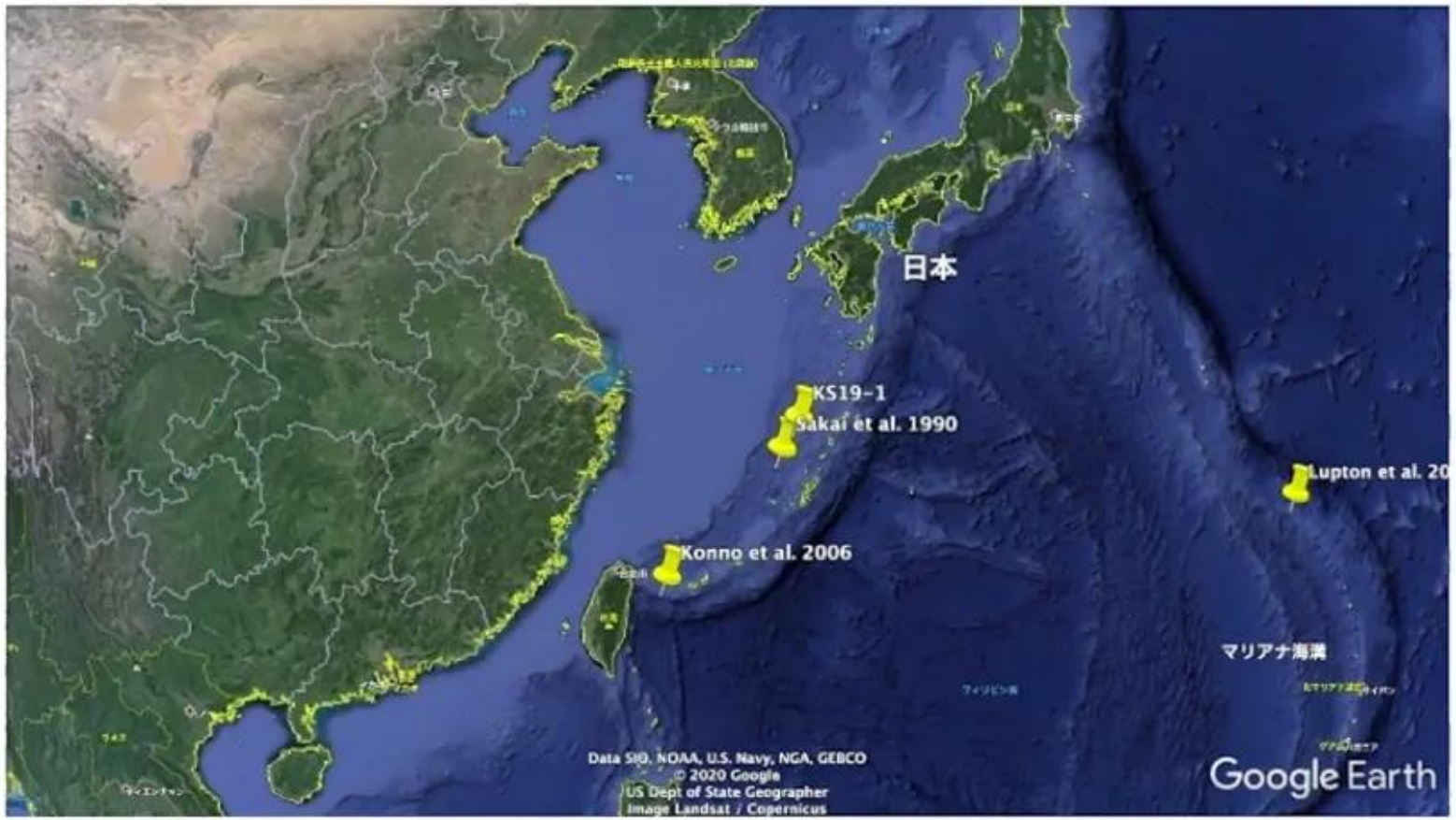
Place where CO_2 fluid is found



Made by Google Earth Pro from Sakai H., *et al*., *Science*. (1990), Konno U., *et al*., *Geophys. Res. Lett*. (2006), Lupton J., *et al*., *Geochemistry, Geophysics, Geosystems*. (2006), KS-19-1, Pederson R.B., *et al*., (2010), Zhang X., *et al*., *Science Bulletin*. (2020)

