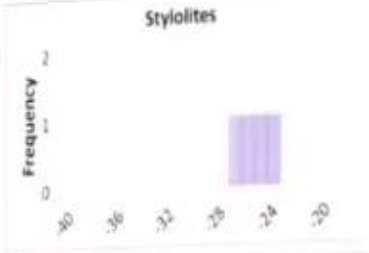
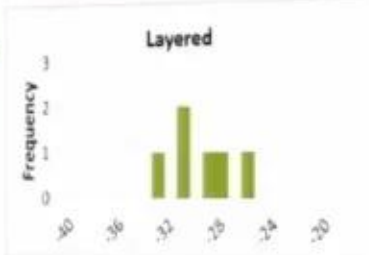
Results of in-situ C isotopic analysis

Sample 84.4

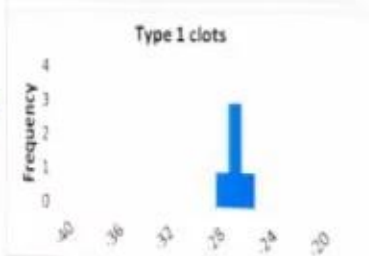
-25.7‰ ±0.9



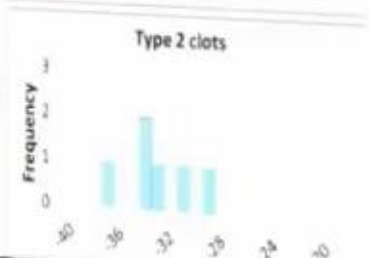
-30.1‰ ±2.2

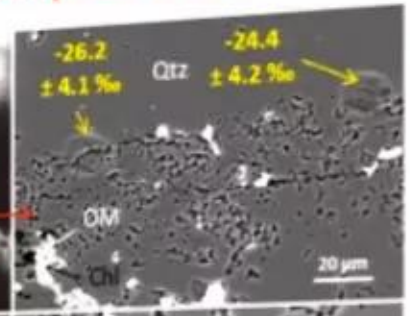


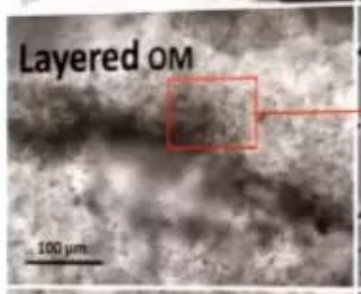
-27.6‰ ±0.8

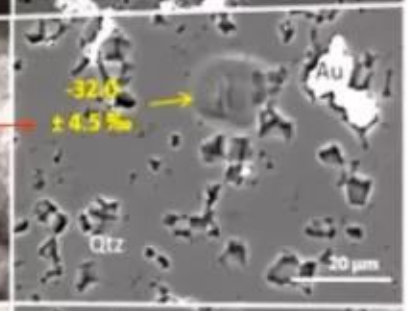


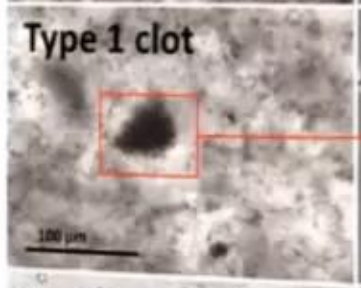
-33.6‰ ±2.0

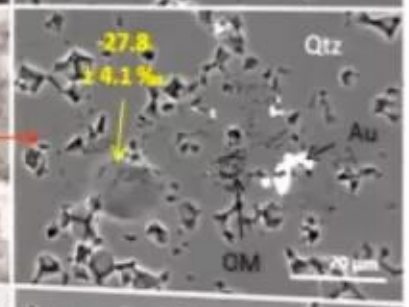


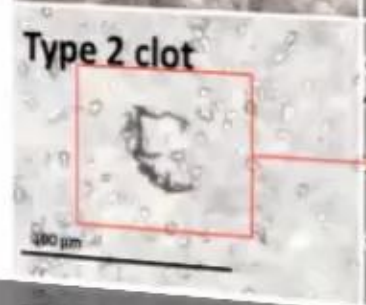


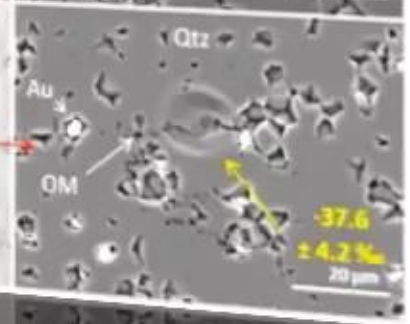












1
00:00:12,440 --> 00:00:10,490
hey thank you good morning um so the

2
00:00:18,620 --> 00:00:12,450
study out I want to present to you now

3
00:00:22,220 --> 00:00:18,630
Islam actually um in situ um isotopic

4
00:00:25,700 --> 00:00:22,230
analysis of carbon isotope in organic

5
00:00:27,890 --> 00:00:25,710
matter from the Church of the dresser

6
00:00:30,470 --> 00:00:27,900
formation in the pill rock python which

7
00:00:33,110 --> 00:00:30,480
are dated to 3.5 billion years and

8
00:00:38,960 --> 00:00:33,120
contains some of the oldest evidence for

9
00:00:41,350 --> 00:00:38,970
life on Earth um so the Pilbara cretonne

10
00:00:43,700 --> 00:00:41,360
is well known not just as the site of

11
00:00:46,220 --> 00:00:43,710
occurrence to my delight but as the

12
00:00:52,850 --> 00:00:46,230
location of Earth all this putative

13
00:00:54,410 --> 00:00:52,860

stromatolites and microfossils um the

14
00:00:59,260 --> 00:00:54,420
beautiful stromatolite of the sturdy

15
00:01:04,340 --> 00:01:02,030
these are probably of biogenic origin I

16
00:01:08,060 --> 00:01:04,350
don't think a lot of people dispute that

17
00:01:10,789 --> 00:01:08,070
now slightly older are the putative

18
00:01:14,840 --> 00:01:10,799
microfossils that were found in the

19
00:01:17,469 --> 00:01:14,850
famous a textured whose biogenic origin

20
00:01:21,080 --> 00:01:17,479
has been debated for over 30 years now

21
00:01:24,349 --> 00:01:21,090
the oldest purity of stromatolites and

22
00:01:27,620 --> 00:01:24,359
microfossils occur in the bed Church of

23
00:01:29,870 --> 00:01:27,630
the dresser formation data to 3.5

24
00:01:32,300 --> 00:01:29,880
billion years all those a biogenic

25
00:01:36,620 --> 00:01:32,310
origin of these oldest structures have

26
00:01:41,149 --> 00:01:36,630
also been debated there are isotopic

27
00:01:43,099 --> 00:01:41,159
evidence that support microbial so for

28
00:01:46,099 --> 00:01:43,109
this proportion ation in microbial

29
00:01:48,289 --> 00:01:46,109
methanogenesis in this rocks and another

30
00:01:52,249 --> 00:01:48,299
important of division is the occurrence

31
00:01:56,539 --> 00:01:52,259
of organic matter in association with

32
00:02:00,409 --> 00:01:56,549
these alleged biogenic structures which

33
00:02:03,559 --> 00:02:00,419
also support some kind of link that

34
00:02:08,870 --> 00:02:03,569
these are actually produced by biologic

35
00:02:11,390 --> 00:02:08,880
activity bulk carbonized topic analysis

36
00:02:14,080 --> 00:02:11,400
of the organic matter that is preserved

37
00:02:19,130 --> 00:02:14,090
in these rocks have shown that it is

38
00:02:21,080 --> 00:02:19,140

depleted in carbon 13 in a manner very

39
00:02:26,830 --> 00:02:21,090
