
AbSciCon
2019

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

2
00:00:13,650 --> 00:00:09,350
[Applause]

3
00:00:16,680 --> 00:00:13,660
thank you all one quick comment

4
00:00:20,100 --> 00:00:16,690
there are even shorter what tri cycles

5
00:00:23,730 --> 00:00:20,110
than Days and seasons Bruce and I

6
00:00:25,350 --> 00:00:23,740
visited volcanic hydrothermal fields all

7
00:00:27,900 --> 00:00:25,360
over the world really

8
00:00:31,470 --> 00:00:27,910
and there are wet/dry cycles measured in

9
00:00:33,630 --> 00:00:31,480
minutes to an hour or so because of hot

10
00:00:35,670 --> 00:00:33,640
spring activity fluctuating levels of

11
00:00:38,130 --> 00:00:35,680
water that just suddenly keep in mind

12
00:00:45,210 --> 00:00:38,140
we're not stuck with really long daily

13
00:00:48,270 --> 00:00:45,220

or seasonal wet/dry cycles okay I gotta

14
00:00:51,180 --> 00:00:48,280
give you a few minutes of introduction

15
00:00:54,450 --> 00:00:51,190
to get to the unpublished material I

16
00:01:00,240 --> 00:00:54,460
want to talk to you about reading button

17
00:01:02,760 --> 00:01:00,250
okay okay so a lot of what I'm showing

18
00:01:05,490 --> 00:01:02,770
you is in fact the experimental results

19
00:01:10,200 --> 00:01:05,500
and that leads to a hot spring

20
00:01:13,289 --> 00:01:10,210
hypothesis that is testable the two

21
00:01:15,359 --> 00:01:13,299
examples of hydrothermal regions that

22
00:01:18,930 --> 00:01:15,369
have been suggested in the literature by

23
00:01:22,200 --> 00:01:18,940
ourselves and by the people interested

24
00:01:24,330 --> 00:01:22,210
in hydrothermal events is the so-called

25
00:01:27,000 --> 00:01:24,340
black smokers and alkaline vents shown

26
00:01:29,429 --> 00:01:27,010
on the Left which in fact are saltwater

27
00:01:31,469 --> 00:01:29,439
and the hydrothermal fields that we're

28
00:01:33,690 --> 00:01:31,479
talking about which is distilled

29
00:01:36,719 --> 00:01:33,700
freshwater distilled by evaporation from

30
00:01:39,240 --> 00:01:36,729
a global ocean and falling on volcanic

31
00:01:41,520 --> 00:01:39,250
land masses I only have time to talk to

32
00:01:43,170 --> 00:01:41,530
you about the freshwater so the

33
00:01:45,749 --> 00:01:43,180
favorable properties that we've observed

34
00:01:49,260 --> 00:01:45,759
in French water is that organic

35
00:01:51,210 --> 00:01:49,270
compounds accumulate on land masses as

36
00:01:54,600 --> 00:01:51,220
opposed to being diluted into the ocean

37
00:01:58,190 --> 00:01:54,610
and as Ben had just suggested they go

38
00:02:02,880 --> 00:01:58,200

through a cyclic process and the the

39
00:02:05,429 --> 00:02:02,890
deposition is a constant rate we have

40
00:02:07,710 --> 00:02:05,439
found that these pools tend to be acidic

41
00:02:10,400 --> 00:02:07,720
which we think is important for the kind

42
00:02:14,819 --> 00:02:10,410
of chemistry we're doing and the acidity

43
00:02:18,449 --> 00:02:14,829
results from so2 that is a volcanic gas

44
00:02:20,580 --> 00:02:18,459
it turns into so3 a weak acid

45
00:02:23,819 --> 00:02:20,590
the pools that we worked with are all

46
00:02:26,250 --> 00:02:23,829
down around pH 2 to ph 3 on the volcanic

47
00:02:28,830 --> 00:02:26,260
areas we've been testing the

48
00:02:31,309 --> 00:02:28,840
concentration of ions is very low Mille

49
00:02:33,750 --> 00:02:31,319
molar concentration wet/dry cycles

50
00:02:36,479 --> 00:02:33,760
concentrate potential reactants and

51
00:02:39,990 --> 00:02:36,489
those condensation reactions can then

52
00:02:43,440 --> 00:02:40,000
occur in the low water activity and

53
00:02:45,360 --> 00:02:43,450
we've done a thermodynamic analysis of

54
00:02:48,209 --> 00:02:45,370
this and it's very clear that there's

