:11:15,679

any more questions if not we can move on

3450

02:11:19,119 --> 02:11:22,790

are those ready mike

3451

02:11:28,390 --> 02:11:25,109

uh yes they are uh first up is uh katie

3452

02:11:30,390 --> 02:11:28,400

rumford uh just give me one moment

3453

02:11:40,229 --> 02:11:30,400

thank you beth

3454

02:11:40,239 --> 02:11:43,589

all right take it away

3455

02:11:47,750 --> 02:11:45,510

okay so today i'm going to be presenting

3456

02:11:49,990 --> 02:11:47,760

some exciting new results from the rpl

3457

02:11:51,030 --> 02:11:50,000

neis team work in the sumail ophilite in

3458

02:11:53,270 --> 02:11:51,040

oman

3459

02:11:55,189 --> 02:11:53,280

and as we've been discussing all morning

3460

02:11:57,189 --> 02:11:55,199

serpentizing systems can sustain

3461

02:11:59,750 --> 02:11:57,199

microbial life through the abiotic

3462

02:12:01,990 --> 02:11:59,760

production of hydrogen and reduce carbon

3463

02:12:04,149 --> 02:12:02,000

compounds however one of the major

3464

02:12:06,310 --> 02:12:04,159

questions remaining is

3465

02:12:08,149 --> 02:12:06,320

are there actually organisms assisting

3466

02:12:11,109 --> 02:12:08,159

officer pensionization reactions in the

3467

02:12:13,350 --> 02:12:11,119

subsurface of these systems and in oman

3468

02:12:15,510 --> 02:12:13,360

we have a unique opportunity

3469

02:12:17,990 --> 02:12:15,520

to study this because we can sample deep

3470

02:12:19,750 --> 02:12:18,000

fluids from a series of wells drilled by

3471

02:12:20,950 --> 02:12:19,760

the omani government to search for water

3472

02:12:23,030 --> 02:12:20,960

resources

3473

02:12:24,870 --> 02:12:23,040

and these walls are up to 300 meters

3474

02:12:26,790 --> 02:12:24,880

deep and span the cross mantle

3475

02:12:28,709 --> 02:12:26,800

transition so we can sample from various

3476

02:12:31,350 --> 02:12:28,719

lithologies such as peridotite and

3477

02:12:34,790 --> 02:12:31,360

gabbro and also various hydrological

3478

02:12:36,870 --> 02:12:34,800

regimes such as shallow and deep flow

3479

02:12:39,350 --> 02:12:36,880

so this allows us to address even

3480

02:12:41,350 --> 02:12:39,360

another question if there is life how is

3481

02:12:42,709 --> 02:12:41,360

life distributed in the subsurface of

3482

02:12:44,470 --> 02:12:42,719

the serpentinite

3483

02:12:46,550 --> 02:12:44,480

and answering this question will be an

3484

02:12:48,629 --> 02:12:46,560

important first step towards developing

3485

02:12:50,709 --> 02:12:48,639

any predictive models for biological

3486

02:12:55,030 --> 02:12:50,719

habitability in these water rock

3487

02:13:00,470 --> 02:12:57,350

so we collected 20 deep fluid samples

3488

02:13:03,030 --> 02:13:00,480

over three years and on the left here is

3489

02:13:05,350 --> 02:13:03,040

a principal component analysis of these

3490

02:13:07,430 --> 02:13:05,360

geochemical parameters and you can see

3491

02:13:10,709 --> 02:13:07,440

that we observe highly variable fluid

3492

02:13:13,589 --> 02:13:10,719

chemistries throughout the opioid and we

3493

02:13:17,510 --> 02:13:13,599

find four main fluid types

3494

02:13:20,470 --> 02:13:17,520

we see a fluid type that is very hyper

3495

02:13:23,350 --> 02:13:20,480

alkaline calcium and methane rich

3496

02:13:25,430 --> 02:13:23,360

hosted in prototypes we see a second

3497

02:13:28,470 --> 02:13:25,440

prototype fluid that is more alkaline in

3498

02:13:31,189 --> 02:13:28,480

ph and higher in magnesium

3499

02:13:34,629 --> 02:13:31,199

we see high silica

3500

02:13:37,109 --> 02:13:34,639

gabbro hosted fluids as well as more of

3501

02:13:38,790 --> 02:13:37,119

a hybrid type fluid found at uh the

3502

02:13:39,910 --> 02:13:38,800

contact between the crest and mantle

3503

02:13:42,229 --> 02:13:39,920

boundary

3504

02:13:43,910 --> 02:13:42,239

and we think that these

3505

02:13:45,990 --> 02:13:43,920

different chemistries are really

3506

02:13:48,390 --> 02:13:46,000

reflecting differences in both the host

3507

02:13:50,709 --> 02:13:48,400

rock pathology and the extent of water

3508

02:13:53,270 --> 02:13:50,719

rock reaction

3509

02:13:55,510 --> 02:13:53,280

we are able to detect life through high

3510

02:13:57,350 --> 02:13:55,520

throughput 16s gene sequencing and all

3511

02:13:59,270 --> 02:13:57,360

these fluid types sampled

3512

02:14:01,350 --> 02:13:59,280

and interestingly these fluid types host

3513

02:14:03,030 --> 02:14:01,360

distinct microbial communities is

3514

02:14:04,870 --> 02:14:03,040

highlighted by this non-metric

3515

02:14:07,270 --> 02:14:04,880

multi-dimensional scaling analysis shown

3516

02:14:09,350 --> 02:14:07,280

on the right and so wells that plot

3517

02:14:12,229 --> 02:14:09,360

closely together have more similar

3518

02:14:14,310 --> 02:14:12,239

microbial community compositions and the

3519

02:14:15,910 --> 02:14:14,320

size of the marker reflects the richness

3520

02:14:18,790 --> 02:14:15,920

or the number of species that we

3521

02:14:21,910 --> 02:14:18,800

observed and what we see here is that in

3522

02:14:24,069 --> 02:14:21,920

the really hyper alkaline fluids

3523

02:14:25,990 --> 02:14:24,079

we see a distinct community of low

3524

02:14:28,390 --> 02:14:26,000

richness

3525

02:14:31,030 --> 02:14:28,400

and in the alkaline prototype and

3526

02:14:33,430 --> 02:14:31,040

gabriel fluids we see rich communities

3527

02:14:35,030 --> 02:14:33,440

of similar composition with contact

3528

02:14:36,149 --> 02:14:35,040

foods having its own

3529

02:14:39,589 --> 02:14:36,159

unique

3530

02:14:42,149 --> 02:14:40,390

and so

3531

02:14:44,470 --> 02:14:42,159

what we really have found is four unique

3532

02:14:46,870 --> 02:14:44,480

habitats um within the same ophelia

3533

02:14:48,390 --> 02:14:46,880

illustrated here um

3534

02:14:51,910 --> 02:14:48,400

where there's shallow flow whether it be

3535

02:14:54,950 --> 02:14:51,920

an alkaline prototype fluids or gabbro

3536

02:14:57,750 --> 02:14:54,960

we see a lower ph

3537

02:15:01,030 --> 02:14:57,760

higher dic and sulfate and nitrate

3538

02:15:03,350 --> 02:15:01,040

concentrations and here we see organisms

3539

02:15:05,310 --> 02:15:03,360

associated with nitrogen cycling such as

3540

02:15:07,669 --> 02:15:05,320

nitrospira and

3541

02:15:10,790 --> 02:15:07,679

nitrosospherase as well as candidate

3542

02:15:12,790 --> 02:15:10,800

phyllo op3 and parvarkiota

3543

02:15:15,430 --> 02:15:12,800

if fluids percolate deeper and have more

3544

02:15:18,470 --> 02:15:15,440

extensive water rock reaction

3545

02:15:21,109 --> 02:15:18,480

we see much lower dic concentrations up

3546

02:15:23,990 --> 02:15:21,119

to 2.9 millimolar hydrogen

3547

02:15:26,229 --> 02:15:24,000

concentrations and up to 2.3 millimolar

3548

02:15:29,510 --> 02:15:26,239

methane concentrations and here the

3549

02:15:31,910 --> 02:15:29,520

communities are dominated by op1 uh mayo

3550

02:15:34,069 --> 02:15:31,920

thermos the sulfate-reducing family

3551
02:15:37,750 --> 02:15:34,079
thermodynamics alpha vibronica and we

3552
02:15:39,990 --> 02:15:37,760
also see methanobacteria

3553
02:15:43,669 --> 02:15:40,000
and the contact fluids

3554
02:15:45,430 --> 02:15:43,679
likely represent zones of mixing and and

3555
02:15:47,030 --> 02:15:45,440
like in other serpentinizing systems

3556
02:15:49,830 --> 02:15:47,040
where there's mixing we see a lot of

3557
02:15:51,830 --> 02:15:49,840
beta protobacteriophyla we think these

3558
02:15:53,270 --> 02:15:51,840
represent areas of more chemical

3559
02:15:55,030 --> 02:15:53,280
disequilibria

3560
02:15:57,109 --> 02:15:55,040
