
AbSciCon
2019

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

2
00:00:11,180 --> 00:00:09,160
[Applause]

3
00:00:13,549 --> 00:00:11,190
we're gonna stay pretty much on this

4
00:00:15,799 --> 00:00:13,559
same theme of looking at life within a

5
00:00:20,080 --> 00:00:15,809
serpent Knights here but from somewhat

6
00:00:22,790 --> 00:00:20,090
more of a theoretical view than what

7
00:00:25,040 --> 00:00:22,800
Alexis talked about just recently just

8
00:00:26,990 --> 00:00:25,050
in the prior talk but I'm gonna I have

9
00:00:30,200 --> 00:00:27,000
mercy on you this afternoon I only have

10
00:00:33,560 --> 00:00:30,210
one data slide in this talk so and this

11
00:00:35,420 --> 00:00:33,570
is work that I've been working on for

12
00:00:37,280 --> 00:00:35,430
several years and then have a number of

13
00:00:39,530 --> 00:00:37,290

collaborators that have worked on helped

14
00:00:44,030 --> 00:00:39,540
and me understand different aspects of

15
00:00:45,799 --> 00:00:44,040
this listed up here so we are looking at

16
00:00:47,689 --> 00:00:45,809
this retinas ation reaction I think most

17
00:00:50,450 --> 00:00:47,699
of you by now are pretty familiar with

18
00:00:52,340 --> 00:00:50,460
this idea that a mantle peridotite rocks

19
00:00:54,020 --> 00:00:52,350
containing olivine and pyroxene react

20
00:00:56,450 --> 00:00:54,030
with water at temperatures below about

21
00:00:58,939 --> 00:00:56,460
350 to undergo there's certain ization

22
00:01:01,070 --> 00:00:58,949
reaction and the reason this is of

23
00:01:02,570 --> 00:01:01,080
interest astrobiology is because one of

24
00:01:04,880 --> 00:01:02,580
the byproducts of this reaction is the

25
00:01:08,180 --> 00:01:04,890
production of hydrogen which can then go

26
00:01:11,359 --> 00:01:08,190
on and feed microbial populations in

27
00:01:14,090 --> 00:01:11,369
these surprising environments and over

28
00:01:15,410 --> 00:01:14,100
the last couple decades these several of

29
00:01:17,599 --> 00:01:15,420
these kind of environments has been the

30
00:01:20,929 --> 00:01:17,609
focus of different microbiology studies

31
00:01:22,370 --> 00:01:20,939
most of these have focused on places

32
00:01:25,340 --> 00:01:22,380
like hydrothermal vents on the ocean

33
00:01:27,889 --> 00:01:25,350
floor a lot like a place like lost city

34
00:01:29,779 --> 00:01:27,899
and alkaline springs where these fluids

35
00:01:32,569 --> 00:01:29,789
are coming up and do being discharged at

36
00:01:35,630 --> 00:01:32,579
the surface where the interaction with

37
00:01:39,649 --> 00:01:35,640
surface oxidants presents a favorable

38
00:01:41,480 --> 00:01:39,659

habitat for biology what I'm really

39
00:01:43,219 --> 00:01:41,490
going to be looking more at today is the

40
00:01:45,249 --> 00:01:43,229
subsurface part of this systems where

41
00:01:47,630 --> 00:01:45,259
you have either seawater or groundwater

42
00:01:49,270 --> 00:01:47,640
penetrating into these rocks reacting

43
00:01:51,410 --> 00:01:49,280
with the olivine and pyroxene and

44
00:01:54,590 --> 00:01:51,420
undergoing this serpent is a ssin

45
00:01:58,340 --> 00:01:54,600
reaction and what I'm looking at here is

46
00:02:00,800 --> 00:01:58,350
the capacity for the rocks to support

47
00:02:04,249 --> 00:02:00,810
life in these subsurface environments so

48
00:02:07,340 --> 00:02:04,259
below these Springs and in hydrothermal