55
00:02:52,379 --> 00:02:48,219
enough chemical energy produced by the

56
00:02:55,409 --> 00:02:52,389
wet/dry cycle to drive ester bond

57
00:02:57,990 --> 00:02:55,419
synthesis finally the elevated

58
00:03:00,929 --> 00:02:58,000
temperature up in the 80 to 90 degree

59
00:03:04,140 --> 00:03:00,939
range provides activation energy for the

60
00:03:06,690 --> 00:03:04,150
formation of phosphodiester linkages and

61
00:03:09,119 --> 00:03:06,700
last of all if there are lipid like

62
00:03:11,520 --> 00:03:09,129
components present the polymers get

63
00:03:14,280 --> 00:03:11,530

encapsulated to become what we call

64
00:03:16,530 --> 00:03:14,290
protocells these are steps toward life

65
00:03:19,229 --> 00:03:16,540
they're not life itself but they are

66
00:03:22,229 --> 00:03:19,239
certainly able to evolve and that's

67
00:03:23,969 --> 00:03:22,239
where we are now in our research so we

68
00:03:26,699 --> 00:03:23,979
wanted to test this hypothesis we

69
00:03:30,059 --> 00:03:26,709
fabricated a simulation chamber that

70
00:03:33,210 --> 00:03:30,069
puts small vog laz files through what

71
00:03:35,849 --> 00:03:33,220
dry cycles we control carbon dioxide

72
00:03:38,159 --> 00:03:35,859
elevated temperature acidic pH range and

73
00:03:42,439 --> 00:03:38,169
the cycle is what we've talked about so

74
00:03:45,679 --> 00:03:42,449
the the device that we've built up

75
00:03:48,869 --> 00:03:45,689
depends on this relatively low energy

76
00:03:51,809 --> 00:03:48,879
synthesis of ester bonds and I want to

77
00:03:54,119 --> 00:03:51,819
make this clear to you if you mix

78
00:03:56,640 --> 00:03:54,129
ethanol and acetic acid there's a

79
00:03:59,610 --> 00:03:56,650
spontaneous reaction in which water

80
00:04:02,789 --> 00:03:59,620
comes off and ethyl acetate is produced

81
00:04:05,339 --> 00:04:02,799
ethyl acetate is the ester that is part

82
00:04:07,069 --> 00:04:05,349
of nail polish remover if you were

83
00:04:10,170 --> 00:04:07,079
probably all familiar with that smell

84
00:04:12,629 --> 00:04:10,180
however the same kind of reaction can

85
00:04:15,539 --> 00:04:12,639
occur between phosphate and the O H

86
00:04:17,729 --> 00:04:15,549
groups on a couple of nucleotides such

87
00:04:20,310 --> 00:04:17,739
as adenosine monophosphate shown here

88
00:04:22,589 --> 00:04:20,320

and if we want to pull the reaction to

89
00:04:25,860 --> 00:04:22,599
the right all we have to do is have a

90
00:04:27,990 --> 00:04:25,870
way for water to leave the reaction so

91
00:04:30,780 --> 00:04:28,000
there's no back reaction and in both

92
00:04:33,330 --> 00:04:30,790
cases we should expect to see

93
00:04:37,500 --> 00:04:33,340
Station reactions leading to fossil

94
00:04:39,510 --> 00:04:37,510
ester linkages in the bottom thing here

95
00:04:40,710 --> 00:04:39,520
we have the device that we built up but

96
00:04:44,340 --> 00:04:40,720
it's got a source of carbon dioxide

97
00:04:45,960 --> 00:04:44,350
basically keeping out air air and oxygen

98
00:04:48,720 --> 00:04:45,970
doesn't turn out to be terribly

99
00:04:51,330 --> 00:04:48,730
important to us but we just have co2 as

100
00:04:53,850 --> 00:04:51,340
a way to reduce the possibility of

101
00:04:56,280 --> 00:04:53,860
oxidation reactions there's a heat

102
00:05:00,000 --> 00:04:56,290
source that brings up that aluminum disk

103
00:05:02,430 --> 00:05:00,010
to about 80 to 90 degrees our choice of

104
00:05:05,880 --> 00:05:02,440
temperature and that disk rotates about

105
00:05:08,520 --> 00:05:05,890
once an hour and brings the vials under

106
00:05:10,440 --> 00:05:08,530
a gas flow of carbon dioxide which tries

107
00:05:14,070 --> 00:05:10,450
them down and then down at the bottom

108