we do detect some methane in these

3561
02:15:58,950 --> 02:15:57,119
fluids but higher concentrations of

3562
02:16:00,790 --> 02:15:58,960
sulfate and nitrate than in the hyper

3563
02:16:01,589 --> 02:16:00,800

alkaline fluids

3564

02:16:03,910 --> 02:16:01,599

so

3565

02:16:05,750 --> 02:16:03,920

overall the consistent parsing of these

3566

02:16:08,790 --> 02:16:05,760

microbial communities as a function of

3567

02:16:10,550 --> 02:16:08,800

fluid type likely represent differential

3568

02:16:12,790 --> 02:16:10,560

energy availability and aqueous

3569

02:16:14,470 --> 02:16:12,800

geochemistry such as ph

3570

02:16:17,750 --> 02:16:14,480

that result from these fundamental

3571

02:16:27,910 --> 02:16:17,760

differences in rock lithology as well as

3572

02:16:27,920 --> 02:16:30,790

thank you kitty

3573

02:16:34,629 --> 02:16:32,870

i have a question about the

3574

02:16:37,110 --> 02:16:34,639

uh the different kinds of fluids were

3575

02:16:38,389 --> 02:16:37,120

those uh definitions of different kinds

3576

02:16:40,870 --> 02:16:38,399

of fluids

3577

02:16:42,469 --> 02:16:40,880

uh hard cutoffs just based on your

3578

02:16:43,509 --> 02:16:42,479

chemistry measurements or were they more

3579

02:16:45,750 --> 02:16:43,519

of a

3580

02:16:48,150 --> 02:16:45,760

holistic interpretation based on your

3581

02:16:50,790 --> 02:16:48,160

insights into the system

3582

02:16:52,950 --> 02:16:50,800

uh so i base these fluid types based on

3583

02:16:54,870 --> 02:16:52,960

the principle component analysis we saw

3584

02:16:57,509 --> 02:16:54,880

with some geologic context from the

3585

02:16:59,750 --> 02:16:57,519

wells i mean there is one well that we

3586

02:17:02,150 --> 02:16:59,760

observe in this system that is on a

3587

02:17:04,790 --> 02:17:02,160

geologic contact but has fluid chemistry

3588

02:17:06,950 --> 02:17:04,800

consistent with hyper alkaline prototype

3589

02:17:08,629 --> 02:17:06,960

fluids um and so

3590

02:17:10,469 --> 02:17:08,639

that is a little more tricky so there's

3591

02:17:12,150 --> 02:17:10,479

definitely not hard cut off it was just

3592

02:17:14,469 --> 02:17:12,160

based on the principal component

3593

02:17:15,990 --> 02:17:14,479

analysis

3594

02:17:18,870 --> 02:17:16,000

okay thanks

3595

02:17:21,190 --> 02:17:18,880

don cartas asks do you see free co2 in

3596

02:17:24,389 --> 02:17:21,200

your gabbro type wells

3597

02:17:25,270 --> 02:17:24,399

so we just measure total dic and we see

3598

02:17:28,389 --> 02:17:25,280

about

3599

02:17:33,110 --> 02:17:28,399

well greater than 2.2 millimolar

3600

02:17:35,830 --> 02:17:33,990

right

3601

02:17:38,629 --> 02:17:35,840

yeah

3602

02:17:40,790 --> 02:17:38,639

um we have some typing going on don says

3603

02:17:43,429 --> 02:17:40,800

thank you jen says can you translate

3604

02:18:02,709 --> 02:17:43,439

this to a rough surface area or a

3605

02:18:07,830 --> 02:18:06,389

well so part of the question is um you

3606

02:18:10,070 --> 02:18:07,840

know rough surface area that's totally

3607

02:18:12,070 --> 02:18:10,080

exposed but when it comes to prototype i

3608

02:18:13,910 --> 02:18:12,080

don't think we have a good handle on how

3609

02:18:16,150 --> 02:18:13,920

much of the fluids that are stored in

3610

02:18:19,110 --> 02:18:16,160

the aquifer are undergoing a shallow

3611

02:18:20,950 --> 02:18:19,120

flow versus a deep flow and we only have

3612

02:18:22,830 --> 02:18:20,960

a few wells that are drilled by the

3613

02:18:25,669 --> 02:18:22,840

ministry where we can even access these

3614

02:18:27,509 --> 02:18:25,679

fluids and so until we get a better grip

3615

02:18:30,790 --> 02:18:27,519

on some of the hydrogeology of the

3616

02:18:32,709 --> 02:18:30,800

setting it would be hard to translate

3617

02:18:36,230 --> 02:18:32,719

at least the alkaline prototype versus

3618

02:18:40,870 --> 02:18:38,309

but gabriel versus prototype in general

3619

02:18:43,110 --> 02:18:40,880

would be easier but i don't have exact

3620

02:18:45,990 --> 02:18:43,120

um yeah katie you did it you did a great

3621

02:18:47,589 --> 02:18:46,000

job handling my poorly poorly expressed

3622

02:18:49,750 --> 02:18:47,599

question i was just wanting to see if

3623

02:18:51,110 --> 02:18:49,760

you could sort of rank the different

3624

02:18:53,349 --> 02:18:51,120

fluid types

3625

02:18:55,589 --> 02:18:53,359

based on how much

3626
02:18:57,990 --> 02:18:55,599
how much exposure there might be in

3627
02:19:00,070 --> 02:18:58,000
smale or other ophelites

3628
02:19:01,669 --> 02:19:00,080
just as i guess prioritize where we

3629
02:19:03,589 --> 02:19:01,679
might look for different

3630
02:19:04,549 --> 02:19:03,599
um

3631
02:19:09,110 --> 02:19:04,559
unique

3632
02:19:13,830 --> 02:19:11,910
ophelia i think there's 15 kilometers of

3633
02:19:15,669 --> 02:19:13,840
the exposed sequence and about eight of

3634
02:19:16,629 --> 02:19:15,679
it is gabbro

3635
02:19:19,349 --> 02:19:16,639
um

3636
02:19:21,509 --> 02:19:19,359
and so but within the prototype

3637
02:19:24,950 --> 02:19:21,519
i'm not sure how much of it would be a

3638
02:19:27,190 --> 02:19:24,960

hyper alkaline versus an alkaline um

3639

02:19:29,830 --> 02:19:27,200

and so i mean the this male ophelite is

3640

02:19:31,429 --> 02:19:29,840

one of the best exposed opalites so

3641

02:19:32,790 --> 02:19:31,439

there's a lot more surface area that

3642

02:19:33,990 --> 02:19:32,800

we're looking at here compared to other

3643

02:19:36,230 --> 02:19:34,000

opalites opoids

3644

02:19:38,709 --> 02:19:36,240

so depending on how much of it was

3645

02:19:40,709 --> 02:19:38,719

abducted how much of the mantle sequence

3646

02:19:43,030 --> 02:19:40,719

i think it would differ

3647

02:19:46,309 --> 02:19:43,040

cytosite

3648

02:19:50,150 --> 02:19:48,469

jesse asks what is the explanation for

3649

02:19:53,349 --> 02:19:50,160

the lack of dissolved hydrogen and three

3650

02:19:58,230 --> 02:19:55,590

so it's a

3651

02:20:00,389 --> 02:19:58,240

lack of detection so it's possible that

3652

02:20:02,469 --> 02:20:00,399

there are nanomolar concentrations of

3653

02:20:04,630 --> 02:20:02,479

hydrogen that we weren't able weren't

3654

02:20:06,630 --> 02:20:04,640

able to measure um and that organisms

3655

02:20:08,950 --> 02:20:06,640

could be drawing down this level below

3656

02:20:15,110 --> 02:20:08,960

detection but at this point we don't

3657

02:20:19,110 --> 02:20:16,710

the hyper um

3658

02:20:23,910 --> 02:20:19,120

fluids that represent extended water

3659

02:20:26,790 --> 02:20:25,429

i would say we always have the paradox

3660

02:20:28,710 --> 02:20:26,800

that if you don't see hydrogen is it

3661

02:20:31,190 --> 02:20:28,720

because it was never there because

3662

02:20:33,190 --> 02:20:31,200

biology ate it

3663

02:20:35,429 --> 02:20:33,200

thank you very much katie

3664

02:20:40,230 --> 02:20:35,439

we can move on to the second pop-up talk

3665

02:20:44,070 --> 02:20:42,870

okay don if you're on the line um

3666

02:20:46,469 --> 02:20:44,080

if you could unmute and start your

3667

02:20:49,349 --> 02:20:46,479

webcam that'd be great

3668

02:20:51,670 --> 02:20:49,359

hi this is dawn can you hear me

3669

02:20:53,429 --> 02:20:51,680

yes yes

3670

02:20:56,230 --> 02:20:53,439

oh great all right i'm starting my

3671

02:20:56,240 --> 02:21:01,349

and

3672

02:21:05,910 --> 02:21:04,389

here i am hello

3673

02:21:07,510 --> 02:21:05,920

you're almost there you're probably

3674

02:21:12,950 --> 02:21:07,520

gonna have to click start sharing on

3675

02:21:17,190 --> 02:21:14,150