49
00:02:10,520 --> 00:02:07,350
vents what how what can live there and

50
00:02:13,600 --> 00:02:10,530
what how much biomass it can support so

51
00:02:16,670 --> 00:02:13,610
I'm looking a couple of questions can

52
00:02:18,890 --> 00:02:16,680
autotrophic communities exist within the

53
00:02:21,470 --> 00:02:18,900
subsurface of these certain izing

54
00:02:22,430 --> 00:02:21,480
systems and if so how much subsurface

55
00:02:24,230 --> 00:02:22,440
microbial lie

56
00:02:26,240 --> 00:02:24,240
can be supported in those kinds of

57
00:02:29,060 --> 00:02:26,250
environments so I'm looking at this from

58
00:02:31,760 --> 00:02:29,070
a kind of an energy balance perspective

59
00:02:34,160 --> 00:02:31,770
where there's some in some system

60
00:02:36,260 --> 00:02:34,170
there's an energy supply and the

61
00:02:39,380 --> 00:02:36,270
organisms lived in there have some sort

62
00:02:41,240 --> 00:02:39,390
of demand of energy in order to run

63
00:02:42,560 --> 00:02:41,250

their metabolism so different

64
00:02:45,020 --> 00:02:42,570
environments can have different degrees

65
00:02:47,530 --> 00:02:45,030
of energy supply and in different

66
00:02:49,880 --> 00:02:47,540
environments organisms can have a

67
00:02:53,840 --> 00:02:49,890
different energy requirements in order

68
00:02:55,340 --> 00:02:53,850
to exist and if the energy supply far

69
00:02:57,650 --> 00:02:55,350
exists the demand then there can be

70
00:02:59,960 --> 00:02:57,660
growth of organisms but if it's not

71
00:03:01,580 --> 00:02:59,970
sufficient to support microbiology then

72
00:03:03,230 --> 00:03:01,590
life is not possible

73
00:03:05,630 --> 00:03:03,240
and then there's an intermediate level

74
00:03:09,440 --> 00:03:05,640
where organisms can exist there but

75
00:03:12,800 --> 00:03:09,450
maybe not actively grow and kind of the

76
00:03:14,210 --> 00:03:12,810
hydrothermal vents and in stand out

77
00:03:16,520 --> 00:03:14,220
plant springs environments are probably

78
00:03:18,770 --> 00:03:16,530
some up here where there's a lot of

79
00:03:20,420 --> 00:03:18,780
energy supply into the environment but

80
00:03:22,280 --> 00:03:20,430
most solar subsurface environments

81
00:03:26,630 --> 00:03:22,290
probably exist somewhere along this

82
00:03:28,610 --> 00:03:26,640
interface where there's enough energy to

83
00:03:32,510 --> 00:03:28,620
to stay there and live there and survive

84
00:03:34,370 --> 00:03:32,520
but not a lot of energy for growth so

85
00:03:36,650 --> 00:03:34,380
I'm gonna first look at the energy

86
00:03:40,160 --> 00:03:36,660
supply and these serpent sizing systems

87
00:03:42,500 --> 00:03:40,170
and ask the question how much energy is

88
00:03:45,199 --> 00:03:42,510

available for hydrogen based little

89
00:03:48,110 --> 00:03:45,209
author little otto trophy in these

90
00:03:50,720 --> 00:03:48,120
subsurface environments so we have this

91
00:03:52,729 --> 00:03:50,730
reaction where all the empiric scene is

92
00:03:55,460 --> 00:03:52,739
grazing this this serpentine mineral is

93
00:03:58,520 --> 00:03:55,470
assemblage and hydrogen and one way to

94
00:04:00,949 --> 00:03:58,530
get at how much hydrogen is potentially

95
00:04:02,870 --> 00:04:00,959
being produced in these environments is

96
00:04:05,030 --> 00:04:02,880
to look at reaction rates and here's my

97
00:04:07,670 --> 00:04:05,040
one data slide and what I've done here

