
AbSciCon
2019

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

2
00:00:11,850 --> 00:00:09,110
[Applause]

3
00:00:13,770 --> 00:00:11,860
so I'm gonna talk a bit about how some

4
00:00:15,539 --> 00:00:13,780
of these smaller monomers could have

5
00:00:17,550 --> 00:00:15,549
formed in geochemical systems and in

6
00:00:19,680 --> 00:00:17,560
particular we're very interested in

7
00:00:22,050 --> 00:00:19,690
understanding how the gradients of redox

8
00:00:23,669 --> 00:00:22,060
mph can affect what distributions of

9
00:00:25,950 --> 00:00:23,679
products you'd get from a very simple

10
00:00:28,200 --> 00:00:25,960
reaction and so we're focusing here on

11
00:00:30,120 --> 00:00:28,210
these small molecules that are formed

12
00:00:31,829 --> 00:00:30,130
from carboxylic acids like glyoxylate

13
00:00:34,050 --> 00:00:31,839

and pyruvate and I have a picture here

14
00:00:35,610 --> 00:00:34,060
of Mars because it's a very iron rich

15
00:00:37,530 --> 00:00:35,620
planet it's got a lot of iron minerals

16
00:00:40,110 --> 00:00:37,540
and possibly redox gradients below the

17
00:00:41,520 --> 00:00:40,120
surface and so this is meant to be kind

18
00:00:43,349 --> 00:00:41,530
of an analogue for stuff that might be

19
00:00:46,650 --> 00:00:43,359
happening not just in seafloor systems

20
00:00:48,689 --> 00:00:46,660
but also perhaps in surface systems so

21
00:00:50,400 --> 00:00:48,699
we're looking at the iron hydroxide

22
00:00:52,080 --> 00:00:50,410
minerals and the iron oxide minerals

23
00:00:54,479 --> 00:00:52,090
these are minerals that are very

24
00:00:57,360 --> 00:00:54,489
reactive and also prone to absorbing

25
00:00:59,340 --> 00:00:57,370
ions and these can vary from a very

26
00:01:01,770 --> 00:00:59,350
reduced mineral like green rust all the

27
00:01:04,500 --> 00:01:01,780
way to iron oxides and oxy hydroxides

28
00:01:06,000 --> 00:01:04,510
that are mostly ferric and when you have

29
00:01:07,860 --> 00:01:06,010
a gradient of redox and these iron

30
00:01:09,330 --> 00:01:07,870
mineral systems you can get a bunch of

31
00:01:11,700 --> 00:01:09,340
different mineral phases that all have

32
00:01:13,920 --> 00:01:11,710
slightly different reactivities and this

33
00:01:16,080 --> 00:01:13,930
could represent for example a seafloor

34
00:01:17,850 --> 00:01:16,090
system where the seafloor is a little

35
00:01:19,770 --> 00:01:17,860
more oxidized and as you go deep it gets

36
00:01:22,499 --> 00:01:19,780
more reducing it could also represent

37
00:01:23,730 --> 00:01:22,509
this hydrothermal vent analog where you

38
00:01:25,590 --> 00:01:23,740

have fluid coming up that's more

39
00:01:27,420 --> 00:01:25,600
alkaline and reducing growing chimneys

40
00:01:29,580 --> 00:01:27,430
or making sediments that could be more

41
00:01:30,990 --> 00:01:29,590
oxidized on the exterior and then it

42
00:01:32,910 --> 00:01:31,000
could also represent subsurface

43
00:01:36,209 --> 00:01:32,920
gradients on Mars for example or on the

44
00:01:37,800 --> 00:01:36,219
early Earth and so the reaction that we

45
00:01:40,440 --> 00:01:37,810
were interested in and seeing how it is

46
00:01:43,109 --> 00:01:40,450
affected by redox gradients is reacting

47
00:01:44,670 --> 00:01:43,119
these simple organic acids with ammonia

48
00:01:46,709 --> 00:01:44,680
which can be sourced from various

49
00:01:48,450 --> 00:01:46,719
