

Chimneys with more concentrated Iron, Sulfur, and Silicate



1
00:00:12,160 --> 00:00:09,220
good afternoon everybody once again my

2
00:00:14,140 --> 00:00:12,170
name is a Bradley burka and I'm from

3
00:00:16,359 --> 00:00:14,150
Rensselaer Polytechnic Institute and

4
00:00:18,310 --> 00:00:16,369
i'll be talking about RNA synthesis at

5
00:00:20,679 --> 00:00:18,320
hydrothermal vents so we've gotten away

6
00:00:24,729 --> 00:00:20,689
from the geology someone and we're

7
00:00:28,659 --> 00:00:24,739
talking about RNA synthesis and more geo

8
00:00:30,010 --> 00:00:28,669
chemistry biochemistry related stuff I'd

9
00:00:31,900 --> 00:00:30,020
like to point out one awesome thing

10
00:00:34,600 --> 00:00:31,910
about this research that's going on is

11
00:00:36,549 --> 00:00:34,610
this research came directly out of a

12
00:00:40,119 --> 00:00:36,559
collaboration that started from AB grad

13
00:00:42,700 --> 00:00:40,129

con last year with Laurie barge at JPL

14

00:00:45,369 --> 00:00:42,710

so she flew out to my laboratory for two

15

00:00:47,680 --> 00:00:45,379

weeks we set up all these experiments as

16

00:00:53,590 --> 00:00:47,690

a preliminary start to this project so

17

00:00:56,169 --> 00:00:53,600

yay AB grad con so once again I'll give

18

00:00:57,819 --> 00:00:56,179

you a brief overview of the RNA world

19

00:00:59,829 --> 00:00:57,829

just help set the stage for what I'm

20

00:01:03,869 --> 00:00:59,839

going to be talking about here so the

21

00:01:07,330 --> 00:01:03,879

premise of the RNA world starts with

22

00:01:08,740 --> 00:01:07,340

essentially a sea of nucleotides you can

23

00:01:10,630 --> 00:01:08,750

take it back a bit further and talk

24

00:01:12,700 --> 00:01:10,640

about how you create nucleotides and all

25

00:01:14,350 --> 00:01:12,710

of that jazz but for the purpose of this

26

00:01:16,990 --> 00:01:14,360

we're going to assume that nucleotides

27

00:01:19,270 --> 00:01:17,000

have been formed in some manner so one

28

00:01:21,069 --> 00:01:19,280

of the tricks becomes trying to get

29

00:01:23,200 --> 00:01:21,079

these nucleotides into these long

30

00:01:26,139 --> 00:01:23,210

strands of RNA so you need some sort of

31

00:01:28,899 --> 00:01:26,149

catalytic chemical system to generate

32

00:01:30,810 --> 00:01:28,909

long strands of RNA the theory is once

33

00:01:33,730 --> 00:01:30,820

you start generating strands of RNA

34

00:01:35,889 --> 00:01:33,740

eventually some of these strands will

35

00:01:39,090 --> 00:01:35,899

have certain a base sequences that can

36

00:01:41,620 --> 00:01:39,100

fold into interesting manners and create

37

00:01:44,020 --> 00:01:41,630

ribozymes and some catalytic activities

38

00:01:46,510 --> 00:01:44,030

so eventually these strands can operate

39

00:01:49,990 --> 00:01:46,520

on each other to cause replication and

40

00:01:52,889 --> 00:01:50,000

so you have a system of replication and

41

00:01:57,249 --> 00:01:52,899

biochemistry using RNA as the main

42

00:01:59,950 --> 00:01:57,259

biochemical the constituent of the

43

00:02:04,029 --> 00:01:59,960

system that eventually sequences get

44

00:02:06,039 --> 00:02:04,039

sampled that create DNA and proteins out

45

00:02:09,160 --> 00:02:06,049

of the system in which they eventually

46

00:02:11,680 --> 00:02:09,170

start to supplant RNA as they're better

47

00:02:14,500 --> 00:02:11,690