should be right in the middle of your

3676

02:21:17,200 --> 02:21:20,950

perfect hi

3677

02:21:25,270 --> 02:21:22,630

and just a reminder um to advance your

3678

02:21:27,750 --> 02:21:25,280

slides click the down arrow icon to the

3679

02:21:28,630 --> 02:21:27,760

bottom left of your slides thanks okay

3680

02:21:32,150 --> 02:21:28,640

thanks

3681

02:21:34,150 --> 02:21:32,160

everybody um

3682

02:21:36,070 --> 02:21:34,160

i know i have just a few minutes

3683

02:21:39,429 --> 02:21:36,080

so i just put together a short

3684

02:21:41,510 --> 02:21:39,439

presentation here kind of an update um

3685

02:21:44,230 --> 02:21:41,520

serpentinization in the philippines and

3686

02:21:47,990 --> 02:21:44,240

i've listed next to me uh darcy meyer

3687

02:21:51,590 --> 02:21:48,000

dombard kristen weichis suhayono and

3688

02:21:53,670 --> 02:21:51,600

um kaloy arcelia so these are all

3689

02:21:55,349 --> 02:21:53,680

members of our sort of problem-solving

3690

02:21:57,670 --> 02:21:55,359

group here trying to understand uh

3691

02:21:59,750 --> 02:21:57,680

what's happening below ground at some

3692

02:22:03,349 --> 02:21:59,760

ophelite sites in the philippines and so

3693

02:22:05,429 --> 02:22:03,359

the backdrop here um is showing you some

3694

02:22:07,349 --> 02:22:05,439

the thin section and cross polars

3695

02:22:09,190 --> 02:22:07,359

showing you fractured olivine relics

3696

02:22:11,030 --> 02:22:09,200

within a mesh of serpentine and

3697

02:22:11,750 --> 02:22:11,040

magnetite rich veins

3698

02:22:15,030 --> 02:22:11,760

and

3699

02:22:17,910 --> 02:22:15,040

this is from our punbato site where we

3700

02:22:19,429 --> 02:22:17,920

visited back in 2012 2013. so this is

3701

02:22:21,670 --> 02:22:19,439

kind of a quick

3702

02:22:23,750 --> 02:22:21,680

review of what we've published back

3703

02:22:25,910 --> 02:22:23,760

two years ago and then i want to give

3704

02:22:27,670 --> 02:22:25,920

you a bit of an update okay so you're in

3705

02:22:29,830 --> 02:22:27,680

the philippines and there's

3706

02:22:31,270 --> 02:22:29,840

two areas there's many many ophelite

3707

02:22:32,870 --> 02:22:31,280

bodies in the in the philippines i want

3708

02:22:34,710 --> 02:22:32,880

you to pay attention to some bali's up

3709

02:22:36,389 --> 02:22:34,720

in the north for a moment and then i'll

3710

02:22:38,230 --> 02:22:36,399

take you down to palawan

3711

02:22:41,349 --> 02:22:38,240

uh this island that's in the lower left

3712

02:22:44,150 --> 02:22:41,359

of your screen um so previously we

3713

02:22:47,349 --> 02:22:44,160

actually had described everything that's

3714

02:22:49,349 --> 02:22:47,359

shown as a white symbol with a label

3715

02:22:51,830 --> 02:22:49,359

so up in zambale's we had monologue

3716

02:22:54,950 --> 02:22:51,840

springs the punbatto springs and then

3717

02:22:57,030 --> 02:22:54,960

agabro hosted artesian well at big biga

3718

02:23:00,389 --> 02:22:57,040

and then down in palawan san ysidro and

3719

02:23:03,590 --> 02:23:00,399

minot falls were some very warm springs

3720

02:23:05,030 --> 02:23:03,600

and then since that time we've

3721

02:23:07,190 --> 02:23:05,040

we're really interested in pursuing

3722

02:23:08,950 --> 02:23:07,200

within that sort of dashed gold circle

3723

02:23:10,469 --> 02:23:08,960

um a set of

3724

02:23:12,150 --> 02:23:10,479

what would appear to be

3725

02:23:14,389 --> 02:23:12,160

hyper alkaline and very shallow

3726

02:23:16,070 --> 02:23:14,399

groundwater flow systems in the nara

3727

02:23:18,790 --> 02:23:16,080

region of palawan

3728

02:23:20,150 --> 02:23:18,800

so first i'll look back in the zambala

3729

02:23:23,110 --> 02:23:20,160

zofiolite

3730

02:23:25,510 --> 02:23:23,120

we had described for for you all

3731

02:23:27,910 --> 02:23:25,520

multiple sites of really high ph

3732

02:23:30,309 --> 02:23:27,920

carbon monoxide methane and hydrogen

3733

02:23:32,870 --> 02:23:30,319

bearing springs and so the two that i

3734

02:23:35,830 --> 02:23:32,880

think really came out as featured in our

3735

02:23:37,830 --> 02:23:35,840

past work um were the manuelawag spring

3736

02:23:39,910 --> 02:23:37,840

and the pumbato spring so quickly on the

3737

02:23:41,110 --> 02:23:39,920

lower left well the main picture is

3738

02:23:43,670 --> 02:23:41,120

actually

3739

02:23:46,150 --> 02:23:43,680

you see calcite rafts right on the

3740

02:23:47,510 --> 02:23:46,160

surface of a of a high ph spring at

3741

02:23:49,110 --> 02:23:47,520

somewhere in the neighborhood of 11

3742

02:23:51,110 --> 02:23:49,120

that's one of our filipino colleagues

3743

02:23:52,309 --> 02:23:51,120

gamma he was a graduate student at the

3744

02:23:54,150 --> 02:23:52,319

time

3745

02:23:56,309 --> 02:23:54,160

but in the lower left inset you see two

3746

02:23:58,469 --> 02:23:56,319

stiff diagrams just showing you from

3747

02:24:01,349 --> 02:23:58,479

mondowag springs

3748

02:24:04,469 --> 02:24:01,359

on the top labeled ml1 uh the kind of

3749

02:24:06,630 --> 02:24:04,479

sort of quick image based

3750

02:24:09,750 --> 02:24:06,640

major ion chemistry that we've got

3751

02:24:12,309 --> 02:24:09,760

um so it's a calcium-rich

3752

02:24:14,389 --> 02:24:12,319

bicarbonate poor fluid with a sort of a

3753

02:24:17,429 --> 02:24:14,399

salt component there and measurable

3754

02:24:19,270 --> 02:24:17,439

chloride pumbato which is the picture on

3755

02:24:21,110 --> 02:24:19,280

the main body of the slide

3756

02:24:22,550 --> 02:24:21,120

is you see really dominated by the

3757

02:24:24,870 --> 02:24:22,560

calcium

3758

02:24:27,510 --> 02:24:24,880

as well and they both sort of proved to

3759

02:24:29,349 --> 02:24:27,520

be rich in serpentization sort of

3760

02:24:31,910 --> 02:24:29,359

influence

3761

02:24:33,830 --> 02:24:31,920

and now here's here's an additional site

3762

02:24:37,190 --> 02:24:33,840

that we're just starting to to learn

3763

02:24:39,590 --> 02:24:37,200

about now in fact i'm refreshingly back

3764

02:24:42,309 --> 02:24:39,600

from field work down in palawan as a

3765

02:24:43,750 --> 02:24:42,319

deep carbon observatory funded uh darcy

3766

02:24:46,150 --> 02:24:43,760

and myself to go

3767

02:24:49,110 --> 02:24:46,160

and meet kristen weichis there

3768

02:24:50,630 --> 02:24:49,120

to do some additional sampling

3769

02:24:52,389 --> 02:24:50,640

and so what we found are multiple new

3770

02:24:54,710 --> 02:24:52,399

sites of high ph springs

3771

02:24:56,950 --> 02:24:54,720

and some shallow groundwater regimes and

3772

02:24:59,750 --> 02:24:56,960

some flammable gas emanating from them

3773

02:25:00,950 --> 02:24:59,760

so this was quite a forensic study um

3774

02:25:03,270 --> 02:25:00,960

just kind of

3775

02:25:04,710 --> 02:25:03,280

exploring the landscape and figuring out

3776

02:25:07,030 --> 02:25:04,720

uh where it might be good for future

3777

02:25:08,389 --> 02:25:07,040

endeavors what you're seeing left in

3778

02:25:10,630 --> 02:25:08,399

sort of the center of your screen it

3779

02:25:11,750 --> 02:25:10,640

looks sort of a bluish green pool

3780

02:25:13,750 --> 02:25:11,760

is

3781

02:25:14,870 --> 02:25:13,760

an excavation down through some chalk

3782

02:25:17,190 --> 02:25:14,880

crusts

3783

02:25:21,190 --> 02:25:17,200

and the standing water

3784

02:25:23,270 --> 02:25:21,200

is elevated in ph it's a high tens or 11

3785

02:25:25,429 --> 02:25:23,280

and it has some really interesting

3786

02:25:26,950 --> 02:25:25,439

carbonate formations

3787

02:25:28,790 --> 02:25:26,960

that seem to be following lines of