1
00:00:06,309 --> 00:00:03,669
hi i'm kaido sale i'm interested in

2
00:00:08,710 --> 00:00:06,319
origin life and here's my picture so you

3
00:00:10,709 --> 00:00:08,720
can match me talking today i will talk

4
00:00:13,190 --> 00:00:10,719
about my research about liquid carbon

5
00:00:15,270 --> 00:00:13,200
dioxide and experiments about

6
00:00:18,470 --> 00:00:15,280
dissolution and distribution of

7
00:00:21,029 --> 00:00:18,480
inorganics into liquid co2

8
00:00:24,710 --> 00:00:21,039
to start with i would like to talk about

9
00:00:28,070 --> 00:00:24,720
the liquid state of co2

10
00:00:30,230 --> 00:00:28,080
generally co2 is known to take gas state

11
00:00:31,750 --> 00:00:30,240
and cells form which you use to keep

12
00:00:34,790 --> 00:00:31,760
your food freezing

13
00:00:36,950 --> 00:00:34,800

but if you give enough pressure co2

14
00:00:40,470 --> 00:00:36,960
turns into liquid

15
00:00:43,030 --> 00:00:40,480
this is the phase diagram of co2 and you

16
00:00:47,750 --> 00:00:43,040
can see in what temperature and pressure

17
00:00:52,389 --> 00:00:49,430
this movie on the right is showing

18
00:00:54,389 --> 00:00:52,399
liquid co2 pouring inside the container

19
00:00:57,590 --> 00:00:54,399
this is what it looks like for those who

20
00:01:00,389 --> 00:00:57,600
have not seen liquid phase of co2 before

21
00:01:03,750 --> 00:01:00,399
it is colorless and transparent just

22
00:01:09,350 --> 00:01:05,910
one of the special characteristics of

23
00:01:11,350 --> 00:01:09,360
liquid co2 is its hydrophobicity

24
00:01:12,950 --> 00:01:11,360
it is known to dissolve less than one

25
00:01:15,190 --> 00:01:12,960
percent of water

26
00:01:17,910 --> 00:01:15,200
as a result it forms two layers of

27
00:01:22,390 --> 00:01:17,920
liquid just like oil and water

28
00:01:24,469 --> 00:01:22,400
as it is shown in the photograph here

29
00:01:27,429 --> 00:01:24,479
now some of you might be wondering how

30
00:01:29,990 --> 00:01:27,439
oil-like liquid co2 relate to ocean life

31
00:01:34,230 --> 00:01:30,000
at all so let's move on to where we can

32
00:01:38,950 --> 00:01:36,950
the existence of liquid co2 in natural

33
00:01:41,270 --> 00:01:38,960
is limitedly reported

34
00:01:44,389 --> 00:01:41,280
it was found near hydrosomal vent at

35
00:01:46,230 --> 00:01:44,399
okinotrov mayan arc and one in

36
00:01:48,710 --> 00:01:46,240
norwegian's ocean

37
00:01:50,230 --> 00:01:48,720
the clip from google earth is showing

38
00:01:53,830 --> 00:01:50,240

you the coordinates

39
00:01:59,270 --> 00:01:56,789
next the mechanism of how liquid co2

40
00:02:00,630 --> 00:01:59,280
reservoir is formed is shown as a

41
00:02:02,950 --> 00:02:00,640
diagram

42
00:02:05,510 --> 00:02:02,960
geothermal heat makes fluid mix of

43
00:02:08,309 --> 00:02:05,520
supplied seawater and magma

44
00:02:10,229 --> 00:02:08,319
as the fluid flows upwards the decrease

45
00:02:11,670 --> 00:02:10,239
in temperature and pressure leads to

46
00:02:14,949 --> 00:02:11,680
phase separation

47
00:02:17,430 --> 00:02:14,959
and co2 accumulates under sediment

48
00:02:19,589 --> 00:02:17,440
since liquid co2 is known to possess

49
00:02:22,070 --> 00:02:19,599
unique oil-like features unlike

50
00:02:24,229 --> 00:02:22,080
surrounding seawater-based fluid this

51
00:02:26,710 --> 00:02:24,239
fluid may act as a solvent for

52
00:02:28,229 --> 00:02:26,720
hydrophobic salute which probably

53
00:02:29,510 --> 00:02:28,239
completion different from the

54
00:02:32,229 --> 00:02:29,520