00:05:16,080 --> 00:05:14,080
right you can see a hydration cycle this

109
00:05:18,570 --> 00:05:16,090
is a syringe pump and the water is

110
00:05:21,390 --> 00:05:18,580
dripping into the vials at those two

111
00:05:23,640 --> 00:05:21,400
points so at the end of a number of

112
00:05:26,940 --> 00:05:23,650
cycles we will pull the stuff out and

113
00:05:29,310 --> 00:05:26,950

analyze it so I'm going to show you one

114
00:05:33,120 --> 00:05:29,320
that we've done with a MP and UMP

115
00:05:36,270 --> 00:05:33,130
mixture we can have a lipid matrix there

116
00:05:38,250 --> 00:05:36,280
to promote the reaction we found that

117
00:05:40,650 --> 00:05:38,260
it's favorable and has a protective

118
00:05:42,450 --> 00:05:40,660
effect on polymers we do multiple

119
00:05:45,000 --> 00:05:42,460
wet/dry cycles we bring down the

120
00:05:48,000 --> 00:05:45,010
products with ethanol precipitation a

121
00:05:50,670 --> 00:05:48,010
very standard way to bring down polymer

122
00:05:52,920 --> 00:05:50,680
products we do that by spin tube or

123
00:05:57,440 --> 00:05:52,930
ethanol precipitation then we run either

124
00:05:59,400 --> 00:05:57,450
gel electrophoresis or we run nanopore

125
00:06:02,250 --> 00:05:59,410
analysis and you're going to see a

126
00:06:04,230 --> 00:06:02,260
little bit of results of that so the

127
00:06:07,830 --> 00:06:04,240
first thing we did ten years ago now

128
00:06:10,560 --> 00:06:07,840
2008 with Souter Rajamani and in the lab

129
00:06:13,800 --> 00:06:10,570
was to see whether these polymers could

130
00:06:17,730 --> 00:06:13,810
be in labelled with enzymes that

131
00:06:20,910 --> 00:06:17,740
recognize biological RNA if we've made

132
00:06:24,150 --> 00:06:20,920
anything that seems that looks like a

133
00:06:27,660 --> 00:06:24,160
biological RNA these enzymes should at

134
00:06:30,570 --> 00:06:27,670
least label the ends of those molecules

135
00:06:33,780 --> 00:06:30,580
and it's the in labeling southland

136
00:06:37,350 --> 00:06:33,790
phosphatase t4 kinase radioactive ATP

137
00:06:39,810 --> 00:06:37,360
you end up with a radioactive phosphor

138
00:06:42,260 --> 00:06:39,820

RNA labeled with radioactive phosphate

139
00:06:45,320 --> 00:06:42,270
so this is what su

140
00:06:47,210 --> 00:06:45,330
put together each of those lanes these

141
00:06:50,870 --> 00:06:47,220
are gel electrophoresis lanes are

142
00:06:53,330 --> 00:06:50,880
separate experiments it works again and

143
00:06:55,730 --> 00:06:53,340
again and again it's very robust all of

144
00:06:58,129 --> 00:06:55,740
these are different conditions that we

145
00:06:59,659 --> 00:06:58,139
put it through I just want to point out

146
00:07:01,969 --> 00:06:59,669
two of these this is the number of

147
00:07:04,279 --> 00:07:01,979
cycles we get more and more and more as

148
00:07:06,589 --> 00:07:04,289
we increase the number of cycles and

149
00:07:09,350 --> 00:07:06,599
look at the length of these polymers

150
00:07:12,469 --> 00:07:09,360
compared to this ladder here this is a

151
00:07:15,260 --> 00:07:12,479
RNA ladder with known RNA links and

152
00:07:18,200 --> 00:07:15,270
right next to it you can see that these

153
00:07:21,409 --> 00:07:18,210
polymers range from 10 burrs up to over

154
00:07:23,480 --> 00:07:21,419
hundred Murs in length that's really

155
00:07:26,510 --> 00:07:23,490
quite extraordinary that's spontaneously

156
00:07:29,870 --> 00:07:26,520
we can make polymers long enough to be

157
00:07:32,570 --> 00:07:29,880
labeled by these enzymes of recognize a

158
00:07:34,399 --> 00:07:32,580
MP I don't have time to show you all of

159
00:07:36,890 --> 00:07:34,409
those but just a variety of conditions

160
00:07:39,860 --> 00:07:36,900