3788

02:25:30,550 --> 02:25:28,800

groundwater seepage down through that

3789

02:25:31,349 --> 02:25:30,560

excavation

3790

02:25:33,590 --> 02:25:31,359

and

3791

02:25:35,110 --> 02:25:33,600

let's see i think i can

3792

02:25:36,790 --> 02:25:35,120

there used to be a way for me to get a

3793

02:25:37,750 --> 02:25:36,800

pointer i'm not sure with this new

3794

02:25:39,990 --> 02:25:37,760

screen

3795

02:25:42,630 --> 02:25:40,000

let's see here right here

3796

02:25:45,750 --> 02:25:42,640

so i think you can see my green arrow so

3797

02:25:47,190 --> 02:25:45,760

up here would be this um excavation

3798

02:25:48,150 --> 02:25:47,200

that was

3799

02:25:49,990 --> 02:25:48,160

yes

3800

02:25:51,510 --> 02:25:50,000

i'll bring the slides back um just click

3801
02:25:54,389 --> 02:25:51,520
where you want the pointer to go and

3802
02:25:56,870 --> 02:25:54,399
then um that'll keep your slides still

3803
02:25:59,590 --> 02:25:56,880
okay right there so now you're seeing a

3804
02:26:03,429 --> 02:25:59,600
green pointer into that same excavated

3805
02:26:08,790 --> 02:26:05,750
organic rich

3806
02:26:10,469 --> 02:26:08,800
based on color anyway uh carbonate

3807
02:26:12,469 --> 02:26:10,479
material that was sort of crumbling

3808
02:26:14,309 --> 02:26:12,479
right off of the edge where there was

3809
02:26:16,309 --> 02:26:14,319
groundwater seepage we we sort of

3810
02:26:17,670 --> 02:26:16,319
prospected around with a multiprobe

3811
02:26:19,270 --> 02:26:17,680
meter and found that this was where

3812
02:26:21,349 --> 02:26:19,280
there was the highest ph and the lowest

3813
02:26:23,190 --> 02:26:21,359

orp in the standing water and you have

3814

02:26:24,550 --> 02:26:23,200

all this carbonate

3815

02:26:26,630 --> 02:26:24,560

formation

3816

02:26:28,230 --> 02:26:26,640

on the right i'll see if i can click

3817

02:26:29,910 --> 02:26:28,240

over the right okay so now the green

3818

02:26:31,750 --> 02:26:29,920

arrow has moved to the right at a new

3819

02:26:34,309 --> 02:26:31,760

site called governor spring

3820

02:26:35,750 --> 02:26:34,319

where we had my field notebook open to

3821

02:26:37,830 --> 02:26:35,760

my left here

3822

02:26:40,870 --> 02:26:37,840

we had at the source which is shown

3823

02:26:42,710 --> 02:26:40,880

right there water is coming out from

3824

02:26:44,469 --> 02:26:42,720

kind of a bedrock contact with some

3825

02:26:48,389 --> 02:26:44,479

travertine deposits

3826

02:26:50,550 --> 02:26:48,399

we had phs ranging from 11.34 up to

3827

02:26:52,950 --> 02:26:50,560

11.42

3828

02:26:55,590 --> 02:26:52,960

and some orp data screaming down to

3829

02:26:58,230 --> 02:26:55,600

about minus 655

3830

02:27:00,389 --> 02:26:58,240

millivolts in terms of raw orp data and

3831

02:27:02,870 --> 02:27:00,399

so these are areas that are just begging

3832

02:27:05,110 --> 02:27:02,880

for a greater description and some of

3833

02:27:06,150 --> 02:27:05,120

the preliminary gas collecting that we

3834

02:27:09,030 --> 02:27:06,160

did there

3835

02:27:10,790 --> 02:27:09,040

will soon be characterized by our whole

3836

02:27:14,389 --> 02:27:10,800

team here

3837

02:27:16,469 --> 02:27:14,399

and so i need to to really

3838

02:27:18,790 --> 02:27:16,479

recognize though kristen why cheese is

3839

02:27:20,550 --> 02:27:18,800

with us as a postdoc in shu heono's lab

3840

02:27:22,630 --> 02:27:20,560

and we're really excited for all the

3841

02:27:24,870 --> 02:27:22,640

data and interpretations we'll soon be

3842

02:27:26,950 --> 02:27:24,880

able to to provide you

3843

02:27:29,990 --> 02:27:26,960

so thank you this is the closing shot

3844

02:27:31,830 --> 02:27:30,000

just a word on it um is an actual it's a

3845

02:27:33,510 --> 02:27:31,840

new sort of field

3846

02:27:36,469 --> 02:27:33,520

locality for me

3847

02:27:37,910 --> 02:27:36,479

um that cursor can go away although i

3848

02:27:39,670 --> 02:27:37,920

don't know how to

3849

02:27:41,910 --> 02:27:39,680

undo it there we go this is an

3850

02:27:44,710 --> 02:27:41,920

ultramafic conglomerate actually and so

3851
02:27:45,990 --> 02:27:44,720
there's some cement crusts that are sort

3852
02:27:48,230 --> 02:27:46,000
of filling it in and this is a real

3853
02:27:50,630 --> 02:27:48,240
weathered spot at the edge

3854
02:27:53,190 --> 02:27:50,640
of near to one of our our higher ph

3855
02:27:55,190 --> 02:27:53,200
steep areas and i i'm finding it really

3856
02:27:57,750 --> 02:27:55,200
interesting that we have a

3857
02:27:59,349 --> 02:27:57,760
i tuned in after teaching just when matt

3858
02:28:00,950 --> 02:27:59,359
frank was mentioning

3859
02:28:03,190 --> 02:28:00,960
you know maybe different kinds of

3860
02:28:05,270 --> 02:28:03,200
environments where serpentization can

3861
02:28:08,309 --> 02:28:05,280
be continuing and here we have

3862
02:28:10,790 --> 02:28:08,319
um kind of landscape scale giant

3863
02:28:12,389 --> 02:28:10,800

conglomerate with serpentinite boulders

3864

02:28:13,990 --> 02:28:12,399

and some really interesting

3865

02:28:16,389 --> 02:28:14,000

geochemical signals uh that's

3866

02:28:19,030 --> 02:28:16,399

repetitization continues

3867

02:28:22,230 --> 02:28:19,040

so thank you and i will be happy to

3868

02:28:25,990 --> 02:28:24,389

thank you don um it's like someone's

3869

02:28:28,469 --> 02:28:26,000

typing i'll ask one question in the

3870

02:28:31,270 --> 02:28:28,479

meantime which is do you know anything

3871

02:28:34,150 --> 02:28:31,280

about salinity or conductivity of these

3872

02:28:35,670 --> 02:28:34,160

new springs matt was talking about how

3873

02:28:38,150 --> 02:28:35,680

the extremely low

3874

02:28:40,309 --> 02:28:38,160

salinity low level of ions and other

3875

02:28:42,309 --> 02:28:40,319

compound systems is a big challenge for

3876

02:28:44,230 --> 02:28:42,319

life

3877

02:28:46,230 --> 02:28:44,240

well for all i mean i have some

3878

02:28:48,309 --> 02:28:46,240

environmental probe data

3879

02:28:49,349 --> 02:28:48,319

that we've just collected so the first

3880

02:28:50,389 --> 02:28:49,359

was that

3881

02:28:53,190 --> 02:28:50,399

um

3882

02:28:54,870 --> 02:28:53,200

sort of the chalk crest x dugout that we

3883

02:28:56,630 --> 02:28:54,880

were that we were looking in the

3884

02:28:59,349 --> 02:28:56,640

conductivity was there was just shy of

3885

02:29:01,270 --> 02:28:59,359

one millisiemens so it was something i'm

3886

02:29:02,349 --> 02:29:01,280

looking at the range

3887

02:29:06,790 --> 02:29:02,359

it was

3888

02:29:08,870 --> 02:29:06,800

0.937 to 0.949 in in millisiemens and

3889

02:29:10,790 --> 02:29:08,880

then for the governor's spring which was

3890

02:29:12,070 --> 02:29:10,800

the one that i had the source pointed

3891

02:29:14,309 --> 02:29:12,080

out and discussed

3892

02:29:16,469 --> 02:29:14,319

uh the really reducing um

3893

02:29:18,230 --> 02:29:16,479

characteristics of the source water that

3894

02:29:22,309 --> 02:29:18,240

one had a conductivity at something like

3895

02:29:23,830 --> 02:29:22,319

one point between 1.84 and 1.89

3896

02:29:26,469 --> 02:29:23,840

so they're still

3897

02:29:30,630 --> 02:29:27,510

they're still

3898

02:29:32,070 --> 02:29:30,640

real but low i would say

3899

02:29:34,790 --> 02:29:32,080

and more on that more on that when we

3900

02:29:40,070 --> 02:29:37,670

cool thanks for reporting

3901

02:29:41,190 --> 02:29:40,080

uh fresh off the field book results

3902

02:29:42,870 --> 02:29:41,200

um

3903

02:29:46,309 --> 02:29:42,880

cool i should move on to our third

3904

02:29:48,309 --> 02:29:46,319