surrounding

55
00:02:35,430 --> 00:02:32,239
however due to lack of observation made

56
00:02:37,670 --> 00:02:35,440
to this underwater co2 reservoir and not

57
00:02:40,550 --> 00:02:37,680
much experimental research conducted

58
00:02:44,710 --> 00:02:40,560
about liquid co2 in natural environment

59
00:02:47,670 --> 00:02:45,670
so

60
00:02:51,110 --> 00:02:47,680
now that i have talked about hydrophobic

61
00:02:52,949 --> 00:02:51,120
nature of liquid co2 and how it's formed

62
00:02:53,990 --> 00:02:52,959
in the subsurface around hydrosome

63
00:02:56,470 --> 00:02:54,000

events

64
00:03:00,390 --> 00:02:56,480
i want to go over how hydrosomal vents

65
00:03:03,190 --> 00:03:00,400
is important to origin of life

66
00:03:05,350 --> 00:03:03,200
hydrosol vent is suggested to be one of

67
00:03:08,070 --> 00:03:05,360
the plausible environments for origin of

68
00:03:10,710 --> 00:03:08,080
life and that is because it supplies

69
00:03:12,630 --> 00:03:10,720
heat continuously and there is water all

70
00:03:13,670 --> 00:03:12,640
around it for chemical reactions to

71
00:03:15,430 --> 00:03:13,680
happen

72
00:03:18,070 --> 00:03:15,440
and those reactions include

73
00:03:20,470 --> 00:03:18,080
electrochemical equilibrium between

74
00:03:22,949 --> 00:03:20,480
thermal fluid sea water through minerals

75
00:03:24,630 --> 00:03:22,959
and also production of organic cir water

76
00:03:27,350 --> 00:03:24,640
rock reactions

77
00:03:28,630 --> 00:03:27,360
however there are problems needed to be

78
00:03:31,750 --> 00:03:28,640
solved

79
00:03:34,390 --> 00:03:31,760
as an example since hydrosomal event is

80
00:03:37,670 --> 00:03:34,400
underwater and everywhere around this

81
00:03:40,229 --> 00:03:37,680
aqueous reactions like condensation is

82
00:03:42,710 --> 00:03:40,239
thermodynamically unstable as well as

83
00:03:45,670 --> 00:03:42,720
other hydrophobic molecules

84
00:03:48,390 --> 00:03:45,680
so we thought what if liquid co2 worked

85
00:03:51,990 --> 00:03:48,400
as a reserve for hydrophobic molecules

86
00:03:57,589 --> 00:03:55,110
interestingly theoretical calculations

87
00:03:59,350 --> 00:03:57,599
suggest the existence of liquid co2 in

88
00:04:02,149 --> 00:03:59,360

hadian ocean

89
00:04:05,429 --> 00:04:02,159
higher concentration of co2 in the early

90
00:04:08,149 --> 00:04:05,439
earth makes this possible to happen

91
00:04:09,429 --> 00:04:08,159
liquid co2 may have a role in elemental

92
00:04:11,910 --> 00:04:09,439
transfer

93
00:04:13,910 --> 00:04:11,920
or is over in the early ocean as it

94
00:04:15,910 --> 00:04:13,920
possessed completely different features

95
00:04:18,390 --> 00:04:15,920
to sea water

96
00:04:20,870 --> 00:04:18,400
but again elemental transfer between

97
00:04:23,990 --> 00:04:20,880
liquid co2 and natural materials focused

98
00:04:26,469 --> 00:04:24,000
on the early earth is limitedly reported

99
00:04:28,950 --> 00:04:26,479
for most of data about liquid co2 is

100
00:04:31,510 --> 00:04:28,960
taken for industrial purposes

101
00:04:33,909 --> 00:04:31,520
therefore we decided to find about the

102
00:04:36,150 --> 00:04:33,919
solution and distribution of elements

103
00:04:39,110 --> 00:04:36,160
experimentally

104
00:04:42,150 --> 00:04:39,120
first we have to construct our own

105
00:04:44,550 --> 00:04:42,160
extraction system for liquid co2 and

106
00:04:45,510 --> 00:04:44,560
then we conducted experiments using the

107
00:04:47,510 --> 00:04:45,520
system

108