98
00:04:11,390 --> 00:04:07,680
is I've compiled all the experimentally

99
00:04:14,060 --> 00:04:11,400
derived in a data for hydrogen

100
00:04:15,920 --> 00:04:14,070
production during experimentalist

101
00:04:18,920 --> 00:04:15,930
organization so experiments that started

102
00:04:20,630 --> 00:04:18,930
out with olivine or olivine pyroxene and

103
00:04:22,880 --> 00:04:20,640
measured the amount of hydrogen coming

104
00:04:24,590 --> 00:04:22,890
off this this thing so I'm plotting

105
00:04:27,290 --> 00:04:24,600
these up as a function of temperature is

106
00:04:29,300 --> 00:04:27,300
this hydrogen production rate in there

107
00:04:32,450 --> 00:04:29,310
in the units of nano moles per gram per

108
00:04:34,310 --> 00:04:32,460
day and this is something that is really

109
00:04:35,270 --> 00:04:34,320
only people have only started to

110
00:04:40,280 --> 00:04:35,280
experiment

111
00:04:42,950 --> 00:04:40,290
the last 15 or so years so there's not a

112
00:04:44,510 --> 00:04:42,960
lot of data could strain this and you'll

113
00:04:46,159 --> 00:04:44,520

notice right away that most of the data

114
00:04:47,540 --> 00:04:46,169
that is available is President have

115
00:04:51,050 --> 00:04:47,550
temperatures that are higher at about

116
00:04:53,500 --> 00:04:51,060
230 degrees another thing you'll note is

117
00:04:56,270 --> 00:04:53,510
that you know at any one particular

118
00:05:02,480 --> 00:04:56,280
temperature there's a about a four order

119
00:05:05,030 --> 00:05:02,490
of magnitude distribution or variation

120
00:05:06,920 --> 00:05:05,040
in the rates that have been measured in

121
00:05:09,050 --> 00:05:06,930
these laboratory experiments these are

122
00:05:11,960 --> 00:05:09,060
due to factors such as rock composition

123
00:05:13,790 --> 00:05:11,970
pH and we're just really beginning to

124
00:05:16,190 --> 00:05:13,800
understand what causes that kind of

125
00:05:18,470 --> 00:05:16,200
variation and understand why different

126
00:05:21,220 --> 00:05:18,480
kind of rocks and can produce different

127
00:05:24,140 --> 00:05:21,230
amounts of hydrogen in different

128
00:05:25,430 --> 00:05:24,150
situations one thing you'll notice too

129
00:05:27,800 --> 00:05:25,440
that there's a there's pretty much a

130
00:05:29,900 --> 00:05:27,810
scarcity of data at lower temperatures

131
00:05:33,230 --> 00:05:29,910
where we were looking at these these

132
00:05:35,510 --> 00:05:33,240
potentially habitable shallow subsurface

133
00:05:36,860 --> 00:05:35,520
environments and all of these data

134
00:05:38,240 --> 00:05:36,870
that's shown here with arrows on it

135
00:05:40,610 --> 00:05:38,250
those are experiments where there was

136
00:05:43,370 --> 00:05:40,620
too little hydrogen presented to measure

137
00:05:46,850 --> 00:05:43,380
on laboratory scales so pretty much at

138
00:05:48,830 --> 00:05:46,860

temperatures below about 175 degrees the

139
00:05:50,630 --> 00:05:48,840
reactant is just going to slow to be

140
00:05:53,750 --> 00:05:50,640
able to measure hydrogen production from

141
00:05:55,279 --> 00:05:53,760
certain ization on laboratory timescale

142
00:05:58,760 --> 00:05:55,289
so that's all weird giving us a clue

143
00:06:01,700 --> 00:05:58,770
that in these in these shallow low

144
00:06:03,170 --> 00:06:01,710
temperature environments a hydrogen rate

145
00:06:04,880 --> 00:06:03,180