or different lipids and different ratios

161
00:07:42,999 --> 00:07:39,870
and so forth so you can also see these

162
00:07:45,980 --> 00:07:43,009
by you know also see these by

163
00:07:51,710 --> 00:07:45,990

fluorescent labeling where we have a dye

164
00:07:54,770 --> 00:07:51,720
that binds to a polymer such as RNA here

165
00:07:57,170 --> 00:07:54,780
we have two three kinds of RNA that are

166
00:07:59,870 --> 00:07:57,180
known RNA this is a home polymer called

167
00:08:01,580 --> 00:07:59,880
poly and Milic acid there's another home

168
00:08:05,149 --> 00:08:01,590
polymer or that's part of your daily

169
00:08:07,640 --> 00:08:05,159
poly Abney leak acid poly a notice that

170
00:08:10,420 --> 00:08:07,650
they die which is Atheneum and a Curie

171
00:08:14,899 --> 00:08:10,430
intercalating guy does not strongly

172
00:08:17,570 --> 00:08:14,909
label these single numbers but if we

173
00:08:20,800 --> 00:08:17,580
make a mixture where we get in fact a

174
00:08:24,439 --> 00:08:20,810
double helical form of a poly a poly

175
00:08:26,390 --> 00:08:24,449
duplex structure now these micro gram

176
00:08:28,879 --> 00:08:26,400
quantities are labeled by the dye

177
00:08:31,550 --> 00:08:28,889
because the dye intercalates between the

178
00:08:34,819 --> 00:08:31,560
stack bases and becomes fluorescent and

179
00:08:37,100 --> 00:08:34,829
here is our polymer product again

180
00:08:37,790 --> 00:08:37,110
ranging from 20 immers up to the Han

181
00:08:40,069 --> 00:08:37,800
River range

182
00:08:43,310 --> 00:08:40,079
here's another dye called cyber safe and

183
00:08:45,380 --> 00:08:43,320
here's our product here's a deist double

184
00:08:47,569 --> 00:08:45,390
stranded 20 mer right there and here's

185
00:08:48,949 --> 00:08:47,579
our product so we were pretty sure that

186
00:08:51,620 --> 00:08:48,959
we were making something that was a

187
00:08:54,350 --> 00:08:51,630
polymer but we wanted to try one more

188
00:08:54,890 --> 00:08:54,360

way to look at this so we did what are

189
00:08:58,250 --> 00:08:54,900
what is

190
00:09:00,590 --> 00:08:58,260
called nanopore sequencing now this is

191
00:09:03,320 --> 00:09:00,600
new so this isn't been published yet

192
00:09:04,760 --> 00:09:03,330
we're repeating this so these are sort

193
00:09:06,980 --> 00:09:04,770
of preliminary work I'm going to show

194
00:09:09,710 --> 00:09:06,990
you now so the idea of nanopore

195
00:09:14,600 --> 00:09:09,720
sequencing is that we can lead a double

196
00:09:18,860 --> 00:09:14,610
strand of DNA or RNA in fact into a

197
00:09:22,850 --> 00:09:18,870
molecular motor which ratchets the DNA

198
00:09:26,720 --> 00:09:22,860
basis at about 450 nucleotides per

199
00:09:29,540 --> 00:09:26,730
second through a limiting aperture in a

200
00:09:32,180 --> 00:09:29,550
protein Nana pour that aperture has

201
00:09:35,390 --> 00:09:32,190
about three bases in it at any given

202
00:09:38,120 --> 00:09:35,400
time as the bases are ratcheted through

203
00:09:40,280 --> 00:09:38,130
that area we have a change in the

204
00:09:42,740 --> 00:09:40,290
electrical current in the Pico ampere

205
00:09:45,350 --> 00:09:42,750
range which reflects the base sequence

206
00:09:46,970 --> 00:09:45,360
so this is now out as a commercial

207
00:09:48,770 --> 00:09:46,980
device that's called the min ion I'm

208
00:09:51,130 --> 00:09:48,780
going to show you one of those and also

209
00:09:54,560 --> 00:09:51,140
the Promethean this is Oxford nanopore

210
00:09:57,640 --> 00:09:54,570
technology building on the nanopore idea

211
00:10:00,890 --> 00:09:57,650
so let's take a look at the next slide

212
00:10:03,440 --> 00:10:00,900
here is what I'm going to show you we

213
00:10:07,370 --> 00:10:03,450