geochemical mechanisms and then seeing

50
00:01:50,190 --> 00:01:48,460
it what happens when we react this with

51
00:01:52,560 --> 00:01:50,200
ammonia and the presence of minerals or

52
00:01:55,050 --> 00:01:52,570
just an aqueous solution and so each

53
00:01:57,240 --> 00:01:55,060
carboxylic acid if you react it can give

54
00:02:00,029 --> 00:01:57,250
you a specific amino acid or a specific

55
00:02:01,950 --> 00:02:00,039
alpha hydroxy acid so pyruvate could

56
00:02:04,440 --> 00:02:01,960
give you alanine or lactate and or

57
00:02:06,480 --> 00:02:04,450
lactate glyoxylate can give you glycine

58
00:02:08,100 --> 00:02:06,490
or glycolate and so in a system with

59
00:02:10,139 --> 00:02:08,110
both precursors you could get a mixture

60
00:02:13,560 --> 00:02:10,149
of all these plus other compounds as

61
00:02:15,540 --> 00:02:13,570
well so when we do these reactions we

62
00:02:16,830 --> 00:02:15,550
basically start out with a bottle where

63
00:02:19,199 --> 00:02:16,840

we make the mineral so this is an

64
00:02:20,970 --> 00:02:19,209
aqueous system we precipitate a mineral

65
00:02:22,259 --> 00:02:20,980
in situ so this way it

66
00:02:24,390 --> 00:02:22,269
not a field sample where there's

67
00:02:25,860 --> 00:02:24,400
contamination possibility it's actually

68
00:02:27,330 --> 00:02:25,870
a mineral that's freshly formed in the

69
00:02:29,940 --> 00:02:27,340
lab which also keeps it a bit more

70
00:02:32,309 --> 00:02:29,950
reactive and so these are reacted at a

71
00:02:34,830 --> 00:02:32,319
temperature usually around 50 to 70

72
00:02:36,660 --> 00:02:34,840
degrees Celsius and then the liquid

73
00:02:38,640 --> 00:02:36,670
phase is analysed after these organics

74
00:02:40,619 --> 00:02:38,650
are added for a period of time and we

75
00:02:43,110 --> 00:02:40,629
analyze them with various techniques but

76
00:02:44,759 --> 00:02:43,120
mostly proton NMR which gives you Peaks

77
00:02:46,020 --> 00:02:44,769
for each compound and you can correlate

78
00:02:48,240 --> 00:02:46,030
the area of the peak to the

79
00:02:51,630 --> 00:02:48,250
concentration of that as its increasing

80
00:02:53,520 --> 00:02:51,640
or decreasing with time and so what we

81
00:02:55,410 --> 00:02:53,530
looked at first was what happens in

82
00:02:58,229 --> 00:02:55,420
aqueous solutions so no mineral present

83
00:03:00,599 --> 00:02:58,239
and we generally see that pyruvate does

84
00:03:03,059 --> 00:03:00,609
not react at all so pyruvate is kind of

85
00:03:05,130 --> 00:03:03,069
less reactive than glyoxylate and an

86
00:03:07,530 --> 00:03:05,140
aqueous solution we see that glyoxylate

87
00:03:09,000 --> 00:03:07,540
does react to give you some glycine but

88
00:03:12,599 --> 00:03:09,010

generally not much of the alpha hydroxy

89
00:03:15,030 --> 00:03:12,609
acid but when we look at the effect of

90
00:03:16,860 --> 00:03:15,040
minerals we basically see that including

91
00:03:18,360 --> 00:03:16,870
the mineral really accelerates the

92
00:03:20,309 --> 00:03:18,370
reaction that you're getting anyway but

93
00:03:22,890 --> 00:03:20,319
it's just much much faster and you get

94
00:03:24,780 --> 00:03:22,900
more product forming so over about 21

95
00:03:26,580 --> 00:03:24,790
days some glycine will form in this

96
00:03:28,500 --> 00:03:26,590
system with no mineral but when you add

97
00:03:30,270 --> 00:03:28,510