of hydrogen delivery by this

146
00:06:08,600 --> 00:06:04,890
urbanization reactant is going to be

147
00:06:11,480 --> 00:06:08,610
pretty slow but if we go down here if we

148
00:06:13,820 --> 00:06:11,490
and if we take just brackets these

149
00:06:16,159 --> 00:06:13,830
higher temperature datas with a very

150
00:06:20,120 --> 00:06:16,169
simple preliminary and probably not very

151
00:06:22,820 --> 00:06:20,130
good model for first-order reaction

152
00:06:25,010 --> 00:06:22,830
kinetics with Arrhenius temperature

153
00:06:26,990 --> 00:06:25,020
dependencies we can just trial and some

154
00:06:29,300 --> 00:06:27,000
provisional lines here about what we

155
00:06:30,830 --> 00:06:29,310
think might be the hydrogen production

156
00:06:33,500 --> 00:06:30,840
late rate in low temperature

157
00:06:37,250 --> 00:06:33,510
environments and I should say too that

158
00:06:39,140 --> 00:06:37,260
these are all are all measured on

159
00:06:42,680 --> 00:06:39,150
laboratory conditions where you have

160
00:06:44,210 --> 00:06:42,690
powdered minerals and very favorable

161
00:06:46,399 --> 00:06:44,220
conditions for the reaction and in the

162
00:06:48,890 --> 00:06:46,409
natural system we would probably expect

163
00:06:51,320 --> 00:06:48,900

things to be going actually slower than

164
00:06:53,480 --> 00:06:51,330
but if we just take this data that we

165
00:06:56,300 --> 00:06:53,490
have and extrapolate it down temperature

166
00:06:58,730 --> 00:06:56,310
if we go down here in like the 52 30 10

167
00:07:00,170 --> 00:06:58,740
degree temperature range where we think

168
00:07:02,870 --> 00:07:00,180
things might be living in subsurface

169
00:07:04,670 --> 00:07:02,880
environments we can extrapolate to

170
00:07:08,150 --> 00:07:04,680
something like a rate of 10 to the minus

171
00:07:10,490 --> 00:07:08,160
18th or 10 to the 14th moles of hydrogen

172
00:07:14,330 --> 00:07:10,500
being produced 4 grand per day in these

173
00:07:16,280 --> 00:07:14,340
shallow subsurface environments so we

174
00:07:18,140 --> 00:07:16,290
get something like that that translates

175
00:07:21,230 --> 00:07:18,150
to something like 10 to the 6 to 10 to

176
00:07:24,230 --> 00:07:21,240
the 10th molecules per hydrogen per gram

177
00:07:26,420 --> 00:07:24,240
of rock per day and just for perspective

178
00:07:28,280 --> 00:07:26,430
on that some cells specific race for

179
00:07:31,340 --> 00:07:28,290
sulfate reduction in marine sediments

180
00:07:33,730 --> 00:07:31,350
that requires about 2,500 molecules per

181
00:07:37,070 --> 00:07:33,740
day per cell in order to maintain that

182
00:07:38,540 --> 00:07:37,080
for aerobic heterotrophs they consume

183
00:07:40,700 --> 00:07:38,550
about something like 10 to the fifth

184
00:07:42,200 --> 00:07:40,710
molecules of oxygen per day so right

185
00:07:44,300 --> 00:07:42,210
away we're getting to see that this is

186
00:07:47,660 --> 00:07:44,310
probably going to be only enough to

187
00:07:49,550 --> 00:07:47,670
support a relatively small population we

188
00:07:52,310 --> 00:07:49,560

can look at this energetically also and

189
00:07:54,050 --> 00:07:52,320
say well if we have a reaction like

190
00:07:56,360 --> 00:07:54,060
sulfate reduction that's using this

191
00:07:59,990 --> 00:07:56,370
hydrogen that produced that yields about

192
00:08:03,590 --> 00:08:00,000