00:04:49,110 --> 00:04:47,520
today i will share about the result of

109
00:04:51,830 --> 00:04:49,120
two experiments

110
00:04:53,909 --> 00:04:51,840
first we focused on major elements that

111
00:04:55,909 --> 00:04:53,919
exist in modern seawater

112
00:04:59,270 --> 00:04:55,919
all of them being important element to

113
00:05:01,670 --> 00:04:59,280

earth and all living cells and animals

114
00:05:03,749 --> 00:05:01,680
second we focus on heavy metals

115
00:05:05,510 --> 00:05:03,759
particularly those found in chimneys of

116
00:05:07,590 --> 00:05:05,520
hydrosomal vents

117
00:05:10,710 --> 00:05:07,600
some of those metals are found to form

118
00:05:12,710 --> 00:05:10,720
organometallic complex that are known to

119
00:05:15,189 --> 00:05:12,720
be soluble to co2

120
00:05:16,950 --> 00:05:15,199
and also they are used inside cells

121
00:05:18,870 --> 00:05:16,960
binding on proteins

122
00:05:22,310 --> 00:05:18,880
our objective here is to know about

123
00:05:25,749 --> 00:05:22,320
lucas co2 as a solvent and elucidate

124
00:05:28,070 --> 00:05:25,759
that rho it had in hadith ocean

125
00:05:31,270 --> 00:05:28,080
so first we tried to study the elemental

126
00:05:32,870 --> 00:05:31,280
transfer of measured eons in seawater to

127
00:05:35,110 --> 00:05:32,880
liquid co2

128
00:05:37,670 --> 00:05:35,120
we prepared artificial seawater from

129
00:05:39,350 --> 00:05:37,680
chemical reagents containing major ears

130
00:05:41,350 --> 00:05:39,360
of modern seawater

131
00:05:44,390 --> 00:05:41,360
then sea water was poured into this

132
00:05:46,790 --> 00:05:44,400
reactor as it shows the photograph

133
00:05:48,469 --> 00:05:46,800
and then the reaction was so tight and

134
00:05:51,110 --> 00:05:48,479
liquid co2 was supported through its

135
00:05:53,270 --> 00:05:51,120
ball so pressure was about five to six

136
00:05:55,670 --> 00:05:53,280
megapascal

137
00:05:58,469 --> 00:05:55,680
seawater and liquid co2 were mixed for

138
00:06:01,510 --> 00:05:58,479

one day using magnetic stroller and left

139
00:06:03,270 --> 00:06:01,520
for one day to stabilize

140
00:06:05,590 --> 00:06:03,280
and it is technically difficult to

141
00:06:08,070 --> 00:06:05,600
analyze this liquid co2 as a solvent

142
00:06:09,270 --> 00:06:08,080
because it vaporizes in atmospheric

143
00:06:12,309 --> 00:06:09,280
pressure

144
00:06:14,390 --> 00:06:12,319
and it's solvent that is not popular so

145
00:06:16,710 --> 00:06:14,400
we decided to collect the solute by

146
00:06:17,909 --> 00:06:16,720
extracting the liquid co2 into another

147
00:06:19,990 --> 00:06:17,919
co tube

148
00:06:22,390 --> 00:06:20,000
this tube was depressurized so the

149
00:06:25,749 --> 00:06:22,400
difference in pressure automatically

150
00:06:27,990 --> 00:06:25,759
moved liquid co2 from the tube

151
00:06:30,710 --> 00:06:28,000
the tube was opened slowly

152
00:06:33,029 --> 00:06:30,720
so gas shield 2 would not burst out and

153
00:06:35,270 --> 00:06:33,039
then pure water it was injected in the

154
00:06:39,029 --> 00:06:35,280
tube and left out for 30 minutes to

155
00:06:41,909 --> 00:06:39,039
collect the elements left behind by co2

156
00:06:45,510 --> 00:06:41,919
finally water was collected and analyzed

157
00:06:48,629 --> 00:06:45,520
by ian chromatography

158
00:06:49,589 --> 00:06:48,639
the result is shown here

159
00:06:52,150 --> 00:06:49,599
and

160
00:06:55,670 --> 00:06:52,160
the graph of y-axis shows the solubility

161
00:06:59,110 --> 00:06:55,680