similar to that of organic matter

40
00:02:29,780 --> 00:02:26,840
produced by autotrophic microorganisms

41
00:02:32,510 --> 00:02:29,790
suggesting that it is of biogenic origin

42
00:02:37,040 --> 00:02:32,520
however experimental studies have shown

43
00:02:40,100 --> 00:02:37,050
that similar isotopic composition can be

44
00:02:42,980 --> 00:02:40,110
obtained during a biotic carbon fixation

45
00:02:45,250 --> 00:02:42,990
in processes which are similar to the

46
00:02:48,170 --> 00:02:45,260
industrial future crop type synthesis

47
00:02:50,930 --> 00:02:48,180
which I will talk about a little I talk

48
00:02:53,690 --> 00:02:50,940
about it a little later and therefore

49
00:02:55,820 --> 00:02:53,700
they concluded that carbon isotopic

50
00:02:58,520 --> 00:02:55,830
composition of organic matter by itself

51
00:03:05,000 --> 00:02:58,530
is not a conclusive evidence for a

52
00:03:07,550 --> 00:03:05,010
biogenic origin so in an attempt to

53
00:03:10,340 --> 00:03:07,560
better constrain to the origin of the

54
00:03:13,820 --> 00:03:10,350
organic matter preserved in these rocks

55
00:03:17,300 --> 00:03:13,830
in this church we have decided to apply

56
00:03:19,850 --> 00:03:17,310
in situ carbon isotopic analysis of the

57
00:03:22,850 --> 00:03:19,860
organic matter and this technique has

58
00:03:26,450 --> 00:03:22,860
the potential of distinguishing between

59
00:03:28,610 --> 00:03:26,460
different generations in now of organic

60
00:03:30,590 --> 00:03:28,620
matter in the same sample like you see

61
00:03:33,470 --> 00:03:30,600
here from the sturdy full formation work

62
00:03:36,380 --> 00:03:33,480
by the fault at all they have found

63
00:03:39,730 --> 00:03:36,390

within one sample organic matter in the

64
00:03:44,740 --> 00:03:39,740
form of these globular clusters and

65
00:03:47,180 --> 00:03:44,750
spheres and they have shown that it has

66
00:03:49,610 --> 00:03:47,190
slightly different carbon isotopic

67
00:03:51,950 --> 00:03:49,620
composition now if you will do bulk

68
00:03:54,980 --> 00:03:51,960
analysis for this sample so you might

69
00:03:59,630 --> 00:03:54,990
just get an average which kind of

70
00:04:02,510 --> 00:03:59,640
obscure the real picture so like the

71
00:04:04,880 --> 00:04:02,520
work shown here our work would also done

72
00:04:08,990 --> 00:04:04,890
in the whisk seems lab which you have

73
00:04:13,490 --> 00:04:09,000
probably visited and Sunday now we have

74
00:04:17,360 --> 00:04:13,500
used a standard of natural church that

75
00:04:19,909 --> 00:04:17,370
contain organic matter which allow us to

76
00:04:22,879 --> 00:04:19,919
accurately correct with instrumental

77
00:04:26,300 --> 00:04:22,889
mass bias unlike previous works who have

78
00:04:29,640 --> 00:04:26,310
targeted microstructures in this sample

79
00:04:32,340 --> 00:04:29,650
which have used crystalline graphite we

80
00:04:38,279 --> 00:04:32,350
who now is known to have a different

81
00:04:41,659 --> 00:04:38,289
instrumental our bias so our samples

82
00:04:46,590 --> 00:04:41,669
come from the Pilbara drilling project

83
00:04:49,620 --> 00:04:46,600
drill core 2 which have penetrated the

84
00:04:53,330 --> 00:04:49,630
dresser bedded church had depth of about

85
00:04:55,920 --> 00:04:53,340