wanted to be sure that we really could

214
00:10:10,910 --> 00:10:07,380
make something that was exactly the same

215
00:10:14,150 --> 00:10:10,920
as a strand of DNA so we kept it simple

216
00:10:16,820 --> 00:10:14,160
we decided to use TMP thymidine mono

217
00:10:21,380 --> 00:10:16,830
phosphate as the monomer this can only

218
00:10:23,780 --> 00:10:21,390
make 3-5 fossil ester linkages we put it

219
00:10:26,780 --> 00:10:23,790
through multiple wet/dry cycles we

220
00:10:29,060 --> 00:10:26,790
expect to get all ago Simon Dilek acid

221
00:10:32,780 --> 00:10:29,070
just a whole bunch of tees in a row and

222
00:10:35,690 --> 00:10:32,790
then we can isolate that we like a tit

223
00:10:38,600 --> 00:10:35,700
to a known strand of DNA in order to

224
00:10:40,790 --> 00:10:38,610
differentiate between the signal we're

225
00:10:44,960 --> 00:10:40,800
going to get from the ala goatee and a

226
00:10:47,630 --> 00:10:44,970
known base sequence of DNA and then we

227
00:10:49,130 --> 00:10:47,640
put that through nanopore sequencing so

228
00:10:52,310 --> 00:10:49,140
here's what it looks like to use the

229
00:10:57,470 --> 00:10:52,320
minion your sample is injected into this

230
00:10:59,420 --> 00:10:57,480
handheld device it goes to 2000 nana

231
00:11:01,280 --> 00:10:59,430
pours in this little area here that's

232
00:11:07,130 --> 00:11:01,290
the sensor chip each one is

233
00:11:09,470 --> 00:11:07,140
independently being being referenced by

234
00:11:13,460 --> 00:11:09,480
the electronics of the system all of the

235
00:11:15,650 --> 00:11:13,470
electronics are are in this device and

236
00:11:18,530 --> 00:11:15,660
the signal is fed into your laptop

237
00:11:22,610 --> 00:11:18,540
computer this is gone all over the world

238
00:11:24,560 --> 00:11:22,620

now looking for Ebola in Africa every 90

239
00:11:26,660 --> 00:11:24,570
minutes it goes over our heads and then

240
00:11:29,960 --> 00:11:26,670
in the international space station

241
00:11:32,660 --> 00:11:29,970
the midnight is being used sequenced the

242
00:11:36,320 --> 00:11:32,670
DNA of the organisms that now coat the

243
00:11:40,190 --> 00:11:36,330
interior of the ISS so let's take a look

244
00:11:43,970 --> 00:11:40,200
now is what we see what we see as a

245
00:11:46,190 --> 00:11:43,980
single nucleus in gold nucleic acid

246
00:11:49,940 --> 00:11:46,200
going through the pore looks like this

247
00:11:53,210 --> 00:11:49,950
this is the known sequence going through

248
00:11:58,220 --> 00:11:53,220
and they'll up and down is in fact the a

249
00:12:02,540 --> 00:11:58,230
G C T of that known bit of DNA and then

250
00:12:05,240 --> 00:12:02,550
right there is this long string which is

251
00:12:07,190 --> 00:12:05,250
just the what we think is the Aldo

252
00:12:10,670 --> 00:12:07,200
goatee homo polymer passing through the

253
00:12:13,310 --> 00:12:10,680
pore we have a base calling device that

254
00:12:15,470 --> 00:12:13,320
allows us to turn this electrical signal

255
00:12:18,350 --> 00:12:15,480
into the nucleobases

256
00:12:21,890 --> 00:12:18,360
and this is what it looks like here's a

257
00:12:24,110 --> 00:12:21,900
gel of the radioactively-labeled i'll

258
00:12:26,930 --> 00:12:24,120
ago simon teens starting down around 30

259
00:12:29,540 --> 00:12:26,940
Murs going all the way up to about 90

260
00:12:31,610 --> 00:12:29,550
Merce you can see these individual all

261
00:12:36,380 --> 00:12:31,620
ago Simon teens showing up in this gel

262
00:12:39,080 --> 00:12:36,390
and here are the base called fragments

263
00:12:42,830 --> 00:12:39,090

the ala goatee we see again and again

264
00:12:45,680 --> 00:12:42,840
attached to the known RNA ligated to the

265
00:12:47,810 --> 00:12:45,690