pop-up talk but thank you very much tom

3905

02:29:56,230 --> 02:29:48,319

and i believe our third one is annie

3906

02:30:00,070 --> 02:29:58,070

rick hello

3907

02:30:01,270 --> 02:30:00,080

yes we can hear you go ahead oh great

3908

02:30:03,990 --> 02:30:01,280

awesome

3909

02:30:06,630 --> 02:30:04,000

um so hi um for those of you who don't

3910

02:30:07,830 --> 02:30:06,640

know me i'm annie rowe i'm a postdoc

3911

02:30:09,830 --> 02:30:07,840

with the

3912

02:30:10,950 --> 02:30:09,840

nasa astrobiology institute based out of

3913

02:30:13,349 --> 02:30:10,960

usc

3914

02:30:14,230 --> 02:30:13,359

called life underground

3915

02:30:15,510 --> 02:30:14,240

and

3916

02:30:17,910 --> 02:30:15,520

i'm going to tell you a little bit about

3917

02:30:19,750 --> 02:30:17,920

the work i started as a postdoc with ken

3918

02:30:22,150 --> 02:30:19,760

nielsen

3919

02:30:24,309 --> 02:30:22,160

looking at the theaters so mike

3920

02:30:26,950 --> 02:30:24,319

sorry matt gave you a nice introduction

3921

02:30:28,630 --> 02:30:26,960

to the students a terrestrial

3922

02:30:30,230 --> 02:30:28,640

serpentization site

3923

02:30:32,870 --> 02:30:30,240

that we've been studying

3924

02:30:35,429 --> 02:30:32,880

for several years in ken's lab

3925

02:30:37,030 --> 02:30:35,439

and it has you know very characteristic

3926
02:30:39,110 --> 02:30:37,040
microbial community of terrestrial

3927
02:30:41,750 --> 02:30:39,120
synchronization systems

3928
02:30:43,510 --> 02:30:41,760
um i'm going to be focusing on a spring

3929
02:30:46,309 --> 02:30:43,520
that um

3930
02:30:49,429 --> 02:30:46,319
has not been well studied microbially

3931
02:30:51,590 --> 02:30:49,439
but one that we think is a mix of sort

3932
02:30:53,750 --> 02:30:51,600
of shallow and deep groundwater

3933
02:30:55,510 --> 02:30:53,760
communities

3934
02:30:57,910 --> 02:30:55,520
and so

3935
02:31:00,790 --> 02:30:57,920
we wanted to use this site to look for

3936
02:31:01,910 --> 02:31:00,800
evidence of mineral reducing bacteria

3937
02:31:03,990 --> 02:31:01,920
um

3938
02:31:05,590 --> 02:31:04,000

but you know sort of as everett

3939

02:31:07,190 --> 02:31:05,600

mentioned you know one of the challenges

3940

02:31:09,030 --> 02:31:07,200

with working with these terrestrial

3941

02:31:10,630 --> 02:31:09,040

serbianization systems is we can see

3942

02:31:13,190 --> 02:31:10,640

microbes there but it's not always

3943

02:31:16,150 --> 02:31:13,200

obvious what the oxidants are

3944

02:31:17,349 --> 02:31:16,160

so geochemically you know oxygen

3945

02:31:19,750 --> 02:31:17,359

is

3946

02:31:22,950 --> 02:31:19,760

uh we don't detect it below the surface

3947

02:31:24,630 --> 02:31:22,960

in most of the springs we have almost no

3948

02:31:26,630 --> 02:31:24,640

uh sulfate in the system i think we

3949

02:31:28,389 --> 02:31:26,640

measure about one micromole

3950

02:31:29,590 --> 02:31:28,399

we don't measure things like nitrate

3951

02:31:31,349 --> 02:31:29,600

strike or

3952

02:31:32,950 --> 02:31:31,359

reduce iron so

3953

02:31:34,150 --> 02:31:32,960

one of the things we wanted to look at

3954

02:31:36,389 --> 02:31:34,160

was

3955

02:31:38,150 --> 02:31:36,399

the availability or the potential for

3956

02:31:39,830 --> 02:31:38,160

microbes in the system to use solid

3957

02:31:41,590 --> 02:31:39,840

minerals with terminal electron

3958

02:31:43,990 --> 02:31:41,600

acceptors

3959

02:31:45,349 --> 02:31:44,000

but again this is a low biomass system

3960

02:31:46,710 --> 02:31:45,359

and so

3961

02:31:49,429 --> 02:31:46,720

to sort of

3962

02:31:52,230 --> 02:31:49,439

begin to circumvent this problem

3963

02:31:55,110 --> 02:31:52,240

we decided to try to enrich in vivo

3964

02:31:56,870 --> 02:31:55,120

sorry in vivo for

3965

02:31:59,190 --> 02:31:56,880

organisms that could do extracellular

3966

02:32:00,309 --> 02:31:59,200

electron transfer so we used a really

3967

02:32:03,190 --> 02:32:00,319

simple

3968

02:32:05,429 --> 02:32:03,200

electrochemical enrichment so this is a

3969

02:32:08,150 --> 02:32:05,439

two electrode system

3970

02:32:11,030 --> 02:32:08,160

um it's very similar to the way a

3971

02:32:13,429 --> 02:32:11,040

microbial fuel cell or battery will

3972

02:32:15,349 --> 02:32:13,439

work we have an anode here that can

3973

02:32:17,910 --> 02:32:15,359

serve as

3974

02:32:19,270 --> 02:32:17,920

an acceptor for electrons from microbial

3975

02:32:21,910 --> 02:32:19,280

processes

3976

02:32:24,230 --> 02:32:21,920

and then we have a cathode here at the

3977

02:32:26,230 --> 02:32:24,240

air water interface that can abiotically

3978

02:32:27,110 --> 02:32:26,240

reduce oxygen

3979

02:32:28,710 --> 02:32:27,120

um

3980

02:32:31,030 --> 02:32:28,720

and so

3981

02:32:33,750 --> 02:32:31,040

we incubated this at a

3982

02:32:35,990 --> 02:32:33,760

campsite spring for about three months

3983

02:32:38,790 --> 02:32:36,000

and we could measure current over this

3984

02:32:41,270 --> 02:32:38,800

time so we had a data logger and we saw

3985

02:32:42,469 --> 02:32:41,280

that after about 20 days

3986

02:32:44,389 --> 02:32:42,479

we could see

3987

02:32:46,630 --> 02:32:44,399

pretty consistent

3988

02:32:47,590 --> 02:32:46,640

current generation

3989

02:32:50,070 --> 02:32:47,600

and so

3990

02:32:51,190 --> 02:32:50,080

you know there may be some lag time in

3991

02:32:53,349 --> 02:32:51,200

terms of

3992

02:32:56,469 --> 02:32:53,359

getting the microbes to

3993

02:32:58,469 --> 02:32:56,479

associate to the anode

3994

02:33:01,910 --> 02:32:58,479

and interestingly we saw

3995

02:33:03,510 --> 02:33:01,920

some oscillations on a daily basis

3996

02:33:06,950 --> 02:33:03,520

and so

3997

02:33:08,230 --> 02:33:06,960

if we zoom in on sort of a three-day

3998

02:33:10,389 --> 02:33:08,240

period here

3999

02:33:11,590 --> 02:33:10,399

we can see that

4000

02:33:14,230 --> 02:33:11,600

um

4001
02:33:16,070 --> 02:33:14,240
we have sort of a boom and bust in terms

4002
02:33:17,429 --> 02:33:16,080
of current generation

4003
02:33:19,429 --> 02:33:17,439
um and this

4004
02:33:21,590 --> 02:33:19,439
bust or this decline in current

4005
02:33:22,790 --> 02:33:21,600
generation happens about noon so this is

4006
02:33:27,990 --> 02:33:22,800
sort of

4007
02:33:29,750 --> 02:33:28,000
high sunlight

4008
02:33:31,190 --> 02:33:29,760
and this is sort of counterintuitive to

4009
02:33:34,950 --> 02:33:31,200
what we would think

4010
02:33:36,950 --> 02:33:34,960
would happen if it was some sort of

4011
02:33:38,469 --> 02:33:36,960
temperature driven process

4012
02:33:40,070 --> 02:33:38,479
so

4013
02:33:41,349 --> 02:33:40,080

we would expect you know during the data

4014

02:33:43,110 --> 02:33:41,359

temperatures to be higher so we'd

4015

02:33:45,590 --> 02:33:43,120

actually expect more current production

4016

02:33:49,910 --> 02:33:45,600

if this was some sort of abiotic

4017

02:33:52,550 --> 02:33:51,110

and i

4018

02:33:54,389 --> 02:33:52,560

you know just sort of in the interest of

4019

02:33:55,590 --> 02:33:54,399

time that was most of what i was going

4020

02:33:57,750 --> 02:33:55,600

to tell you

4021

02:33:59,510 --> 02:33:57,760

from here

4022

02:34:01,030 --> 02:33:59,520

we enriched in this electric

4023

02:34:02,790 --> 02:34:01,040

chemical system

4024

02:34:04,150 --> 02:34:02,800

heavily for firmicute

4025

02:34:06,150 --> 02:34:04,160

um and

4026
02:34:08,950 --> 02:34:06,160
you know unfortunately it wasn't easy at

4027
02:34:10,790 --> 02:34:08,960
this point to get an isolate but

4028
02:34:12,630 --> 02:34:10,800