at containing information or better at

48

00:02:16,900 --> 00:02:14,510

doing the biochemistry and they supplant

49

00:02:17,600 --> 00:02:16,910

RNA and we have modern organisms and

50

00:02:19,310 --> 00:02:17,610

modern

51
00:02:21,320 --> 00:02:19,320
as we know it with the DNA and the

52
00:02:23,330 --> 00:02:21,330
protein system with RNA that helps out

53
00:02:25,880 --> 00:02:23,340
every once in a while to do the rest of

54
00:02:28,030 --> 00:02:25,890
this stuff and so this is how you get

55
00:02:31,460 --> 00:02:28,040
from a world based solely on RNA to

56
00:02:34,640 --> 00:02:31,470
modern organisms and the main focus of

57
00:02:36,680 --> 00:02:34,650
my research is looking at the step one

58
00:02:39,260 --> 00:02:36,690
as I have depicted here trying to get

59
00:02:41,210 --> 00:02:39,270
these nucleotides somehow to come

60
00:02:43,460 --> 00:02:41,220
together to overcome their energy

61
00:02:47,050 --> 00:02:43,470
barriers to create these long chains of

62
00:02:50,570 --> 00:02:47,060
RNA so what I've been looking at is

63
00:02:54,290 --> 00:02:50,580

these hydrothermal systems as possible

64

00:02:57,949 --> 00:02:54,300

sort of chemical incubators for creating

65

00:02:59,780 --> 00:02:57,959

these RNA molecules and so the

66

00:03:01,280 --> 00:02:59,790

hydrothermal systems I'm looking at our

67

00:03:02,810 --> 00:03:01,290

little bit different than a lot of

68

00:03:05,570 --> 00:03:02,820

people have been talking about in the

69

00:03:08,300 --> 00:03:05,580

last couple days as they aren't magma

70

00:03:12,590 --> 00:03:08,310

driven they don't have the extremely hot

71

00:03:16,210 --> 00:03:12,600

multi hundreds of degrees Celsius water

72

00:03:20,750 --> 00:03:16,220

that's coming out of them they're just

73

00:03:22,479 --> 00:03:20,760

nice warm to semi hot water systems that

74

00:03:25,940 --> 00:03:22,489

form at the bottom of the ocean or

75

00:03:28,880 --> 00:03:25,950

possibly at the bottom of Europa as long

76
00:03:31,789 --> 00:03:28,890
as you have some water system and some

77
00:03:35,000 --> 00:03:31,799
mineral system you can possibly get this

78
00:03:38,150 --> 00:03:35,010
sort of formation forming and so the

79
00:03:40,550 --> 00:03:38,160
main energy source for these serpent

80
00:03:43,699 --> 00:03:40,560
ization chimneys is from the serpent

81
00:03:47,060 --> 00:03:43,709
ization reaction which you take olivine

82
00:03:49,039 --> 00:03:47,070
which is a very ubiquitous mineral found

83
00:03:51,259 --> 00:03:49,049
in the Earth's crust you react it with

84
00:03:53,960 --> 00:03:51,269
basically water and you create

85
00:03:56,600 --> 00:03:53,970
serpentine some high-energy chemical

86
00:03:58,550 --> 00:03:56,610
molecules and a lot of energy and so

87
00:04:00,979 --> 00:03:58,560
this chemical reaction generates heat

88
00:04:03,530 --> 00:04:00,989

energy and high-energy compounds to do

89

00:04:05,120 --> 00:04:03,540

interesting biochemistry with if you mix

90

00:04:09,080 --> 00:04:05,130

things in there like carbon dioxide or

91

00:04:11,930 --> 00:04:09,090

sulfur you can create magnetite if you

92

00:04:14,539 --> 00:04:11,940

had some a silicon you can create a

93

00:04:16,580 --> 00:04:14,549

silicate and you can create a hydrogen

94

00:04:18,590 --> 00:04:16,590

sulphur things like this so you can get

95

00:04:23,380 --> 00:04:18,600

some nice high-energy chemical compounds