mineral you get a lot more glycine a lot

98
00:03:32,940 --> 00:03:30,280
more quickly plus you get the alpha

99
00:03:36,180 --> 00:03:32,950
hydroxy acid in a pretty high yield and

100
00:03:38,789 --> 00:03:36,190
so this was published recently in PNAS

101
00:03:40,890 --> 00:03:38,799
and we're looking at the the effect of

102
00:03:42,780 --> 00:03:40,900
the overall redox gradient of iron on

103
00:03:45,120 --> 00:03:42,790
the reactions of pyruvate in a system

104
00:03:46,740 --> 00:03:45,130
and so we found that when the iron

105
00:03:48,449 --> 00:03:46,750
minerals are completely oxidized you

106
00:03:50,370 --> 00:03:48,459
basically get no reaction at all and

107
00:03:52,589 --> 00:03:50,380
then when the minerals are completely

108
00:03:54,150 --> 00:03:52,599
reduced you don't form any amino acid

109
00:03:56,460 --> 00:03:54,160
even though there's ammonia present you

110
00:03:57,750 --> 00:03:56,470
form just the alpha hydroxy acid but

111
00:03:59,640 --> 00:03:57,760
there's kind of a sweet spot in the

112
00:04:01,920 --> 00:03:59,650
middle where you get a maximum of amino

113
00:04:03,509 --> 00:04:01,930

acid formation and in this case it tends

114
00:04:06,089 --> 00:04:03,519
to out-compete for the alpha hydroxy

115
00:04:07,949 --> 00:04:06,099
acid so that's the case of pyruvate and

116
00:04:09,990 --> 00:04:07,959
when you do the same reaction with

117
00:04:12,119 --> 00:04:10,000
glyoxylate it's kind of a similar but

118
00:04:14,129 --> 00:04:12,129
not completely the same result so you

119
00:04:16,080 --> 00:04:14,139
tend to get again more alpha hydroxy

120
00:04:18,060 --> 00:04:16,090
acid which is a reduction happening when

121
00:04:19,740 --> 00:04:18,070
the mineral is more reduced but when you

122
00:04:21,300 --> 00:04:19,750
have a more oxidized or kind of half

123
00:04:23,580 --> 00:04:21,310
oxidized mineral you can get both

124
00:04:25,320 --> 00:04:23,590
products but their their relative

125
00:04:27,240 --> 00:04:25,330
abundance is changing based on which

126
00:04:29,190 --> 00:04:27,250
precursor you started with so that's the

127
00:04:31,230 --> 00:04:29,200
important thing here the amino acid kind

128
00:04:33,810 --> 00:04:31,240
of dominates at intermediate redox state

129
00:04:34,170 --> 00:04:33,820
and here the alpha hydroxy acid and the

130
00:04:37,380 --> 00:04:34,180
amino

131
00:04:40,050 --> 00:04:37,390
that are about even so we looked at this

132
00:04:42,000 --> 00:04:40,060
a bit more for Glocks Olek acid where we

133
00:04:43,860 --> 00:04:42,010
vary the amount of ammonia in the system

134
00:04:46,230 --> 00:04:43,870
generally more ammonia makes more amino

135
00:04:48,270 --> 00:04:46,240
acid which makes sense and then if you

136
00:04:50,520 --> 00:04:48,280
go to a more reducing versus and more

137
00:04:52,710 --> 00:04:50,530
oxidizing mineral of iron in the system

138
00:04:54,090 --> 00:04:52,720

you just make more glycolate but the

139
00:04:55,860 --> 00:04:54,100
amount of glycine kind of stays the same

140
00:04:57,450 --> 00:04:55,870
so there's a bunch of gradients that

141
00:04:59,100 --> 00:04:57,460
intersect here you have redox there's

142
00:05:00,840 --> 00:04:59,110
also pH which I don't have time to show

143
00:05:02,700 --> 00:05:00,850
that data and then there's this ammonia

144
00:05:06,180 --> 00:05:02,710
concentration gradient all of which