80 to 90 meters below a section of

86
00:04:58,350 --> 00:04:55,930
padova sods providing relatively fresh

87
00:05:00,870 --> 00:04:58,360
samples to work with our samples come

88
00:05:03,090 --> 00:05:00,880

mostly from the bedded church at the

89
00:05:06,900 --> 00:05:03,100
upper part of the core but also from a

90
00:05:09,510 --> 00:05:06,910
hydrothermal trade vein at the bottom

91
00:05:13,219 --> 00:05:09,520
part of the core and so samples were cut

92
00:05:15,990 --> 00:05:13,229
into thin sections and studied under

93
00:05:22,350 --> 00:05:16,000
reflected and transmitted light before

94
00:05:26,670 --> 00:05:22,360
the analysis so here you see a clean

95
00:05:28,740 --> 00:05:26,680
section of bedded shirt from the

96
00:05:31,820 --> 00:05:28,750
uppermost part of the section I which

97
00:05:34,800 --> 00:05:31,830
yielded the most diverse assemblage of

98
00:05:37,589 --> 00:05:34,810
organic micro structures and we have

99
00:05:40,320 --> 00:05:37,599
identified five main types of organic

100
00:05:44,120 --> 00:05:40,330
micro structures in the samples there's

101
00:05:47,100 --> 00:05:44,130
of dispersed organic matter amorphous

102
00:05:50,640 --> 00:05:47,110
organic matter clot that occur in this

103
00:05:53,279 --> 00:05:50,650
rich organic matter each beds and these

104
00:05:55,140 --> 00:05:53,289
were designated type 1 plot and there

105
00:05:58,710 --> 00:05:55,150
was another type of clots which had a

106
00:06:01,230 --> 00:05:58,720
more distinct shape and occur mostly in

107
00:06:04,409 --> 00:06:01,240
the organic matter for beds and these

108
00:06:06,240 --> 00:06:04,419
were designated type to clot and except

109
00:06:07,620 --> 00:06:06,250
for those we have also find organic

110
00:06:10,200 --> 00:06:07,630
matter which was concentrated along

111
00:06:13,159 --> 00:06:10,210
state oolitic front and organic matter

112
00:06:18,629 --> 00:06:13,169
that is preserved in the core of

113
00:06:22,140 --> 00:06:18,639

carbonate so here are the results of our

114
00:06:28,010 --> 00:06:22,150
carbon in situ isotopic analysis over on

115
00:06:34,939 --> 00:06:28,020
the right sorry you see images of

116
00:06:38,490 --> 00:06:34,949
individual analysis pits in selected

117
00:06:40,409 --> 00:06:38,500
micro structures and the isotopic

118
00:06:42,510 --> 00:06:40,419
composition that was obtained for this

119
00:06:43,360 --> 00:06:42,520
specific pit and overall that you see

120
00:06:45,730 --> 00:06:43,370
that the the over

121
00:06:49,540 --> 00:06:45,740
range of isotopic composition in this

122
00:06:51,850 --> 00:06:49,550
sample is over 13 per meal over on the

123
00:06:56,170 --> 00:06:51,860
left you see histograms which present

124
00:06:58,960 --> 00:06:56,180
the distribution of isotopic composition

125
00:07:02,770 --> 00:06:58,970
in specific armed organic micro

126
00:07:04,480 --> 00:07:02,780
structures and the most interesting

127
00:07:08,710 --> 00:07:04,490
observation here is the bimodal

128
00:07:13,150 --> 00:07:08,720
distribution of organic of isotopic

129
00:07:14,909 --> 00:07:13,160
composition in in the clods between the

130
00:07:17,590 --> 00:07:14,919
type 1 plot which had an average

131
00:07:20,110 --> 00:07:17,600
isotopic composition of minus 28 per