96

00:04:26,659 --> 00:04:23,390

just from chemistry yay chemistry and so

97

00:04:28,969 --> 00:04:26,669

these serpentinization chimneys are

98

00:04:31,080 --> 00:04:28,979

located off center from the ridge

99

00:04:33,750 --> 00:04:31,090

volcanoes where you see

100

00:04:36,780 --> 00:04:33,760

the nice black smokers and all the

101
00:04:38,909 --> 00:04:36,790
really warm sites these take place

102
00:04:41,129 --> 00:04:38,919
between 40 degrees and 90 degrees

103
00:04:42,960 --> 00:04:41,139
Celsius which is good because if you get

104
00:04:45,390 --> 00:04:42,970
too hot you start to worry about the

105
00:04:48,360 --> 00:04:45,400
problems of degrading the RNA that you

106
00:04:49,890 --> 00:04:48,370
could possibly be forming the pH from

107
00:04:52,800 --> 00:04:49,900
the chemical reactions actually make

108
00:04:56,640 --> 00:04:52,810
this alkaline so on a primordial earth

109
00:04:59,490 --> 00:04:56,650
you would have the alkaline vents out

110
00:05:01,230 --> 00:04:59,500
get or out pouring into an acidic ocean

111
00:05:04,500 --> 00:05:01,240
from the carbon dioxide that's dissolved

112
00:05:07,379 --> 00:05:04,510
in it in the modern-day oceans these for

113
00:05:09,420 --> 00:05:07,389

these calcium carbonate this giant white

114

00:05:12,320 --> 00:05:09,430

chimneys which these would not have been

115

00:05:14,580 --> 00:05:12,330

present in a prebiotic earth because the

116

00:05:17,460 --> 00:05:14,590

pH of the oceans is thought to have been

117

00:05:20,390 --> 00:05:17,470

much lower than it is today and an

118

00:05:23,760 --> 00:05:20,400

interesting note for astrobiology is a

119

00:05:25,800 --> 00:05:23,770

lot of some modern life forms can

120

00:05:27,690 --> 00:05:25,810

survive at these completely independent

121

00:05:30,029 --> 00:05:27,700

of energy from the Sun so if you're

122

00:05:32,520 --> 00:05:30,039

looking at this from the early Archaean

123

00:05:35,879 --> 00:05:32,530

as a possible source of biochemistry it

124

00:05:37,920 --> 00:05:35,889

provides enough high-energy compounds to

125

00:05:39,900 --> 00:05:37,930

be able to have living systems and so if

126

00:05:41,219 --> 00:05:39,910

you are able to synthesize life at these

127

00:05:43,200 --> 00:05:41,229

vents it could be completely

128

00:05:45,930 --> 00:05:43,210

self-sustaining without having to worry

129

00:05:47,879 --> 00:05:45,940

about photon capture or UV light or any

130

00:05:51,300 --> 00:05:47,889

other outputs other than what is

131

00:05:54,000 --> 00:05:51,310

provided at these chimney sites and so

132

00:05:58,339 --> 00:05:54,010

this is the experimental setup as it

133

00:06:05,279 --> 00:06:01,920

we have a simple ocean setup that's rich

134

00:06:07,350 --> 00:06:05,289

in a ferrous iron as the talk before has

135

00:06:09,480 --> 00:06:07,360

shown that iron two would have been a

136

00:06:12,960 --> 00:06:09,490

very important constituent of the early

137

00:06:15,810 --> 00:06:12,970

Earth ocean a little bit salty we purged

138

00:06:18,210 --> 00:06:15,820

it of all of the oxygen in there and

139

00:06:20,129 --> 00:06:18,220

just create a nitrogen environment above

140

00:06:23,900 --> 00:06:20,139

it so we try to keep it an toxic and

141

00:06:27,629 --> 00:06:23,910

iron rich and from the bottom we inject

142

00:06:29,909 --> 00:06:27,639

some sodium sulfide sodium chloride the