145
00:05:07,800 --> 00:05:06,190
could coexist in a sediment column so

146
00:05:09,180 --> 00:05:07,810
what we're looking at it's kind of a

147
00:05:11,250 --> 00:05:09,190
system like this where even though you

148
00:05:13,290 --> 00:05:11,260
have just two precursors in just four

149
00:05:15,030 --> 00:05:13,300
plus some minor products you have a

150
00:05:17,160 --> 00:05:15,040
pretty complicated reaction Network

151
00:05:19,590 --> 00:05:17,170
that's possible here so if you have say

152
00:05:20,940 --> 00:05:19,600
an ocean floor or let's say some hot

153
00:05:22,920 --> 00:05:20,950
spring floor or something where you've

154
00:05:25,050 --> 00:05:22,930
got minerals and then as you go deeper

155
00:05:26,490 --> 00:05:25,060
they get more reducing you can get all

156
00:05:28,140 --> 00:05:26,500
sorts of different combinations of

157
00:05:29,790 --> 00:05:28,150
things depending where and that gradient

158
00:05:31,830 --> 00:05:29,800
you are so if you're in just the aqueous

159
00:05:32,220 --> 00:05:31,840
solution you might not react pyruvate at

160
00:05:34,230 --> 00:05:32,230
all

161
00:05:36,480 --> 00:05:34,240
you might only get glycine from Glaxo

162
00:05:38,040 --> 00:05:36,490
like acid but then as you go a little

163
00:05:39,840 --> 00:05:38,050

bit deeper you can get all the products

164
00:05:41,420 --> 00:05:39,850
if you go really reduced you're just

165
00:05:44,550 --> 00:05:41,430
gonna get the alpha hydroxy acids

166
00:05:46,080 --> 00:05:44,560
another way to look at this is that if

167
00:05:49,050 --> 00:05:46,090
you kind of think about it on the this

168
00:05:51,150 --> 00:05:49,060
axis of redox and pH so in a reducing

169
00:05:54,000 --> 00:05:51,160
iron system going to an oxidizing iron

170
00:05:57,570 --> 00:05:54,010
system in an alkaline pH going to a more

171
00:05:59,490 --> 00:05:57,580
neutral pH like pH 7 we see that you

172
00:06:01,290 --> 00:05:59,500
look at these kind of the main products

173
00:06:02,580 --> 00:06:01,300
of this reaction and this is not

174
00:06:04,260 --> 00:06:02,590
quantitative graphs that it does show

175
00:06:06,870 --> 00:06:04,270
their relative abundances of things that

176
00:06:08,670 --> 00:06:06,880
we've observed you tend to see that in

177
00:06:10,170 --> 00:06:08,680
the reduced and alkaline situation

178
00:06:12,540 --> 00:06:10,180
you make a lot of the alpha hydroxy

179
00:06:14,490 --> 00:06:12,550
acids you make some amino acid but

180
00:06:16,470 --> 00:06:14,500
mostly glycine not as much alanine and

181
00:06:18,660 --> 00:06:16,480
you kind of lose both of your precursors

182
00:06:20,790 --> 00:06:18,670
but as you go slightly more oxidized

183
00:06:22,620 --> 00:06:20,800
with these minerals it really starts

184
00:06:24,870 --> 00:06:22,630
increasing the abundance of amino acids

185
00:06:26,940 --> 00:06:24,880
so kind of an intermediate oxidation

186
00:06:28,620 --> 00:06:26,950
state of iron you get more alanine than

187
00:06:30,810 --> 00:06:28,630
glycine and you just have a lot of amino

188
00:06:32,700 --> 00:06:30,820

acids in general relative to the alpha

189
00:06:34,200 --> 00:06:32,710
hydroxy acids and when you go pretty

190
00:06:36,510 --> 00:06:34,210
oxidized you actually have a lot of

191
00:06:38,820 --> 00:06:36,520
pyruvate left and then some amino acid

192
00:06:41,460 --> 00:06:38,830