no night and this then is the alla

266
00:12:50,270 --> 00:12:47,820
goatee now attach that we have

267
00:12:53,690 --> 00:12:50,280
synthesized this at least convinces us

268
00:12:57,530 --> 00:12:53,700
that we can make very long strands of

269
00:13:01,010 --> 00:12:57,540
nucleic acids using just wet/dry cycles

270
00:13:03,350 --> 00:13:01,020
the 90 the 30 mer by the way is down in

271
00:13:06,800 --> 00:13:03,360
this range you can see that these links

272
00:13:09,890 --> 00:13:06,810
match so we see here the this is an

273
00:13:12,680 --> 00:13:09,900
intermediate length approximately v 40

274
00:13:15,079 --> 00:13:12,690
mer range then here is a very long one

275
00:13:18,269 --> 00:13:15,089
up in the ATM array

276
00:13:20,939 --> 00:13:18,279
okay now what we want to do is to see

277
00:13:22,259 --> 00:13:20,949
whether this actually works in out in

278
00:13:24,569 --> 00:13:22,269
the wild

279
00:13:27,359 --> 00:13:24,579
well I won't show you this - this stuff

280
00:13:29,399 --> 00:13:27,369
accumulates inside the lipid vesicles

281
00:13:31,979 --> 00:13:29,409
who we have a little bit there we can

282
00:13:35,189 --> 00:13:31,989
stain it with faculty in orange this is

283
00:13:37,489 --> 00:13:35,199
an are starting with a and P and um P

284
00:13:41,189 --> 00:13:37,499
these are the lipids and the

285
00:13:45,989 --> 00:13:41,199
encapsulated material after about three

286
00:13:52,619 --> 00:13:45,999
cycles ear is with DNA the this is a da

287
00:13:55,289 --> 00:13:52,629
MP and C and sorry TMP and you can see

288
00:13:59,099 --> 00:13:55,299

the Dappy now staining these vesicles

289
00:14:00,899 --> 00:13:59,109
with this encapsulated DNA so we're

290
00:14:03,089 --> 00:14:00,909
pretty sure that not only can we make it

291
00:14:05,249 --> 00:14:03,099
but it becomes encapsulated to make

292
00:14:07,139 --> 00:14:05,259
protocells now we're going to take out

293
00:14:09,779 --> 00:14:07,149
in the wild and ask this last question

294
00:14:12,359 --> 00:14:09,789
in my talk does it actually work in

295
00:14:14,549 --> 00:14:12,369
conditions such as we assumed were

296
00:14:18,379 --> 00:14:14,559
available on the early Earth what you

297
00:14:21,960 --> 00:14:18,389
just saw is a hot spring in Rotorua

298
00:14:24,089 --> 00:14:21,970
Bruce Bruce saw was down there just last

299
00:14:27,960 --> 00:14:24,099
summer doing this work so he's my

300
00:14:32,099 --> 00:14:27,970
co-author on this talk he would put

301
00:14:34,229 --> 00:14:32,109
these tubes in a large aluminum plate

302
00:14:37,710 --> 00:14:34,239
there's approximately a hundred of them

303
00:14:40,649 --> 00:14:37,720
they have the dried material that I did

304
00:14:43,589 --> 00:14:40,659
in the lab at UC Santa Cruz and he put

305
00:14:46,979 --> 00:14:43,599
these through four cycles about 3045

306
00:14:49,979 --> 00:14:46,989
minutes each and he added water from an

307
00:14:53,819 --> 00:14:49,989
acidic hot spring for the recycling so

308
00:14:55,739 --> 00:14:53,829
four cycles here is the products they

309
00:14:58,979 --> 00:14:55,749
were getting out notice that the

310
00:15:01,199 --> 00:14:58,989
products containing you were more

311
00:15:03,569 --> 00:15:01,209
abundant than the products containing a

312
00:15:05,069 --> 00:15:03,579
which was interesting we didn't expect

313
00:15:08,489 --> 00:15:05,079

that but that's just the way it turned

314
00:15:11,099 --> 00:15:08,499
out we then did a gel of this and

315
00:15:13,229 --> 00:15:11,109
compared what I showed you in that first

316
00:15:15,059 --> 00:15:13,239
gel with the products here's what I

317
00:15:18,799 --> 00:15:15,069
showed you the first time around and

318
00:15:22,319 --> 00:15:18,809
here is what we see in the hot spring