143

00:06:32,129 --> 00:06:29,919

silicate and other reaction constitutes

144

00:06:34,620 --> 00:06:32,139

into it to create these nice little

145

00:06:38,339 --> 00:06:34,630

black chimneys that can form in there

146

00:06:40,230 --> 00:06:38,349

and so here's a nice time sequence that

147

00:06:42,149 --> 00:06:40,240

you can see if the chimney growth over

148

00:06:43,830 --> 00:06:42,159

the minutes of reaction so you can see

149

00:06:45,330 --> 00:06:43,840

it gets bigger and bigger

150

00:06:48,890 --> 00:06:45,340

and these structures are hollow

151
00:06:51,000 --> 00:06:48,900
structures that have a membranous a

152
00:06:55,670 --> 00:06:51,010
membrane on the outside that can

153
00:06:57,960 --> 00:06:55,680
actually support the transfer of

154
00:07:01,890 --> 00:06:57,970
molecules from the inside to the outside

155
00:07:06,330 --> 00:07:01,900
it's a pH gradient and it creates a

156
00:07:08,580 --> 00:07:06,340
energy an energy gradient that can drive

157
00:07:10,890 --> 00:07:08,590
reactions which the talk after mine is

158
00:07:13,890 --> 00:07:10,900
going to discuss in a lot more detail so

159
00:07:16,230 --> 00:07:13,900
keep in mind pH gradient energy gradient

160
00:07:18,409 --> 00:07:16,240
it's hollow with the membrane and stuff

161
00:07:21,290 --> 00:07:18,419
can pass through and so here's some

162
00:07:24,750 --> 00:07:21,300
environmental scanning electron

163
00:07:28,110 --> 00:07:24,760

microscopy images to show what it looks

164

00:07:29,820 --> 00:07:28,120

like up close and personal another

165

00:07:31,050 --> 00:07:29,830

interesting thing is these chimneys have

166

00:07:33,450 --> 00:07:31,060

been shown to be able to incorporate

167

00:07:37,800 --> 00:07:33,460

some very small organics into them and

168

00:07:39,690 --> 00:07:37,810

so in these e SEM images it's a some

169

00:07:41,760 --> 00:07:39,700

small peptides that have been directly

170

00:07:44,100 --> 00:07:41,770

incorporated into the walls that have

171

00:07:48,960 --> 00:07:44,110

formed and it changes the morphology

172

00:07:51,120 --> 00:07:48,970

that is seen with the iron sulfide

173

00:07:53,400 --> 00:07:51,130

surfaces and so the incorporation

174

00:07:56,969 --> 00:07:53,410

changes how they grow and it also

175

00:07:58,650 --> 00:07:56,979

provides possible sites that catalysis

176

00:08:00,659 --> 00:07:58,660

could happen on maybe some interesting

177

00:08:03,570 --> 00:08:00,669

protein interactions things like that

178

00:08:07,050 --> 00:08:03,580

this has also been shown with some yeast

179

00:08:10,890 --> 00:08:07,060

that's been taken from some RNA that has

180

00:08:12,930 --> 00:08:10,900

been extracted from yeast and this long

181

00:08:15,420 --> 00:08:12,940

sequence of RNA has been shown to be

182

00:08:17,670 --> 00:08:15,430

incorporated into the iron sulfide

183

00:08:19,800 --> 00:08:17,680

chimneys as well and this is a great

184

00:08:21,450 --> 00:08:19,810

close-up showing the inside of the

185

00:08:23,070 --> 00:08:21,460

chimney versus the outside and these

186

00:08:27,150 --> 00:08:23,080

little compartments that can actually

187

00:08:29,070 --> 00:08:27,160

trap some organic molecules and that you

188

00:08:33,000 --> 00:08:29,080

can get a lot of membranous transport

189

00:08:36,089 --> 00:08:33,010

through so this is a picture of the

190

00:08:38,880 --> 00:08:36,099