10 kill a jam kelly gems kilojoules per

193
00:08:05,090 --> 00:08:03,600
mole of hydrogen this would and equate

194
00:08:06,860 --> 00:08:05,100
to an energetic power supply is

195
00:08:09,770 --> 00:08:06,870
something on the order of 10 to the 15

196
00:08:12,140 --> 00:08:09,780
to the 10 to 19 watts per gram of rock

197
00:08:15,050 --> 00:08:12,150
so that's our power supply what about

198
00:08:17,360 --> 00:08:15,060
the energy demand well this is something

199
00:08:20,150 --> 00:08:17,370
that's really not very known very well

200
00:08:23,060 --> 00:08:20,160
at all about how much energy is the

201
00:08:27,350 --> 00:08:23,070
minimum amount of organisms can survive

202
00:08:29,960 --> 00:08:27,360
on one study recently there's been

203
00:08:32,150 --> 00:08:29,970
looked at this is is this paper by a

204
00:08:34,790 --> 00:08:32,160
Doug Leier Owen yan Amin where they

205
00:08:37,850 --> 00:08:34,800
looked at looked at microbial

206
00:08:40,250 --> 00:08:37,860
populations in submarine sediments in

207
00:08:42,950 --> 00:08:40,260
the South Pacific Gyre and compared it

208
00:08:44,960 --> 00:08:42,960
with various models of the minimal

209
00:08:46,790 --> 00:08:44,970
energy supply and they came up with

210
00:08:49,490 --> 00:08:46,800
something an estimate of the basal well

211
00:08:51,560 --> 00:08:49,500
basil maintenance energy requirement to

212
00:08:56,300 --> 00:08:51,570
sell of something like 2 to the minus 10

213
00:09:00,110 --> 00:08:56,310

to the 19th watts per cell or 200 Zepto

214
00:09:02,720 --> 00:09:00,120
watts of energy so we can compare this

215
00:09:04,790 --> 00:09:02,730
with our our serpentinization supply

216
00:09:07,400 --> 00:09:04,800
of energy and it looks like there is

217
00:09:10,189 --> 00:09:07,410
enough energy being supplied to support

218
00:09:12,949 --> 00:09:10,199
less than only a few hundred cells per

219
00:09:16,370 --> 00:09:12,959
centimeter cubed and this is again this

220
00:09:18,050 --> 00:09:16,380
may be the mystic number based on these

221
00:09:20,540 --> 00:09:18,060
laboratory experiments in the actual

222
00:09:24,370 --> 00:09:20,550
hydrogen generation rate in natural

223
00:09:27,439 --> 00:09:24,380
rocks maybe somewhat lower than that but

224
00:09:30,740 --> 00:09:27,449
I'm not sure that that that kind of

225
00:09:33,170 --> 00:09:30,750
maintenance energy requirement applies

226
00:09:35,150 --> 00:09:33,180
so much these high pH serpent analyzing

227
00:09:39,290 --> 00:09:35,160
environments where the high pH may

228
00:09:41,000 --> 00:09:39,300
impose additional energetic costs for

229
00:09:43,939 --> 00:09:41,010
example I took this from some work by

230
00:09:45,710 --> 00:09:43,949
holer that's in preparations and

231
00:09:48,530 --> 00:09:45,720
preliminary calculations of what it

232
00:09:51,259 --> 00:09:48,540
costs to maintain your energy mint your

233
00:09:52,449 --> 00:09:51,269
the pH across the cellular membrane if

234
00:09:56,180 --> 00:09:52,459
you're consuming something like

235
00:09:59,900 --> 00:09:56,190
bicarbonate or sulphate with hydrogen

236
00:10:02,949 --> 00:09:59,910
and as you go up in pH the cost of

237
00:10:06,139 --> 00:10:02,959
maintaining your cellular membrane

238
00:10:07,850 --> 00:10:06,149

potential increases substantially so we

239
00:10:09,620 --> 00:10:07,860
may be looking at additional energetic

240
00:10:12,170 --> 00:10:09,630