132
00:07:21,840 --> 00:07:20,120
meal and type 2 clouds which have I

133
00:07:31,120 --> 00:07:21,850
average edges of the composition of

134
00:07:37,659 --> 00:07:31,130
minus 34 / mill here you see individual

135
00:07:41,980 --> 00:07:37,669
analysis isotopic composition that 13 C

136
00:07:44,650 --> 00:07:41,990
values plotted against on the 13 c h /

137
00:07:46,930 --> 00:07:44,660
13 c ratio which was also measured

138
00:07:49,330 --> 00:07:46,940

during the analysis in this ratio served

139
00:07:52,750 --> 00:07:49,340
as a proxy for the samples hydrogen

140
00:07:57,279 --> 00:07:52,760
carbon ratio so there is no correlation

141
00:07:59,140 --> 00:07:57,289
seen between these two parameters which

142
00:08:02,020 --> 00:07:59,150
is which is important for two reasons

143
00:08:04,270 --> 00:08:02,030
first of all it indicates that the range

144
00:08:09,089 --> 00:08:04,280
of isotopic composition that we see is

145
00:08:13,300 --> 00:08:09,099
not the result of a variable instrument

146
00:08:15,570 --> 00:08:13,310
bias that might arise from varying

147
00:08:18,760 --> 00:08:15,580
hydrogen content in the samples and

148
00:08:22,480 --> 00:08:18,770
second during thermal maturation of

149
00:08:25,089 --> 00:08:22,490
organic matter it can change isotopic

150
00:08:29,020 --> 00:08:25,099
composition by preferential loss of

151
00:08:30,909 --> 00:08:29,030
isotopically like methane and this this

152
00:08:33,790 --> 00:08:30,919
process usually leads to a negative

153
00:08:36,250 --> 00:08:33,800
correlation between isotopic composition

154
00:08:39,730 --> 00:08:36,260
and hydrogen carbon ratio which is not

155
00:08:41,620 --> 00:08:39,740
seen in the samples and therefore we

156
00:08:44,980 --> 00:08:41,630
interpret that the range of isotopic

157
00:08:48,699 --> 00:08:44,990
composition seen in the sample is a is

158
00:08:54,370 --> 00:08:48,709
an original heterogeneity another result

159
00:08:57,629 --> 00:08:54,380
of later thermal adoration here is the

160
00:09:01,509 --> 00:08:57,639
sample from a hydrothermal shirt vein

161
00:09:02,949 --> 00:09:01,519
and in this sample the only organic

162
00:09:06,759 --> 00:09:02,959
micro structure that we have identified

163
00:09:09,519 --> 00:09:06,769

is these are organic matter clots

164
00:09:11,979 --> 00:09:09,529
similar in appearance to the type 1

165
00:09:15,339 --> 00:09:11,989
clots which have I have shown in the bed

166
00:09:20,169 --> 00:09:15,349
at two example and isotopic composition

167
00:09:23,379 --> 00:09:20,179
in these clots are also similar to the

168
00:09:25,989 --> 00:09:23,389
idea topic composition of the type 1

169
00:09:29,289 --> 00:09:25,999
clots in the previous in the bed example

170
00:09:32,109 --> 00:09:29,299
with an average of about minus 28 per

171
00:09:34,839 --> 00:09:32,119
mil so this chick textural and isotopic

172
00:09:36,939 --> 00:09:34,849
similarity suggest that the clots both

173
00:09:40,779 --> 00:09:36,949
in the bed church and in the

174
00:09:46,119 --> 00:09:40,789
hydrothermal truth then have the same

175
00:09:51,279 --> 00:09:46,129
origin so what is the origin of this

176
00:09:52,689 --> 00:09:51,289
organic matter so as I said before some

177
00:09:54,189 --> 00:09:52,699