setup in our laboratory so under our

191

00:08:41,219 --> 00:08:38,890

typical reaction conditions we form

192

00:08:45,150 --> 00:08:41,229

instead of those gnarly looking calcite

193

00:08:47,790 --> 00:08:45,160

or car beta calcium-based chimneys we

194

00:08:50,040 --> 00:08:47,800

formed these nice iron sulphide mounds

195

00:08:51,870 --> 00:08:50,050

that are still hollow and still have the

196

00:08:54,510 --> 00:08:51,880

membranes on the outside if you really

197

00:08:57,330 --> 00:08:54,520

ramp up the concentrations you get these

198

00:08:59,550 --> 00:08:57,340

really cool looking gnarly structures

199

00:09:02,250 --> 00:08:59,560

that are pretty photogenic so they're

200

00:09:06,300 --> 00:09:02,260

nice to show but this is probably

201
00:09:08,070 --> 00:09:06,310
unrealistic for an early Earth but who

202
00:09:09,990 --> 00:09:08,080
knows it's hard to know exactly what the

203
00:09:14,430 --> 00:09:10,000
concentrations of all the chemicals were

204
00:09:15,930 --> 00:09:14,440
back in the day so what our project

205
00:09:17,910 --> 00:09:15,940
started to do over the couple of weeks

206
00:09:20,430 --> 00:09:17,920
was to incorporate some of these small

207
00:09:24,900 --> 00:09:20,440
molecules into the growing chimneys that

208
00:09:27,330 --> 00:09:24,910
we have notably amino acids and some of

209
00:09:31,550 --> 00:09:27,340
the base pairs to some small nucleotides

210
00:09:33,810 --> 00:09:31,560
as the amino acids might encourage

211
00:09:37,410 --> 00:09:33,820
interesting polymerization reactions

212
00:09:38,640 --> 00:09:37,420
that could happen so one of the things

213
00:09:39,720 --> 00:09:38,650

that we're focusing on is glycine

214

00:09:43,080 --> 00:09:39,730

because it would have been very

215

00:09:44,910 --> 00:09:43,090

ubiquitous and proline as proline itself

216

00:09:49,650 --> 00:09:44,920

has been shown to have some catalytic

217

00:09:51,840 --> 00:09:49,660

properties just freeform and solution

218

00:09:54,180 --> 00:09:51,850

most notably with a homo chiral

219

00:09:58,080 --> 00:09:54,190

formation of different sort of amino

220

00:10:01,830 --> 00:09:58,090

acids or RNA and also it's thought that

221

00:10:03,930 --> 00:10:01,840

by incorporating some of the nucleotides

222

00:10:06,330 --> 00:10:03,940

into the walls of the chimneys it might

223

00:10:08,670 --> 00:10:06,340

promote aggregation to the chimneys by

224

00:10:12,840 --> 00:10:08,680

providing nice pairing sites which could

225

00:10:16,850 --> 00:10:12,850

promote adenosine or guanosine for

226

00:10:19,440 --> 00:10:16,860

example to be drawn to the chimney and

227

00:10:21,720 --> 00:10:19,450

something that I'll point out that's

228

00:10:23,880 --> 00:10:21,730

very important to what our lab group

229

00:10:28,710 --> 00:10:23,890

does in this experiment in particular is

230

00:10:30,720 --> 00:10:28,720

we use this mineral catalyst and an

231

00:10:32,790 --> 00:10:30,730

activated nucleotide to drive a bunch of

232

00:10:33,780 --> 00:10:32,800

our reactions and so this is something

233

00:10:35,730 --> 00:10:33,790

else that we're going to incorporate

234

00:10:37,890 --> 00:10:35,740

into the that we have incorporated in

235

00:10:40,470 --> 00:10:37,900

the chimneys is our Montreal night clay

236

00:10:42,360 --> 00:10:40,480

which under some prebiotic reactions has

237