we sort of stuck with it

4029
02:34:15,270 --> 02:34:12,640
and

4030
02:34:17,670 --> 02:34:15,280
we eventually got an isolate this

4031
02:34:19,429 --> 02:34:17,680
activity electrochemical activity seems

4032
02:34:21,670 --> 02:34:19,439
to not be

4033
02:34:23,750 --> 02:34:21,680
linked to hydrogen production which was

4034
02:34:25,750 --> 02:34:23,760
a little bit of a surprise

4035
02:34:28,950 --> 02:34:25,760
but that might have to do with the

4036
02:34:30,790 --> 02:34:28,960
spring that we were working in um and

4037
02:34:33,270 --> 02:34:30,800
you know it's functionally anaerobic

4038
02:34:35,510 --> 02:34:33,280

because of the activity of

4039

02:34:39,270 --> 02:34:35,520

um hydrogen oxidizing

4040

02:34:41,750 --> 02:34:39,280

um aerobics but potentially it's also um

4041

02:34:43,270 --> 02:34:41,760

pretty hydrogen limited as well by those

4042

02:34:46,950 --> 02:34:43,280

same activities

4043

02:34:48,950 --> 02:34:46,960

um and we had some evidence of you know

4044

02:34:50,309 --> 02:34:48,960

connections with phototrophs as well and

4045

02:34:52,630 --> 02:34:50,319

so maybe that's

4046

02:34:54,150 --> 02:34:52,640

um there's some sort of link here

4047

02:34:56,790 --> 02:34:54,160

um but nonetheless we think this is an

4048

02:34:58,389 --> 02:34:56,800

interesting approach to start looking at

4049

02:34:59,349 --> 02:34:58,399

microbial activity and i think in the

4050

02:35:00,870 --> 02:34:59,359

future

4051

02:35:02,790 --> 02:35:00,880

we want to try this in a different

4052

02:35:04,389 --> 02:35:02,800

spring that maybe isn't

4053

02:35:05,990 --> 02:35:04,399

quite so influenced by the shallow

4054

02:35:07,349 --> 02:35:06,000

community

4055

02:35:09,429 --> 02:35:07,359

um

4056

02:35:11,670 --> 02:35:09,439

so we have a nice isolate we could look

4057

02:35:13,910 --> 02:35:11,680

at electrochemical activity

4058

02:35:15,910 --> 02:35:13,920

and i just really quickly want to

4059

02:35:16,950 --> 02:35:15,920

touch on sort of the energetics of iron

4060

02:35:19,270 --> 02:35:16,960

reduction

4061

02:35:21,429 --> 02:35:19,280

at high ph because

4062

02:35:22,630 --> 02:35:21,439

um well

4063

02:35:24,389 --> 02:35:22,640

basically

4064

02:35:26,710 --> 02:35:24,399

if you can see if you have an iron

4065

02:35:28,710 --> 02:35:26,720

reduction reaction that drives all of

4066

02:35:30,790 --> 02:35:28,720

your iron to dissolved iron this is a

4067

02:35:32,469 --> 02:35:30,800

very ph dependent process

4068

02:35:34,150 --> 02:35:32,479

um but i think one thing we have to

4069

02:35:35,830 --> 02:35:34,160

consider as a community are these

4070

02:35:38,150 --> 02:35:35,840

reactions that involve mineral

4071

02:35:41,590 --> 02:35:38,160

transformations and so these are much

4072

02:35:42,710 --> 02:35:41,600

less dependent on ph this is an example

4073

02:35:44,710 --> 02:35:42,720

of

4074

02:35:46,950 --> 02:35:44,720

mag hematite going all the way to

4075

02:35:49,349 --> 02:35:46,960

magnetite under a variety of ph

4076

02:35:51,750 --> 02:35:49,359

conditions and see a really

4077

02:35:55,190 --> 02:35:51,760

shallow slope here

4078

02:35:57,670 --> 02:35:55,200

um yeah and that was all i was

4079

02:35:59,990 --> 02:35:57,680

hoping to tell you guys about um these

4080

02:36:02,070 --> 02:36:00,000

are my co-authors this was done in

4081

02:36:04,070 --> 02:36:02,080

collaboration with an electric chemist

4082

02:36:07,429 --> 02:36:04,080

who is also a postdoc intense lab when i

4083

02:36:09,270 --> 02:36:07,439

started um akihiro okamoto

4084

02:36:12,550 --> 02:36:09,280

um and

4085

02:36:16,550 --> 02:36:14,710

thank you very much annie uh penny asks

4086

02:36:18,150 --> 02:36:16,560

which spring did you use

4087

02:36:19,830 --> 02:36:18,160

i'm sorry penny yeah this is campsite

4088

02:36:22,150 --> 02:36:19,840

springs

4089

02:36:24,230 --> 02:36:22,160

campsites right thank you i think we

4090

02:36:26,150 --> 02:36:24,240

have just enough time to get to our

4091

02:36:31,830 --> 02:36:26,160

fourth and final pop-up talk um but

4092

02:36:37,750 --> 02:36:35,429

all right alberto are you here

4093

02:36:39,030 --> 02:36:37,760

all right yes

4094

02:36:40,950 --> 02:36:39,040

can you hear me

4095

02:36:43,270 --> 02:36:40,960

we can hear you if i can't see you

4096

02:36:45,349 --> 02:36:43,280

so i think as mike says there's a button

4097

02:36:48,550 --> 02:36:45,359

on the center of your

4098

02:37:00,870 --> 02:36:48,560

webcam window that you click to share

4099

02:37:04,230 --> 02:37:02,550

you just want to click the down arrow

4100

02:37:05,910 --> 02:37:04,240

icon that's in the lower left of your

4101
02:37:08,309 --> 02:37:05,920
slides

4102
02:37:09,110 --> 02:37:08,319
yeah okay perfect

4103
02:37:10,950 --> 02:37:09,120
so

4104
02:37:16,870 --> 02:37:10,960
thank you

4105
02:37:20,550 --> 02:37:18,630
um actually if you click the down arrow

4106
02:37:22,950 --> 02:37:20,560
icon to the bottom left of your slides

4107
02:37:24,870 --> 02:37:22,960
that'll advance them in slides that's

4108
02:37:28,790 --> 02:37:24,880
better okay perfect

4109
02:37:30,950 --> 02:37:28,800
okay thank you so the uh the idea is to

4110
02:37:33,030 --> 02:37:30,960
show some results about the potential

4111
02:37:34,870 --> 02:37:33,040
role of

4112
02:37:36,150 --> 02:37:34,880
serpentinization at high pressure

4113
02:37:39,110 --> 02:37:36,160

conditions

4114

02:37:43,429 --> 02:37:39,120
as a source of hydrogen and

4115

02:37:48,070 --> 02:37:46,389
so i'll start with this diagram to to

4116

02:37:51,510 --> 02:37:48,080
the left

4117

02:37:52,950 --> 02:37:51,520
can you see the green arrow here

4118

02:37:54,790 --> 02:37:52,960
maybe

4119

02:37:56,950 --> 02:37:54,800
anyway this is a pressure temperature

4120

02:37:59,750 --> 02:37:56,960
diagram and

4121

02:38:01,910 --> 02:37:59,760
you can see in blue

4122

02:38:04,150 --> 02:38:01,920
stability field of serpentine minerals

4123

02:38:06,469 --> 02:38:04,160
that is in in other words the stability

4124

02:38:07,270 --> 02:38:06,479
field of certs so plenty like

4125

02:38:09,830 --> 02:38:07,280
and

4126
02:38:14,790 --> 02:38:12,550
to the left there is a small circle

4127
02:38:16,309 --> 02:38:14,800
that should extend to

4128
02:38:17,750 --> 02:38:16,319
it should extend to much higher

4129
02:38:20,070 --> 02:38:17,760
temperature

4130
02:38:22,150 --> 02:38:20,080
but the idea of this circle is just just

4131
02:38:25,030 --> 02:38:22,160
to show that oh that most

4132
02:38:25,910 --> 02:38:25,040
natural laboratories we have

4133
02:38:27,270 --> 02:38:25,920
for

4134
02:38:30,309 --> 02:38:27,280
uh studying

4135
02:38:32,469 --> 02:38:30,319
serpentinization are from the very

4136
02:38:35,910 --> 02:38:32,479
shallowest part of the serpent

4137
02:38:37,750 --> 02:38:35,920
instability field and we can have

4138
02:38:40,150 --> 02:38:37,760

almost the same processes at much

4139

02:38:43,110 --> 02:38:40,160

greater depth down to

4140

02:38:45,590 --> 02:38:43,120

at least four gpa and the best place to

4141

02:38:47,429 --> 02:38:45,600

study these processes uh are subduction

4142

02:38:49,830 --> 02:38:47,439

zones

4143

02:38:50,630 --> 02:38:49,840

so you can see to the right

4144

02:38:51,990 --> 02:38:50,640

the

4145

02:38:54,630 --> 02:38:52,000

blue box

4146

02:38:57,270 --> 02:38:54,640

that shows the the region where we can

4147

02:38:59,349 --> 02:38:57,280

have and we know that from from natural

4148

02:39:01,750 --> 02:38:59,359

studies and from geophysics

4149

02:39:03,349 --> 02:39:01,760

that quite a lot of fresh

4150

02:39:05,590 --> 02:39:03,359