costs just to live in those kind of

241
00:10:14,540 --> 00:10:12,180
environments more than what we see in

242
00:10:18,259 --> 00:10:14,550
the in those other estimates I showed so

243
00:10:20,809 --> 00:10:18,269
it may cost more but in any case it

244
00:10:23,000 --> 00:10:20,819
looks like very small populations can be

245
00:10:25,129 --> 00:10:23,010
maintaining the subsurface serpentine

246
00:10:28,430 --> 00:10:25,139
izing environments based on hydrogen and

247
00:10:29,809 --> 00:10:28,440
that seems to be consistent with some

248
00:10:31,790 --> 00:10:29,819
data that are beginning to come in

249
00:10:34,610 --> 00:10:31,800
looking at these environments and for

250
00:10:36,470 --> 00:10:34,620
example this is some data that came out

251
00:10:38,689 --> 00:10:36,480
last year from drill holes drilled into

252
00:10:42,199 --> 00:10:38,699
the Atlantic math seif where the slaw

253
00:10:43,400 --> 00:10:42,209
city system is hosted here so looking

254
00:10:45,920 --> 00:10:43,410
down these drill calls

255
00:10:48,139 --> 00:10:45,930
what they find is cell populations in

256
00:10:50,990 --> 00:10:48,149
those rocks on the order of ten to a

257
00:10:54,319 --> 00:10:51,000
hundred cells per centimeter cubes have

258
00:10:57,410 --> 00:10:54,329
very small populations and that may be

259
00:10:59,300 --> 00:10:57,420
all that this hydrogen producing reacts

260
00:11:03,579 --> 00:10:59,310
serpentinization reaction may be able to

261
00:11:05,629 --> 00:11:03,589
produce another environment where

262
00:11:08,449 --> 00:11:05,639
astrobiologists are interested in this

263
00:11:11,240 --> 00:11:08,459

in the solar system is Mars and because

264
00:11:12,829 --> 00:11:11,250
we see serpent Knights on Mars and we

265
00:11:15,889 --> 00:11:12,839
have a surface that really seems

266
00:11:16,550 --> 00:11:15,899
relatively inhospitable there's a lot of

267
00:11:18,769 --> 00:11:16,560
people there

268
00:11:21,470 --> 00:11:18,779
we need to go look at subsurface

269
00:11:23,569 --> 00:11:21,480
environments and serpent Knights there

270
00:11:25,939 --> 00:11:23,579
certainly and in my a good target for

271
00:11:28,610 --> 00:11:25,949
that kind of thing but these extremely

272
00:11:30,439 --> 00:11:28,620
low biomass populations may indicate

273
00:11:32,749 --> 00:11:30,449
that these impose really serious

274
00:11:34,280 --> 00:11:32,759
challenges for detection of life within

275
00:11:36,949 --> 00:11:34,290
serpent knives and rocks if you're

276
00:11:39,439 --> 00:11:36,959
trying to find a rock on Mars that only

277
00:11:44,090 --> 00:11:39,449
is supporting a couple of hundred or

278
00:11:46,929 --> 00:11:44,100
less selves per centimeter of rock it

279
00:11:49,699 --> 00:11:46,939
may be tough finding those biomarkers

280
00:11:51,559 --> 00:11:49,709
what may be more favorable as it goes

281
00:11:53,660 --> 00:11:51,569
through these to look for places like

282
00:11:57,049 --> 00:11:53,670
these alkaline springs or other areas

283
00:12:00,439 --> 00:11:57,059
where fluid flow is focusing these

284
00:12:04,309 --> 00:12:00,449
energy sources into a more confined

285
00:12:06,019 --> 00:12:04,319
environment and may be better targets

286
00:12:08,210 --> 00:12:06,029
those place may be better targets to go

287
00:12:12,139 --> 00:12:08,220
and look for for evidence of life in

288
00:12:14,889 --> 00:12:12,149