00:10:47,880 --> 00:10:42,370

been shown to encourage oligomerization

238

00:10:51,750 --> 00:10:47,890

and we use normal nucleotides and these

239

00:10:54,270 --> 00:10:51,760

emit is elated nucleotides which help to

240

00:10:57,330 --> 00:10:54,280

speed up the reaction and some reactions

241

00:10:59,040 --> 00:10:57,340

are ness some reactions don't get

242

00:11:01,370 --> 00:10:59,050

completed unless you have this

243

00:11:06,060 --> 00:11:01,380

admittedly they've activated nucleotide

244

00:11:08,430 --> 00:11:06,070

and so some of our initial results from

245

00:11:10,170 --> 00:11:08,440

this since a lot of her reaction showed

246

00:11:11,970 --> 00:11:10,180

nothing

247

00:11:14,760 --> 00:11:11,980

the very first time this has been

248

00:11:16,200 --> 00:11:14,770

attempted and so we've run a lot of

249

00:11:17,940 --> 00:11:16,210

tests to try to figure out what works

250

00:11:19,950 --> 00:11:17,950

and what doesn't so one of the things

251

00:11:22,650 --> 00:11:19,960

that we discovered worked at a very

252

00:11:24,750 --> 00:11:22,660

small degree was the chimneys that were

253

00:11:27,480 --> 00:11:24,760

formed with you and Pete incorporated

254

00:11:30,590 --> 00:11:27,490

into the side and so this is our mass

255

00:11:32,820 --> 00:11:30,600

spec data which is a good way to

256

00:11:34,650 --> 00:11:32,830

determine the composition of solutions

257

00:11:36,540 --> 00:11:34,660

based upon the mass of the molecules

258

00:11:39,570 --> 00:11:36,550

that are in there and this has shown

259

00:11:42,030 --> 00:11:39,580

that we created up to oligomers that are

260

00:11:44,150 --> 00:11:42,040

four units in length and so it shows

261

00:11:47,040 --> 00:11:44,160

that we get a small amount of

262

00:11:50,760 --> 00:11:47,050

oligomerization in this reaction with

263

00:11:53,370 --> 00:11:50,770

ump in the chimney and this one used the

264

00:11:56,100 --> 00:11:53,380

activated a MP that we had so the

265

00:11:57,900 --> 00:11:56,110

Middle's elated but it shows we got some

266

00:12:00,690 --> 00:11:57,910

degree of success from these chimney

267

00:12:02,340 --> 00:12:00,700

formations and so what are the

268

00:12:04,230 --> 00:12:02,350

subsequent experiments that we followed

269

00:12:07,560 --> 00:12:04,240

up was using the mop Marilla Mike clay

270

00:12:10,530 --> 00:12:07,570

as an ocean floor to actually have the

271

00:12:12,060 --> 00:12:10,540

iron sulfide or the the sulfide reaction

272

00:12:16,260 --> 00:12:12,070

come through the bottom to see if the

273

00:12:18,390 --> 00:12:16,270

combination of the the creation of the

274

00:12:21,870 --> 00:12:18,400

chimneys with the catalytic Clay had an

275

00:12:24,480 --> 00:12:21,880

effect upon it and what we saw was with

276

00:12:27,090 --> 00:12:24,490

impair we got the polymerization like we

277

00:12:29,910 --> 00:12:27,100

saw before so this one has no ump in it

278

00:12:31,350 --> 00:12:29,920

just the clay as the ocean floor but

279

00:12:33,840 --> 00:12:31,360

what's interesting we've never observed

280

00:12:36,510 --> 00:12:33,850

this in laboratory before is with a and

281

00:12:39,720 --> 00:12:36,520

P with the non-activated nucleotide we

282

00:12:43,530 --> 00:12:39,730

got a distinct dimer here which could be

283

00:12:46,350 --> 00:12:43,540

pyrophosphate it could be a small RNA

284