works have suggested that the organic

178
00:09:56,019 --> 00:09:54,199
matter could have formed by a biotic

179
00:09:58,329 --> 00:09:56,029
processes similar to the industrial

180
00:10:01,299 --> 00:09:58,339
fischer-tropsch synthesis in this

181
00:10:03,489 --> 00:10:01,309
process inorganic carbon mostly in the

182
00:10:07,479 --> 00:10:03,499
form of carbon monoxide or carbon

183
00:10:11,199 --> 00:10:07,489
dioxide is reduced by hydrogen over the

184
00:10:13,659 --> 00:10:11,209
surface of a metal catalyst and this

185
00:10:17,649 --> 00:10:13,669
process can form simple chains of

186
00:10:20,349 --> 00:10:17,659
hydrocarbon however the correlation that

187
00:10:24,189 --> 00:10:20,359
i have seen between isotopic composition

188
00:10:26,289 --> 00:10:24,199

and specific micro check stereotypes is

189
00:10:28,869 --> 00:10:26,299
hard to reconcile with this process if

190
00:10:32,139 --> 00:10:28,879
the source of organic matter was just

191
00:10:34,749 --> 00:10:32,149
simple polymerization of hydrocarbons

192
00:10:38,799 --> 00:10:34,759
formed this way we would have expected

193
00:10:41,259 --> 00:10:38,809
it to have a uniform as a topic

194
00:10:43,689 --> 00:10:41,269
composition at least in one single

195
00:10:46,149 --> 00:10:43,699
samples with in one sample which is not

196
00:10:48,519 --> 00:10:46,159
the case and likewise there are no

197
00:10:50,949 --> 00:10:48,529
evidence for extensive serpentine

198
00:10:52,269 --> 00:10:50,959
ization in the underlying puzzles which

199
00:10:54,429 --> 00:10:52,279
could have served as a source of

200
00:10:56,259 --> 00:10:54,439
hydrogen needed for the reaction over

201
00:10:59,199 --> 00:10:56,269
the occurrence of suitable

202
00:11:02,769 --> 00:10:59,209
metal-catalyzed catalyst in the dresser

203
00:11:05,349 --> 00:11:02,779
choot and how it does i did i reconcile

204
00:11:08,229 --> 00:11:05,359
with a biogenic origin in some of the

205
00:11:10,960 --> 00:11:08,239
sample studies we have also measured

206
00:11:13,860 --> 00:11:10,970
years to be composition of anchor I

207
00:11:16,929 --> 00:11:13,870
Bernard Rome's and we have found that

208
00:11:19,269 --> 00:11:16,939
the isotopic on Carter fractionation

209
00:11:21,579 --> 00:11:19,279
between anchorite which is the inorganic

210
00:11:23,980 --> 00:11:21,589
carbon and organic matter is in the

211
00:11:28,590 --> 00:11:23,990
range of twenty five to thirty three per

212
00:11:34,269 --> 00:11:28,600
mil and this range is consistent with

213
00:11:36,639 --> 00:11:34,279

carbon fixation both by autotrophic

214
00:11:39,280 --> 00:11:36,649
organisms using the reductive acetyl-coa

215
00:11:43,090 --> 00:11:39,290
pathways which are mostly Kim autotrophs

216
00:11:46,569 --> 00:11:43,100
and organisms that utilize the calvin

217
00:11:49,059 --> 00:11:46,579
cycle so our data cannot distinguish

218
00:11:53,369 --> 00:11:49,069
between these two carbon fixation path

219
00:11:58,240 --> 00:11:53,379
but it is generally consistent with

220
00:12:02,470 --> 00:11:58,250
autotrophic microbial carbon fixation so

221
00:12:05,199 --> 00:12:02,480
just a quick conclusion so we have shown

222
00:12:08,230 --> 00:12:05,209
that in situ carbon isotopic analysis in

223
00:12:09,910 --> 00:12:08,240
a destitute reveal submicron