Mars and other planetary bodies beyond

289
00:12:16,699 --> 00:12:14,899
Earth anyway that's all I have today and

290
00:12:29,929 --> 00:12:16,709
happily I only have to answer any

291
00:12:34,329 --> 00:12:29,939
questions you showed a diagram of the

292
00:12:39,769 --> 00:12:34,339
rate of h2 generation versus temperature

293
00:12:43,449 --> 00:12:39,779
yes and the highest rate was around 250

294
00:12:49,369 --> 00:12:43,459
degrees and shoes however you did not I

295
00:12:51,230 --> 00:12:49,379
did not see the pH well it that that's

296
00:12:53,210 --> 00:12:51,240
one of the very pH is probably one of

297
00:12:56,210 --> 00:12:53,220
the variables that accounts for this

298
00:12:57,920 --> 00:12:56,220
this this range in hydrogen generation

299
00:13:00,679 --> 00:12:57,930
rates and actually these ones in red

300
00:13:02,660 --> 00:13:00,689
those are all what experiments that have

301
00:13:04,340 --> 00:13:02,670
a room temperature pH greater than 10

302
00:13:07,850 --> 00:13:04,350
everything else has a room temperature

303
00:13:10,160 --> 00:13:07,860
pH below s so in some cases you see

304
00:13:12,220 --> 00:13:10,170
greater faster hydrogen generation at

305
00:13:15,009 --> 00:13:12,230
higher pH some cases you don't and

306
00:13:17,419 --> 00:13:15,019
that's that's something is that is

307
00:13:20,989 --> 00:13:17,429
subjective ongoing investigations of why

308
00:13:23,680 --> 00:13:20,999
that I think is very important for h2

309
00:13:29,050 --> 00:13:23,690
generation because if

310
00:13:33,730 --> 00:13:29,060
you look at the diagram of if put upon

311
00:13:37,420 --> 00:13:33,740
the potential electric potential versus

312
00:13:40,450 --> 00:13:37,430
pH you can realize that at high

313
00:13:45,100 --> 00:13:40,460

colliding pH very high nine point five

314
00:13:50,770 --> 00:13:45,110
to fourteen and at high temperature 300

315
00:13:56,320 --> 00:13:50,780
to 350 degrees Celsius and also 10 to 25

316
00:13:58,450 --> 00:13:56,330
mega Pascal if the ferrous ion is

317
00:14:04,150 --> 00:13:58,460
transformed into ferric iron with

318
00:14:06,700 --> 00:14:04,160
emission of h2 so you you approach the

319
00:14:07,930 --> 00:14:06,710
temperature but the pressure is also

320
00:14:10,450 --> 00:14:07,940
very important

321
00:14:12,150 --> 00:14:10,460
yes well yeah yeah and these are all

322
00:14:18,330 --> 00:14:12,160
these experiments are almost all

323
00:14:24,280 --> 00:14:18,340
performed at about 350 to 500 bars yes

324
00:14:26,140 --> 00:14:24,290
the correct pressure because a 300 bars

325
00:14:27,940 --> 00:14:26,150
is 50 mega Pascal

326
00:14:29,800 --> 00:14:27,950
yeah I'm love I would agree I would

327
00:14:31,060 --> 00:14:29,810
agree that high pH and and these

328
00:14:33,820 --> 00:14:31,070
temperatures there there is a lot of

329
00:14:37,000 --> 00:14:33,830
thermodynamic potential to create higher

330
00:14:38,740 --> 00:14:37,010
amounts of hydrogen but these rates are

331
00:14:40,750 --> 00:14:38,750
pretty much all controlled by kinetic

332
00:14:43,630 --> 00:14:40,760
factors so you have to add that into the

333
00:14:46,690 --> 00:14:43,640
into thinking about you know that what

334
00:14:49,330 --> 00:14:46,700
what is thermodynamically favorable yes

335
00:14:51,850 --> 00:14:49,340
but I just wanted to show that in this

336
00:14:56,320 --> 00:14:51,860