mantle material

4151
02:39:06,469 --> 02:39:05,600
is serpentinized so the question is is

4152
02:39:08,469 --> 02:39:06,479
this

4153
02:39:10,550 --> 02:39:08,479
deep process

4154
02:39:11,590 --> 02:39:10,560
able to release hydrogen and produce

4155
02:39:15,030 --> 02:39:11,600
some

4156
02:39:16,710 --> 02:39:15,040
ebiotic methane or not

4157
02:39:19,270 --> 02:39:16,720
so i'm going to show you some results

4158
02:39:23,110 --> 02:39:21,270
the italian alps

4159
02:39:25,750 --> 02:39:23,120
here you have a map and there are two

4160
02:39:27,750 --> 02:39:25,760
main things to keep in mind

4161
02:39:30,389 --> 02:39:27,760
so you can see in the in the middle of

4162
02:39:32,790 --> 02:39:30,399
the map a light green zone this is a

4163
02:39:36,710 --> 02:39:32,800

fresh uh core of

4164

02:39:38,550 --> 02:39:36,720

peridotites so all within pyroxene and

4165

02:39:41,349 --> 02:39:38,560

and everything

4166

02:39:43,110 --> 02:39:41,359

and uh

4167

02:39:45,510 --> 02:39:43,120

then there's a shell

4168

02:39:48,469 --> 02:39:45,520

a serpentine shell

4169

02:39:51,510 --> 02:39:48,479

all around this uh peridotite body that

4170

02:39:55,750 --> 02:39:53,270

slightly uh

4171

02:39:58,230 --> 02:39:55,760

deeper green color in the map

4172

02:40:03,270 --> 02:40:01,030

yeah the two things that must be uh kept

4173

02:40:07,429 --> 02:40:03,280

in mind are that the shell

4174

02:40:10,790 --> 02:40:07,439

contains serpentinites and carbonate

4175

02:40:12,950 --> 02:40:10,800

and the second is that we know from

4176

02:40:14,550 --> 02:40:12,960

several data from the literature

4177

02:40:16,469 --> 02:40:14,560

literature that

4178

02:40:19,429 --> 02:40:16,479

at least a large part of the

4179

02:40:24,070 --> 02:40:21,990

occurred in the subduction zone

4180

02:40:26,710 --> 02:40:24,080

so these serpentinites formed at high

4181

02:40:29,349 --> 02:40:26,720

pressure conditions i'm not gonna talk

4182

02:40:31,349 --> 02:40:29,359

about this in detail but uh this is well

4183

02:40:32,830 --> 02:40:31,359

known from from the literature so the

4184

02:40:34,389 --> 02:40:32,840

question

4185

02:40:42,389 --> 02:40:34,399

uh

4186

02:40:45,030 --> 02:40:42,399

was produced during the serpentinitization

4187

02:40:46,790 --> 02:40:45,040

and what was the effect of this fluid

4188

02:40:49,269 --> 02:40:46,800

on the surrounding rock

4189

02:40:51,349 --> 02:40:49,279

and all i'm going to show you is from

4190

02:40:53,830 --> 02:40:51,359

the shell so it's from this

4191

02:40:55,349 --> 02:40:53,840

serpentinized and

4192

02:41:00,150 --> 02:40:55,359

carbonated

4193

02:41:05,269 --> 02:41:00,160

here from the shell

4194

02:41:07,670 --> 02:41:05,279

so let's slide so these are data that uh

4195

02:41:10,309 --> 02:41:07,680

are in press so they should appear in

4196

02:41:12,630 --> 02:41:10,319

nature communications quite soon and i'm

4197

02:41:15,910 --> 02:41:12,640

just gonna show you two uh details that

4198

02:41:17,830 --> 02:41:15,920

are the two most uh remarkable

4199

02:41:20,550 --> 02:41:17,840

features

4200

02:41:22,070 --> 02:41:20,560

so um

4201
02:41:23,750 --> 02:41:22,080
the first thing

4202
02:41:26,389 --> 02:41:23,760
is uh

4203
02:41:29,750 --> 02:41:26,399
on the picture to the left

4204
02:41:31,349 --> 02:41:29,760
you see in oh maybe you cannot see the

4205
02:41:33,910 --> 02:41:31,359
labels but

4206
02:41:37,429 --> 02:41:33,920
so all you can see all the white matrix

4207
02:41:38,469 --> 02:41:37,439
is carbonate calcium carbonate and

4208
02:41:42,870 --> 02:41:38,479
in

4209
02:41:45,429 --> 02:41:42,880
have some

4210
02:41:48,790 --> 02:41:45,439
small fragments of serpentine

4211
02:41:51,590 --> 02:41:48,800
you can see an elevated one

4212
02:41:54,309 --> 02:41:51,600
to the bottom of this figure and

4213
02:41:55,349 --> 02:41:54,319

there are many others

4214

02:41:56,630 --> 02:41:55,359

and

4215

02:41:58,950 --> 02:41:56,640

all the small

4216

02:42:01,429 --> 02:41:58,960

dots or bubbles you can see in in the

4217

02:42:02,550 --> 02:42:01,439

photo are food inclusions

4218

02:42:04,389 --> 02:42:02,560

that

4219

02:42:06,950 --> 02:42:04,399

mainly consist of

4220

02:42:09,590 --> 02:42:06,960

methane and dehydrogen

4221

02:42:12,950 --> 02:42:09,600

so this is the first thing first natural

4222

02:42:14,550 --> 02:42:12,960

evidence we have methane and hydrogen in

4223

02:42:16,790 --> 02:42:14,560

these deep rocks

4224

02:42:19,830 --> 02:42:16,800

the second thing is uh on the other

4225

02:42:21,429 --> 02:42:19,840

picture to the to the right this is a an

4226

02:42:22,550 --> 02:42:21,439

sm image

4227

02:42:24,950 --> 02:42:22,560

showing

4228

02:42:27,110 --> 02:42:24,960

the interface between these serpentinite

4229

02:42:28,790 --> 02:42:27,120

fragments and the carbonate matrix and

4230

02:42:31,510 --> 02:42:28,800

you see that there's quite a lot of

4231

02:42:33,670 --> 02:42:31,520

black stuff all around the serpent in

4232

02:42:35,030 --> 02:42:33,680

class and this is graphite

4233

02:42:36,550 --> 02:42:35,040

so we try to

4234

02:42:37,670 --> 02:42:36,560

understand how

4235

02:42:41,030 --> 02:42:37,680

this

4236

02:42:42,950 --> 02:42:41,040

graphite formed and

4237

02:42:44,790 --> 02:42:42,960

i'll be very fast on this because i

4238

02:42:47,590 --> 02:42:44,800

don't have time but

4239

02:42:51,510 --> 02:42:47,600

we reconstructed based on several pieces

4240

02:42:53,750 --> 02:42:51,520

of evidence uh three main stages

4241

02:42:57,110 --> 02:42:53,760

with two

4242

02:43:00,790 --> 02:42:57,120

possibly new paths to generate methane

4243

02:43:02,870 --> 02:43:00,800

at high pressure conditions so the first

4244

02:43:06,389 --> 02:43:02,880

is reaction one

4245

02:43:09,910 --> 02:43:06,399

that involves antigrid calcium carbonate

4246

02:43:12,070 --> 02:43:09,920

and an external fluid that is dehydrogen

4247

02:43:13,269 --> 02:43:12,080

to give some new phases like dioxide

4248

02:43:18,230 --> 02:43:13,279

broochite

4249

02:43:20,309 --> 02:43:19,349

then

4250

02:43:22,870 --> 02:43:20,319

what we

4251

02:43:25,269 --> 02:43:22,880

imagine is that part of this methane

4252

02:43:27,990 --> 02:43:25,279

saturated the fluids in carbon and

4253

02:43:29,910 --> 02:43:28,000

precipitated the graphite

4254

02:43:31,190 --> 02:43:29,920

and then there is the second stage of

4255

02:43:33,590 --> 02:43:31,200

reaction that

4256

02:43:36,150 --> 02:43:33,600

in our model produced from some methane

4257

02:43:39,269 --> 02:43:36,160

that is the interaction with the

4258

02:43:40,309 --> 02:43:39,279

external hydrogen rich fluid and the

4259

02:43:43,110 --> 02:43:40,319

graphite

4260

02:43:45,190 --> 02:43:43,120

so we believe that we have two

4261

02:43:47,830 --> 02:43:45,200

successive

4262

02:43:50,950 --> 02:43:47,840

reactions able to produce

4263

02:43:53,750 --> 02:43:50,960

methane through kinds of

4264

02:43:55,830 --> 02:43:53,760

dry reaction at high pressure conditions

4265

02:43:57,750 --> 02:43:55,840

so again i cannot give you all the

4266

02:43:59,429 --> 02:43:57,760

details but

4267

02:44:03,670 --> 02:43:59,439

we have several pieces of evidence for

4268

02:44:08,790 --> 02:44:06,469

so here in this cartoon you have a

4269

02:44:11,349 --> 02:44:08,800

summary of what we

4270

02:44:13,990 --> 02:44:11,359

believe for these rocks so the principle

4271

02:44:18,550 --> 02:44:16,070

um

4272

02:44:21,190 --> 02:44:18,560

serpentinization of the big peridotite

4273

02:44:25,510 --> 02:44:21,200

body i showed you in the first map