if you start going to more neutral pH

193
00:06:43,740 --> 00:06:41,470
you get different effects so pyruvate is

194
00:06:45,650 --> 00:06:43,750
back you get kind of a glycine dominated

195
00:06:47,420 --> 00:06:45,660
system at the reduced iron

196
00:06:49,310 --> 00:06:47,430
Allanon dominated at the oxidized iron

197
00:06:51,560 --> 00:06:49,320
and then more lactate and glycolate

198
00:06:53,900 --> 00:06:51,570
throughout so basically when we're

199
00:06:55,820 --> 00:06:53,910
looking for organics on other worlds or

200
00:06:57,350 --> 00:06:55,830
we're trying to understand what kinds of

201
00:06:59,480 --> 00:06:57,360
you know peptides or polymers we could

202
00:07:00,890 --> 00:06:59,490
make it's possible that these gradients

203
00:07:03,140 --> 00:07:00,900
and systems could really affect the

204
00:07:05,360 --> 00:07:03,150
relative initial distributions of the

205
00:07:07,160 --> 00:07:05,370
monomers in question but also that means

206
00:07:08,780 --> 00:07:07,170
that when were looking for life if we

207
00:07:10,520 --> 00:07:08,790
can't really use organic distributions

208
00:07:12,050 --> 00:07:10,530
necessarily as a bio signature because

209
00:07:13,940 --> 00:07:12,060
the gradients could affect a lot of this

210
00:07:17,000 --> 00:07:13,950
so at the very least that deserves some

211
00:07:19,310 --> 00:07:17,010
further investigation so maybe in a

212
00:07:20,960 --> 00:07:19,320
situation like this you might be more

213
00:07:23,270 --> 00:07:20,970

prone to peptide formation if you have

214
00:07:25,340 --> 00:07:23,280
more amino acid and or if you're in

215
00:07:27,020 --> 00:07:25,350
these kind of conditions you might be

216
00:07:29,180 --> 00:07:27,030
more prone toward having these oligomers

217
00:07:30,410 --> 00:07:29,190
at the alpha hydroxy acids or the

218
00:07:33,710 --> 00:07:30,420
mixtures that was mentioned in the

219
00:07:35,540 --> 00:07:33,720
previous talk and then we also kind of

220
00:07:37,340 --> 00:07:35,550
we looked at the organics that have gone

221
00:07:39,230 --> 00:07:37,350
into the minerals themselves generally

222
00:07:41,030 --> 00:07:39,240
speaking in these experiments we see

223
00:07:42,740 --> 00:07:41,040
about half the organics go into the

224
00:07:44,690 --> 00:07:42,750
mineral and he can't come out and

225
00:07:46,520 --> 00:07:44,700
they're basically adsorbed in there so

226
00:07:49,010 --> 00:07:46,530
we did combustion experiments on these

227
00:07:51,470 --> 00:07:49,020
minerals and we found about 0.4 weight

228
00:07:52,790 --> 00:07:51,480
percent carbon so that if you look at

229
00:07:54,410 --> 00:07:52,800
what was initially in the experiment

230
00:07:56,360 --> 00:07:54,420
that's about what you would expect it's

231
00:07:58,970 --> 00:07:56,370
a best-case scenario but that's trace

232
00:08:00,410 --> 00:07:58,980
levels so analyzing organics in a

233
00:08:02,810 --> 00:08:00,420
mineral sample like this would be pretty

234
00:08:04,130 --> 00:08:02,820
challenging but you can kind of think

235
00:08:05,960 --> 00:08:04,140
about you know what organics are in the

236
00:08:09,440 --> 00:08:05,970
sample versus mo liquid phase and what

237
00:08:12,380 --> 00:08:09,450
species might those be in so in

238
00:08:14,300 --> 00:08:12,390

conclusion in these abiotic or prebiotic

239
00:08:16,580 --> 00:08:14,310
reaction networks they occur in these