specific domain of water which is called

337
00:14:59,440 --> 00:14:56,330
high subcritical and also where the

338
00:15:02,590 --> 00:14:59,450

silica deserves much better than at

339
00:15:05,650 --> 00:15:02,600
lower temperature and higher temperature

340
00:15:10,300 --> 00:15:05,660
the all these compounds will dissolve

341
00:15:12,310 --> 00:15:10,310
and from h2 and sio2 maybe if you still

342
00:15:14,110 --> 00:15:12,320
have time in five minutes I can show you

343
00:15:16,570 --> 00:15:14,120
my poster about that and I shall send

344
00:15:18,570 --> 00:15:16,580
you my articles yeah please do

345
00:15:20,710 --> 00:15:18,580
I'm going to talk about that more

346
00:15:22,630 --> 00:15:20,720
because I think we should probably move

347
00:15:24,640 --> 00:15:22,640
Oh quick question just a quick question

348
00:15:27,190 --> 00:15:24,650
yes I mean it's great work one thing I'd

349
00:15:28,630 --> 00:15:27,200
like to just question is when we talk

350
00:15:29,770 --> 00:15:28,640
about Mars applications from Mars you

351
00:15:31,150 --> 00:15:29,780
use in situ

352
00:15:32,410 --> 00:15:31,160
that's the argument that's what you look

353
00:15:34,660 --> 00:15:32,420
we're looking at the lower temperatures

354
00:15:35,800 --> 00:15:34,670
now maybe when you think about biomass

355
00:15:37,100 --> 00:15:35,810
estimations from Mars so be sure you

356
00:15:39,200 --> 00:15:37,110
don't think all tumbled in sich you

357
00:15:40,640 --> 00:15:39,210
we have gradients so if you go example

358
00:15:42,620 --> 00:15:40,650
you know think about Mars support water

359
00:15:44,690 --> 00:15:42,630
percolating you can have actually water

360
00:15:46,460 --> 00:15:44,700
mostly in contact with much water what

361
00:15:48,350 --> 00:15:46,470
warmer regions where you have much large

362
00:15:51,110 --> 00:15:48,360
production in the order of you below 100

363
00:15:52,490 --> 00:15:51,120

C so you can produce much more and bring

364
00:15:55,310 --> 00:15:52,500
it into the regions where there's more

365
00:15:56,720 --> 00:15:55,320
may be life so which means you've eh in

366
00:15:57,890 --> 00:15:56,730
you know you'd have production rates

367
00:16:00,020 --> 00:15:57,900
which are orders of magnitude larger

368
00:16:01,910 --> 00:16:00,030
than the lower temperature wants so I

369
00:16:03,620 --> 00:16:01,920
would be careful using the in situ low

370
00:16:05,780 --> 00:16:03,630
temperature as a prediction for my mass

371
00:16:08,390 --> 00:16:05,790
because it might be quite misleading yes

372
00:16:10,850 --> 00:16:08,400
and I I absolutely agree and I think a

373
00:16:13,100 --> 00:16:10,860
lot of these these systems for example

374
00:16:14,840 --> 00:16:13,110
the one in Oman those kinds of

375
00:16:18,110 --> 00:16:14,850
environments I think they're they are

376
00:16:20,540 --> 00:16:18,120
largely driven by higher temp long

377
00:16:21,890 --> 00:16:20,550
residence time fluid at probably higher

378
00:16:23,600 --> 00:16:21,900
temperatures that are carrying their

379
00:16:25,340 --> 00:16:23,610
their hydrogen and methane load up

380
00:16:27,050 --> 00:16:25,350
towards the surface where it begins to

381
00:16:30,500 --> 00:16:27,060
be so it's kind of a focusing mechanism

382
00:16:32,120 --> 00:16:30,510
there yes yes so that that that that of

383
00:16:36,610 --> 00:16:32,130
course changes the old picture yes yes