4274

02:44:25,520 --> 02:44:29,030

can you hear me

4275

02:44:33,190 --> 02:44:30,790

yes we can hear you but we should

4276

02:44:35,910 --> 02:44:33,200

probably wrap up some okay so

4277

02:44:37,349 --> 02:44:35,920

i have some problems on the phone

4278

02:44:39,670 --> 02:44:37,359

um

4279

02:44:42,389 --> 02:44:39,680

so the idea is 30 more seconds 30 more

4280

02:44:44,870 --> 02:44:42,399

seconds or a minute thanks

4281

02:44:47,269 --> 02:44:44,880

okay uh the idea is that

4282

02:44:49,510 --> 02:44:47,279

serpentinization of the big piece of

4283

02:44:51,510 --> 02:44:49,520

fresh peridotites released a lot of

4284

02:44:54,309 --> 02:44:51,520

hydrogen and we found

4285

02:44:56,070 --> 02:44:54,319

some hydrogen preserved inclusions and

4286

02:44:57,590 --> 02:44:56,080

then the interaction between this

4287

02:44:59,510 --> 02:44:57,600

hydrogen and

4288

02:45:00,550 --> 02:44:59,520

other rocks just

4289

02:45:03,269 --> 02:45:00,560

next by

4290

02:45:06,630 --> 02:45:03,279

the prohibited bodies

4291

02:45:07,830 --> 02:45:06,640

produced a lot of methane

4292

02:45:08,150 --> 02:45:07,840

so

4293

02:45:09,990 --> 02:45:08,160

then

4294

02:45:12,790 --> 02:45:10,000

[Music]

4295

02:45:15,349 --> 02:45:12,800

just a just for

4296

02:45:17,030 --> 02:45:15,359

conclusions from our study we estimated

4297

02:45:18,230 --> 02:45:17,040

the depth at which this method is

4298

02:45:20,309 --> 02:45:18,240

released

4299

02:45:23,510 --> 02:45:20,319

and we can say that it happened

4300

02:45:25,590 --> 02:45:23,520

between 40 and let's say 15 kilometers

4301

02:45:28,389 --> 02:45:25,600

depth during the examination of this

4302

02:45:30,790 --> 02:45:28,399

body then the duration of this process

4303

02:45:33,269 --> 02:45:30,800

based on some uh pathological evidence

4304

02:45:34,070 --> 02:45:33,279

we can say that uh methane was produced

4305

02:45:37,670 --> 02:45:34,080

over

4306

02:45:39,910 --> 02:45:37,680

uh uh 0.5 to 1 million years we don't

4307

02:45:41,110 --> 02:45:39,920

we don't know if this was episodic or

4308

02:45:41,910 --> 02:45:41,120

continuous

4309

02:45:44,070 --> 02:45:41,920

but

4310

02:45:46,710 --> 02:45:44,080

we have good constraint

4311

02:45:49,030 --> 02:45:46,720

for that and then the fluxes based on

4312

02:45:52,070 --> 02:45:49,040

the mineralogy and the reactions we

4313

02:45:55,990 --> 02:45:52,080

estimated that more than 350 kilograms

4314

02:45:57,830 --> 02:45:56,000

of methane were produced for 2-bit meter

4315

02:46:00,790 --> 02:45:57,840

and we also got some

4316

02:46:02,309 --> 02:46:00,800

estimates on what could be released at

4317

02:46:03,910 --> 02:46:02,319

subduction zones

4318

02:46:06,389 --> 02:46:03,920

from this kind of

4319

02:46:09,110 --> 02:46:06,399

deep serpentinization processes that is

4320

02:46:13,830 --> 02:46:09,120

in the order of 0.8 megatons of hydrogen

4321

02:46:15,830 --> 02:46:13,840

annually and 1.5 megatons of methane

4322

02:46:18,070 --> 02:46:15,840

so these are

4323

02:46:19,269 --> 02:46:18,080

possibly two new and alternative

4324

02:46:21,030 --> 02:46:19,279

pathways

4325

02:46:23,110 --> 02:46:21,040

to produce methane at high pressure

4326

02:46:25,110 --> 02:46:23,120

conditions

4327

02:46:27,750 --> 02:46:25,120

it is true that uh this is from

4328

02:46:30,230 --> 02:46:27,760

subduction zones and it is not sure that

4329

02:46:31,670 --> 02:46:30,240

the same process may take place in in

4330

02:46:33,750 --> 02:46:31,680

other planets but

4331

02:46:36,630 --> 02:46:33,760

the message is that uh from

4332

02:46:38,950 --> 02:46:36,640

high-pressure rocks we can have uh some

4333

02:46:41,830 --> 02:46:38,960

alternative ideas of

4334

02:46:44,790 --> 02:46:41,840

the reactions the the abiotic reactions

4335

02:46:46,710 --> 02:46:44,800

that can produce this kind of gases

4336

02:46:49,510 --> 02:46:46,720

thank you

4337

02:46:52,070 --> 02:46:49,520

really interesting you have some

4338

02:46:55,269 --> 02:46:52,080

questions in the chat window that i um

4339

02:46:57,670 --> 02:46:55,279

if you could answer them uh via typing

4340

02:46:59,190 --> 02:46:57,680

and then we can call a close

4341

02:47:00,710 --> 02:46:59,200

to our session for today and we can

4342

02:47:03,190 --> 02:47:00,720

carry on the conversation in the chat

4343

02:47:05,910 --> 02:47:03,200

window but thank you very much

4344

02:47:08,550 --> 02:47:05,920

alexis or jen and tori like to do a wrap

4345

02:47:14,790 --> 02:47:11,110

or should we just call it and reconvene

4346

02:47:19,429 --> 02:47:17,510

i will just say it was wonderful to have

4347

02:47:21,750 --> 02:47:19,439

such excellent participation today and

4348

02:47:24,150 --> 02:47:21,760

again knowing the top the topics and the

4349

02:47:25,590 --> 02:47:24,160

speakers tomorrow i'm not sure if jen or

4350

02:47:27,190 --> 02:47:25,600

tory have heard from you or those

4351
02:47:29,830 --> 02:47:27,200
organizers but if you are interested in

4352
02:47:31,590 --> 02:47:29,840
doing a pop-up talk even injecting ideas

4353
02:47:33,590 --> 02:47:31,600
particularly in a really brief format to

4354
02:47:35,190 --> 02:47:33,600
get them on the table um it's again

4355
02:47:37,349 --> 02:47:35,200
welcome

4356
02:47:39,110 --> 02:47:37,359
we look forward to it

4357
02:47:41,030 --> 02:47:39,120
thanks alexis yeah i think we can just

4358
02:47:42,790 --> 02:47:41,040
quickly wrap up from our invite uh

4359
02:47:45,349 --> 02:47:42,800
thanking everybody for the great talks

4360
02:47:47,670 --> 02:47:45,359
today and in particular um it's really

4361
02:47:49,590 --> 02:47:47,680
pleasing to see the pop-up talks and and

4362
02:47:50,790 --> 02:47:49,600
how well those work so as alexis said

4363
02:47:52,630 --> 02:47:50,800

please do

4364

02:47:53,990 --> 02:47:52,640

chime in we have still a couple of open

4365

02:47:55,910 --> 02:47:54,000

spots i think for the next couple of

4366

02:47:59,110 --> 02:47:55,920

days and related to that we're going to

4367

02:48:00,710 --> 02:47:59,120

put a link to a survey that we do we try

4368

02:48:02,630 --> 02:48:00,720

to do after all of our events because

4369

02:48:04,309 --> 02:48:02,640

we'd love to get your feedback on what

4370

02:48:06,950 --> 02:48:04,319

you thought about the technologies how

4371

02:48:09,670 --> 02:48:06,960

we integrated it um the

4372

02:48:11,510 --> 02:48:09,680

whole production and also topics if

4373

02:48:13,750 --> 02:48:11,520

there's any upcoming topics that you'd

4374

02:48:15,830 --> 02:48:13,760

like to suggest that we

4375

02:48:18,070 --> 02:48:15,840

that we cover so please take a minute

4376

02:48:19,269 --> 02:48:18,080

and fill in the survey if there if you

4377

02:48:21,830 --> 02:48:19,279

know people that have already dropped

4378

02:48:23,750 --> 02:48:21,840

off uh forward that to them and we we

4379

02:48:26,309 --> 02:48:23,760

want your feedback so we can always be

4380

02:48:28,309 --> 02:48:26,319

improving things thanks

4381

02:48:33,030 --> 02:48:28,319

and then so now back to question sorry

4382

02:48:35,510 --> 02:48:33,990

um

4383

02:48:37,110 --> 02:48:35,520

uh yeah i think we'll just let people

4384

02:48:39,830 --> 02:48:37,120

continue uh

4385

02:48:41,990 --> 02:48:39,840

typing away and we'll call a close to

4386

02:48:43,030 --> 02:48:42,000

the out loud portion of the

4387

02:48:44,710 --> 02:48:43,040

of today

4388

02:48:46,230 --> 02:48:44,720

i think that sounds great okay thanks

4389

02:48:48,469 --> 02:48:46,240

all right thank you everyone hope to see