240
00:08:18,560 --> 00:08:16,590
iron minerals systems and it happens in

241
00:08:20,690 --> 00:08:18,570
kind of a short timescale days to weeks

242
00:08:22,130 --> 00:08:20,700
and it's under fairly mild conditions

243
00:08:25,430 --> 00:08:22,140
there's nothing super crazy here it's

244
00:08:28,100 --> 00:08:25,440
like 50 to 70 C pH to seven to ten and

245
00:08:29,900 --> 00:08:28,110
so we do see products forming the

246
00:08:31,310 --> 00:08:29,910
organic products formed are stable in

247
00:08:33,440 --> 00:08:31,320
the liquid phase we don't see these

248
00:08:35,900 --> 00:08:33,450
degrading or decreasing over time and

249
00:08:37,339 --> 00:08:35,910
they could in theory if you had a porous

250
00:08:37,820 --> 00:08:37,349
medium like a sediment column or

251
00:08:39,500 --> 00:08:37,830
something

252
00:08:41,150 --> 00:08:39,510
it could diffuse into other conditions

253
00:08:43,040 --> 00:08:41,160
and that gradient to continue to react

254
00:08:45,340 --> 00:08:43,050
but there's also other organics that

255
00:08:47,570 --> 00:08:45,350
remain trapped in the solid phase and

256
00:08:49,460 --> 00:08:47,580
the distribution of products that's

257
00:08:52,040 --> 00:08:49,470
formed relies very heavily on the

258
00:08:54,530 --> 00:08:52,050
gradients and particular redox of iron

259
00:08:57,020 --> 00:08:54,540
pH and the ammonia concentration in this

260
00:08:59,060 --> 00:08:57,030
case and so we see that highly reduced

261
00:09:01,160 --> 00:08:59,070
minerals tend to make more alpha

262
00:09:02,990 --> 00:09:01,170
see acids amino acids tend to be highest

263
00:09:04,879 --> 00:09:03,000

when you are alkaline and have high

264
00:09:06,980 --> 00:09:04,889
ammonia but not all the way reduce just

265
00:09:08,030 --> 00:09:06,990
semi reduce and there's also I didn't

266
00:09:10,009 --> 00:09:08,040
have time to talk about but there's

267
00:09:12,889 --> 00:09:10,019
other products identified here too they

268
00:09:15,170 --> 00:09:12,899
also exist in these systems and so

269
00:09:17,930 --> 00:09:15,180
basically when looking at alanine

270
00:09:20,120 --> 00:09:17,940
lactate glycol 8 and glycine at least

271
00:09:22,490 --> 00:09:20,130
these specific molecules have different

272
00:09:24,110 --> 00:09:22,500
maximum abundance conditions depending

273
00:09:26,030 --> 00:09:24,120
on the gradients that they're in so

274
00:09:27,379 --> 00:09:26,040
perhaps that might have an effect on the

275
00:09:29,240 --> 00:09:27,389
distribution of these molecules and

276
00:09:30,350 --> 00:09:29,250
peptides are in oligomers and it might

277
00:09:32,210 --> 00:09:30,360
be interesting to try to view

278
00:09:34,009 --> 00:09:32,220
polymerization experiments starting with

279
00:09:35,660 --> 00:09:34,019
these initial concentrations of things

280
00:09:38,300 --> 00:09:35,670
based on what environments we think it's

281
00:09:40,040 --> 00:09:38,310
happening in so that's it I just want to

282
00:09:41,900 --> 00:09:40,050
acknowledge our lab group the origins

283
00:09:43,670 --> 00:09:41,910
and habitability lab and in particular

284
00:09:45,889 --> 00:09:43,680
Erika Flores who's the grad student who

285
00:09:49,570 --> 00:09:45,899
perform these experiments and thank NASA

286
00:09:53,670 --> 00:09:49,580
and JPL for funding if we have time

287
00:09:57,179 --> 00:09:53,680
[Music]