319
00:15:24,809 --> 00:15:22,329
cycles so we're convinced that this is

320
00:15:25,840 --> 00:15:24,819
not just the laboratory phenomenon but

321
00:15:28,059 --> 00:15:25,850
also can

322
00:15:30,550 --> 00:15:28,069
or out there in the real world and I

323
00:15:32,620 --> 00:15:30,560
recommend that people are doing work in

324
00:15:35,230 --> 00:15:32,630
the laboratory once in a while

325
00:15:37,059 --> 00:15:35,240
step out of the lab into a place that we

326
00:15:39,550 --> 00:15:37,069
consider be a prebiotic analog

327
00:15:42,930 --> 00:15:39,560
environment and see if your result

328
00:15:46,660 --> 00:15:42,940
actually works under real conditions so

329
00:15:48,939 --> 00:15:46,670
finally I'll end up with our conclusions

330
00:15:51,309 --> 00:15:48,949
this is an alternative scenario that

331
00:15:53,860 --> 00:15:51,319
we're developing for the origin of

332
00:15:56,110 --> 00:15:53,870
cellular life we think that life began

333
00:15:59,740 --> 00:15:56,120
in freshwater hydro thermal pools

334
00:16:04,170 --> 00:15:59,750
subject to cycles life did not invent

335
00:16:06,850 --> 00:16:04,180
nucleic acids instead life discovered

336
00:16:09,550 --> 00:16:06,860
pre-existing hydrothermally cycled

337
00:16:13,360 --> 00:16:09,560
polymers and encapsulated them to make

338
00:16:15,790 --> 00:16:13,370

protocells the if amphiphiles are

339
00:16:19,509 --> 00:16:15,800
present they get encapsulated if you

340
00:16:22,420 --> 00:16:19,519
have proto cell populations they vary

341
00:16:24,370 --> 00:16:22,430
just as is always required for evolution

342
00:16:26,949 --> 00:16:24,380
selection and evolution there had to be

343
00:16:29,800 --> 00:16:26,959
variables they can undergo selection and

344
00:16:33,189 --> 00:16:29,810
evolution and what we're now looking for

345
00:16:35,920 --> 00:16:33,199
is Dutch how to test this conjecture the

346
00:16:38,019 --> 00:16:35,930
life began when rare systems of

347
00:16:40,480 --> 00:16:38,029
encapsulated polymers happen to be

348
00:16:43,780 --> 00:16:40,490
capable of the catalytic functions

349
00:16:47,290 --> 00:16:43,790
related to the light process we put this

350
00:16:50,050 --> 00:16:47,300
into a sort of a geological scenario and

351
00:16:53,650 --> 00:16:50,060
that's just my last slide now and we

352
00:16:57,699 --> 00:16:53,660
have a synthesis of organic material

353
00:17:01,480 --> 00:16:57,709
being accumulated on these volcanic land

354
00:17:03,189 --> 00:17:01,490
masses the as these pilot of these pools

355
00:17:06,039 --> 00:17:03,199
go through cycles and the sugar gets

356
00:17:08,649 --> 00:17:06,049
concentrated it begins to react here's

357
00:17:11,919 --> 00:17:08,659
the reaction cycle you can see going

358
00:17:16,029 --> 00:17:11,929
around this circle between a wet phase

359
00:17:19,179 --> 00:17:16,039
down drying to a dry phase and back to a

360
00:17:21,329 --> 00:17:19,189
wet face this cycle then builds up cycle

361
00:17:25,630 --> 00:17:21,339
after cycle increasingly complex

362
00:17:28,390 --> 00:17:25,640
protocells as they accumulate they get

363
00:17:31,480 --> 00:17:28,400

distributed downhill toward the sea

364
00:17:34,510 --> 00:17:31,490
water ocean and finally adapt to sea

365
00:17:37,210 --> 00:17:34,520
water where they colonize the ocean as

366
00:17:38,100 --> 00:17:37,220
the last step in this origin of life

367
00:17:46,320 --> 00:17:38,110
scenario

368
00:17:47,909 --> 00:17:46,330
thank you I'm afraid we're a little bit

369
00:17:49,769 --> 00:17:47,919
limited for time but please find dr.

370
00:17:51,779 --> 00:17:49,779
Deemer if you have any questions for him

371
00:17:52,529 --> 00:17:51,789
and we'll go to our next speaker Vincent