224
00:12:13,119 --> 00:12:09,920
heterogeneities which correlate to

225
00:12:16,299 --> 00:12:13,129
specific micro structural types and the

226
00:12:19,660 --> 00:12:16,309
range of values is thought to represent

227
00:12:23,710 --> 00:12:19,670
the original primary organic matter as a

228
00:12:26,019 --> 00:12:23,720
topic heterogeneity and the correlation

229
00:12:27,790 --> 00:12:26,029
between isotopic composition and

230
00:12:30,759 --> 00:12:27,800
specific microstructure type is hard to

231
00:12:33,280 --> 00:12:30,769
reconcile with solely a biotic origin

232
00:12:35,439 --> 00:12:33,290
for the organic matter and the

233
00:12:36,869 --> 00:12:35,449
fractionation between inorganic and

234
00:12:39,280 --> 00:12:36,879
organic carbon in the sample is

235
00:12:42,429 --> 00:12:39,290
consistent with somatic carbon fixation

236
00:12:45,699 --> 00:12:42,439
both by photo edit row' and chemo dito

237
00:12:49,869 --> 00:12:45,709
electrical and I will finish with this

238
00:12:52,540 --> 00:12:49,879

artist impression of early life and I

239
00:12:54,340 --> 00:12:52,550
think it's nice can nicely fit the

240
00:12:58,240 --> 00:12:54,350
environment represented dresser

241
00:13:00,009 --> 00:12:58,250
formation which could have both photo

242
00:13:03,460 --> 00:13:00,019
autotrophs represented by stromatolite

243
00:13:07,530 --> 00:13:03,470
and kim water troughs which could have

244
00:13:13,920 --> 00:13:07,540
thrived in the hydrothermal environment

245
00:13:28,150 --> 00:13:24,190
huh thank you very much for a

246
00:13:29,949 --> 00:13:28,160
presentation I so you have a schematic

247
00:13:33,699 --> 00:13:29,959
view for the formation of the

248
00:13:37,300 --> 00:13:33,709
hydrocarbon species on the surface I

249
00:13:40,150 --> 00:13:37,310
just learned because you have carbon

250
00:13:44,139 --> 00:13:40,160
monoxide and also oxygen on the surface

251
00:13:49,060 --> 00:13:44,149
it will be that form most stable like a

252
00:13:50,410 --> 00:13:49,070
carbon dioxide species home you're

253
00:13:53,199 --> 00:13:50,420
talking about the carbon monoxide which

254
00:13:55,949 --> 00:13:53,209
is shown for the fish for the future

255
00:13:59,100 --> 00:13:55,959
dropped accent is it well industrial

256
00:14:02,380 --> 00:13:59,110
fischer-tropsch synthesis utilize arm

257
00:14:04,360 --> 00:14:02,390
carbon monoxide mostly but this process

258
00:14:09,550 --> 00:14:04,370
was also suggested that could happen

259
00:14:12,759 --> 00:14:09,560
with carbon dioxide so the the

260
00:14:14,620 --> 00:14:12,769
hydrothermal system the dresser probably

261
00:14:19,480 --> 00:14:14,630
had a lot of carbon dioxide I don't know

262
00:14:24,010 --> 00:14:19,490
if it had carbon monoxide you know this

263
00:14:26,920 --> 00:14:24,020

is just as a possibility of a biotic of

264
00:14:29,650 --> 00:14:26,930
information and by the fischer-tropsch

265
00:14:34,660 --> 00:14:29,660
synthesis it's just a suggestion I mean

266
00:14:36,579 --> 00:14:34,670
oh come and it was suggested that it can

267
00:14:41,079 --> 00:14:36,589
also utilize carbon dioxide it just

268
00:14:42,040 --> 00:14:41,089
shown it as an example I don't really

269
00:14:50,220 --> 00:14:42,050
think that this process actually