288
00:09:59,489 --> 00:09:57,189

okay I'd like to start a question so I

289
00:10:01,079 --> 00:09:59,499
know that we talked about hot springs

290
00:10:03,359 --> 00:10:01,089
specifically is there any reason that

291
00:10:04,939 --> 00:10:03,369
you're invoking sequel or could this

292
00:10:07,769 --> 00:10:04,949
occur in any kind of geothermal

293
00:10:10,230 --> 00:10:07,779
environment it could certainly occur in

294
00:10:11,699 --> 00:10:10,240
any any geo environment really that has

295
00:10:14,189 --> 00:10:11,709
a redox gradient it doesn't even have to

296
00:10:15,419 --> 00:10:14,199
be that hot so I mean these reactions

297
00:10:17,699 --> 00:10:15,429
will occur eventually at lower

298
00:10:19,470 --> 00:10:17,709
temperature it just takes longer so yeah

299
00:10:21,720 --> 00:10:19,480
it can be anywhere where you have iron

300
00:10:24,210 --> 00:10:21,730
hydroxide or oxyhydroxide precipitation

301
00:10:26,309 --> 00:10:24,220
in redox and pH gradients and would we

302
00:10:29,189 --> 00:10:26,319
expect those on hot springs probably

303
00:10:33,840 --> 00:10:29,199
depending on the spring alright first

304
00:10:35,910 --> 00:10:33,850
question two related questions so can

305
00:10:39,889 --> 00:10:35,920
you differentiate the relative

306
00:10:43,530 --> 00:10:39,899
contributions of your mineral grains

307
00:10:47,100 --> 00:10:43,540
acting as reagents versus acting as

308
00:10:47,910 --> 00:10:47,110
catalysts yes so they are very agents

309
00:10:49,290 --> 00:10:47,920
not catalysts

310
00:10:51,119 --> 00:10:49,300
well but are they but are there also

311
00:10:54,889 --> 00:10:51,129
catalyzing because of because of

312
00:10:57,239 --> 00:10:54,899
differential contributions there as well

313
00:10:58,710 --> 00:10:57,249

it's possible there's some catalytic

314
00:11:00,150 --> 00:10:58,720
activity and we're still testing to see

315
00:11:02,519 --> 00:11:00,160
if that's the case but generally I think

316
00:11:05,549 --> 00:11:02,529
it is its psychometric with the iron I

317
00:11:08,759 --> 00:11:05,559
think it is mostly a reactant nice as a

318
00:11:10,980 --> 00:11:08,769
second question is your different

319
00:11:12,629 --> 00:11:10,990
mixtures where you of the input minerals

320
00:11:15,480 --> 00:11:12,639
we're giving you different different

321
00:11:16,919 --> 00:11:15,490
ratios output products it may be you

322
00:11:20,340 --> 00:11:16,929
just answered my next question by the

323
00:11:23,720 --> 00:11:20,350
stoichiometry thing but if is there any

324
00:11:25,919 --> 00:11:23,730
evidence of grain to grain interaction

325
00:11:27,569 --> 00:11:25,929
it's kind of hard to tell honestly

326
00:11:29,879 --> 00:11:27,579
because it's a bulk system with such

327
00:11:31,980 --> 00:11:29,889
small particles and so it is possible

328
00:11:33,929 --> 00:11:31,990
though because you could have things

329
00:11:35,189 --> 00:11:33,939
absorbing and desorbing we don't really

330
00:11:36,660 --> 00:11:35,199
see that to be honest with these

331
00:11:38,009 --> 00:11:36,670
molecules you don't see a lot of

332
00:11:39,780 --> 00:11:38,019
decrease in the liquid phase for example

333
00:11:44,440 --> 00:11:39,790
but it's still something that we're

334
00:11:50,750 --> 00:11:48,620
hi I think your synthesis of amino acids

335
00:11:52,310 --> 00:11:50,760
by reductive amination is a really

336
00:11:54,890 --> 00:11:52,320
interesting alternative to the

337
00:11:56,780 --> 00:11:54,900
traditional Stryker synthesis and I was

338
00:12:00,650 --> 00:11:56,790

wondering what is the prebiotic source

339
00:12:02,930 --> 00:12:00,660
of the alpha oxoacids substrates there's

340
00:12:05,450 --> 00:12:02,940
various ideas for depending which one

341
00:12:08,570 --> 00:12:05,460
you look at and for pyruvate it can come

342
00:12:10,160 --> 00:12:08,580
from CO or co2 reduction on metal

343