00:12:48,030 --> 00:12:46,360

molecule and it's arguable whether or

285

00:12:49,890 --> 00:12:48,040

not we have a three marin there but we

286

00:12:51,510 --> 00:12:49,900

haven't seen this dimer before and a

287

00:12:53,490 --> 00:12:51,520

very small amount of dreamer so it shows

288

00:12:56,190 --> 00:12:53,500

like this lemur ization ray actually

289

00:12:58,380 --> 00:12:56,200

could be successful and also i'll point

290

00:13:01,860 --> 00:12:58,390

out from this we are showing a strong

291

00:13:04,860 --> 00:13:01,870

iron aggregate effect in these reactions

292

00:13:07,199 --> 00:13:04,870

as we know iron is Durrant RNA from the

293

00:13:10,280 --> 00:13:07,209

previous talk and so we could see that

294

00:13:13,500 --> 00:13:10,290

in our reaction analysis as well it's

295

00:13:15,870 --> 00:13:13,510

the initial results show that clay and

296

00:13:17,670 --> 00:13:15,880

unp are incorporated into the growing

297

00:13:19,290 --> 00:13:17,680

chimneys that's from data that I had it

298

00:13:21,269 --> 00:13:19,300

presented but we have verified that it

299

00:13:23,820 --> 00:13:21,279

is actually incorporated into the

300

00:13:25,980 --> 00:13:23,830

structure and like I said we observed

301
00:13:28,770 --> 00:13:25,990
finer oligomers formation with UMP and

302
00:13:31,350 --> 00:13:28,780
with the catalytic clay with activated

303
00:13:33,810 --> 00:13:31,360
and not activated nucleotides and we've

304
00:13:37,020 --> 00:13:33,820
observed some initial iron clustering as

305
00:13:39,450 --> 00:13:37,030
well and once again I'd like to a

306
00:13:43,100 --> 00:13:39,460
knowledge Laurie barge for working with

307
00:13:46,500 --> 00:13:43,110
me on this in our very intensive project

308
00:13:48,450 --> 00:13:46,510
my group members and group at rpi that

309
00:13:50,970 --> 00:13:48,460
we work along with and of course the

310
00:13:57,470 --> 00:13:50,980
astrobiology institute for providing

311
00:14:04,200 --> 00:13:59,370
alright we have time for one quick

312
00:14:07,280 --> 00:14:04,210
question if anyone has anything those

313
00:14:10,380 --> 00:14:07,290

small peptides with like lysine and

314

00:14:13,200 --> 00:14:10,390

alanine were those forming on their own

315

00:14:15,420 --> 00:14:13,210

or they oh no those were preformed and

316

00:14:17,490 --> 00:14:15,430

just incorporated in as a test of

317

00:14:20,760 --> 00:14:17,500

concept to see if it was possible did

318

00:14:24,150 --> 00:14:20,770

you and you were putting in amino acids

319

00:14:25,590 --> 00:14:24,160

into your model and well you ever tried

320

00:14:27,600 --> 00:14:25,600

the same reaction that you're looking

321

00:14:29,190 --> 00:14:27,610

for did you ever try putting amino acids

322

00:14:33,120 --> 00:14:29,200

and seeing if they would maybe

323

00:14:34,440 --> 00:14:33,130

polymerize not oh I have not done that I

324

00:14:36,330 --> 00:14:34,450

think works been done than that I know

325

00:14:37,950 --> 00:14:36,340

that some of the hydrothermal systems

326

00:14:40,050 --> 00:14:37,960

I'm not sure if it's the hot ones or the

327

00:14:45,210 --> 00:14:40,060

cooler ones have been shown to promote

328

00:14:47,160 --> 00:14:45,220

some amino are some of the organic amino

329

00:14:49,770 --> 00:14:47,170

acid formations I'm not sure if that

330

00:14:52,530 --> 00:14:49,780

formed peptides or proteins but we did