00:12:11,690 --> 00:12:10,170
sulphide minerals for example but also

344
00:12:13,850 --> 00:12:11,700
both of them can come from meteorites

345
00:12:15,740 --> 00:12:13,860
and so there's various ways you can get

346
00:12:17,090 --> 00:12:15,750
both it can also just be it can be

347
00:12:20,510 --> 00:12:17,100
brought in as well

348
00:12:23,840 --> 00:12:20,520
great thanks yeah those are very

349
00:12:28,370 --> 00:12:23,850
interesting results I assume that these

350
00:12:30,770 --> 00:12:28,380
reactions require minerals and therefore

351
00:12:33,680 --> 00:12:30,780
they're going to be at the seafloor and

352
00:12:36,590 --> 00:12:33,690
the point I'm making or asking about is

353
00:12:40,090 --> 00:12:36,600
that we assume that most of the iron in

354
00:12:43,130 --> 00:12:40,100
solution would be ferrous iron so what

355
00:12:45,860 --> 00:12:43,140
reaction would pull enough of the iron

356
00:12:48,620 --> 00:12:45,870
toward the oxidized state to support

357
00:12:50,240 --> 00:12:48,630
that sweet spot you're talking about so

358
00:12:51,740 --> 00:12:50,250
it depends what reaction I mean what

359
00:12:53,780 --> 00:12:51,750
environment we were looking at and it's

360
00:12:55,040 --> 00:12:53,790
not actually just the seafloor so for

361
00:12:56,870 --> 00:12:55,050
early Earth you're right it would be a

362
00:12:59,210 --> 00:12:56,880
lot of ferrous iron but you would have

363
00:13:01,010 --> 00:12:59,220

some ferric iron from from reduction

364
00:13:02,840 --> 00:13:01,020
reactions with say nitrates and nitrites

365
00:13:05,360 --> 00:13:02,850
and other things so you can get kind of

366
00:13:07,490 --> 00:13:05,370
depending on where you are exactly in

367
00:13:09,290 --> 00:13:07,500
this redox system you could get ferric

368
00:13:11,210 --> 00:13:09,300
communal x' as well but I'm also looking

369
00:13:12,530 --> 00:13:11,220
at this as example in a Mars condition

370
00:13:14,930 --> 00:13:12,540
where you would have a lot of oxidation

371
00:13:16,220 --> 00:13:14,940
and then also in surface environments

372
00:13:18,290 --> 00:13:16,230
where you go from the surface and then

373
00:13:19,880 --> 00:13:18,300
down below you can have other oxidants

374
00:13:22,070 --> 00:13:19,890
you know besides oxygen causing that

375
00:13:23,660 --> 00:13:22,080
iron to oxidize and sometimes you may

376
00:13:25,880 --> 00:13:23,670
not get all the way to be oxidized end

377
00:13:27,500 --> 00:13:25,890
of this and so that's possibility to is

378
00:13:28,850 --> 00:13:27,510
kind of understanding where the

379
00:13:35,030 --> 00:13:28,860
environment limits you on the gradient

380
00:13:39,530 --> 00:13:35,040
itself good morning doctor barge nice

381
00:13:41,800 --> 00:13:39,540
talk I had a question or I was hoping

382
00:13:45,110 --> 00:13:41,810
you could comment on peptide

383
00:13:47,480 --> 00:13:45,120
polymerization and what successes that

384
00:13:51,260 --> 00:13:47,490
you've had with that we have not attend

385
00:13:53,510 --> 00:13:51,270
yes and why not we've been a little busy

386
00:13:55,400 --> 00:13:53,520
with this but you will hopefully try to

387
00:13:57,530 --> 00:13:55,410
do some polymerization and also have the

388
00:13:59,210 --> 00:13:57,540

lactating glycolate that's been also

389
00:14:00,440 --> 00:13:59,220
done by other people and so we would you

390
00:14:04,340 --> 00:14:00,450
know try to build on what hasn't been

391
00:14:06,380 --> 00:14:04,350
done specifically okay do you know off

392
00:14:08,300 --> 00:14:06,390
the top of your head how successful it's

393
00:14:10,130 --> 00:14:08,310
been than the other laboratories well I

394
00:14:12,050 --> 00:14:10,140
read a paper that was a lactating

395
00:14:18,440 --> 00:14:12,060
glycolate polymers you make all sorts of

396
00:14:19,650 --> 00:14:18,450
things with that okay so thank you great

397
00:14:21,760 --> 00:14:19,660
let's think