of elements in co2 with unit of molar

162
00:07:01,510 --> 00:06:59,120
fraction multiplied by 1000 and x shows

163
00:07:04,550 --> 00:07:01,520

the number of extractions where we have

164
00:07:06,550 --> 00:07:04,560
to extract liquid co2 from the reactor

165
00:07:09,270 --> 00:07:06,560
multiple times

166
00:07:11,510 --> 00:07:09,280
multiple extraction had to be done to

167
00:07:13,350 --> 00:07:11,520
exclude the effect of small drops of

168
00:07:16,230 --> 00:07:13,360
water left in the tube

169
00:07:17,749 --> 00:07:16,240
contaminating when co2 was extracted

170
00:07:20,230 --> 00:07:17,759
from outside

171
00:07:23,029 --> 00:07:20,240
so the plot shown here which is

172
00:07:25,830 --> 00:07:23,039
six sevens in ace extraction

173
00:07:28,629 --> 00:07:25,840
the concentration stabilized which we

174
00:07:30,870 --> 00:07:28,639
think that was successful in excluding

175
00:07:32,150 --> 00:07:30,880
any contamination of small drops of

176
00:07:34,309 --> 00:07:32,160
water

177
00:07:36,870 --> 00:07:34,319
now from this result sodium and

178
00:07:39,990 --> 00:07:36,880
magnesium seems to be rather insoluble

179
00:07:42,550 --> 00:07:40,000
to liquid co2 with very low solubility

180
00:07:45,430 --> 00:07:42,560
potassium in calcium was not detected at

181
00:07:48,309 --> 00:07:45,440
all the concentration ratio of sodium

182
00:07:50,950 --> 00:07:48,319
and magnesium in liquid co2 is lysis

183
00:07:54,150 --> 00:07:50,960
ratio in seawater which suggests that

184
00:07:56,390 --> 00:07:54,160
this solubility is resembling seawater

185
00:07:59,029 --> 00:07:56,400
and maybe potassium calcium could be

186
00:08:02,309 --> 00:07:59,039
detected if concentration was higher in

187
00:08:04,390 --> 00:08:02,319
the accuracy solution of seawater

188
00:08:06,390 --> 00:08:04,400

so we thought there should be difference

189
00:08:08,950 --> 00:08:06,400
based on their elementary properties

190
00:08:11,510 --> 00:08:08,960
because likeliness to form complex with

191
00:08:13,990 --> 00:08:11,520
co2 is probably different by these

192
00:08:16,230 --> 00:08:14,000
elemental properties so by using aqua

193
00:08:19,430 --> 00:08:16,240
solution with higher concentration

194
00:08:21,350 --> 00:08:19,440
we might be able to find out about this

195
00:08:23,110 --> 00:08:21,360
but as for now we conclude that

196
00:08:25,270 --> 00:08:23,120
distribution of major elements in

197
00:08:27,189 --> 00:08:25,280
seawater from liquid co2

198
00:08:29,670 --> 00:08:27,199
is very small

199
00:08:32,630 --> 00:08:29,680
next i will explain about dissolution of

200
00:08:34,709 --> 00:08:32,640
heavy metals in liquid co2 this time i

201
00:08:36,870 --> 00:08:34,719
used chimney samples from hydrosome

202
00:08:39,350 --> 00:08:36,880
event that was powdered

203
00:08:41,670 --> 00:08:39,360
in previous study liquid co2 was found

204
00:08:42,709 --> 00:08:41,680
near these hydrosol vents at okinawa

205
00:08:45,030 --> 00:08:42,719
trough

206
00:08:47,670 --> 00:08:45,040
before the experiment we had to change

207
00:08:50,470 --> 00:08:47,680
the parts of the reactor to make the

208
00:08:52,470 --> 00:08:50,480
them corrosion resistant

209
00:08:55,030 --> 00:08:52,480
since the reactor itself was made from

210
00:08:56,389 --> 00:08:55,040
stainless steel which contains heavy

211
00:08:59,110 --> 00:08:56,399
metal itself

212
00:09:02,310 --> 00:08:59,120
and those heavy metals could be detected

213
00:09:04,630 --> 00:09:02,320

in the extraction service solution

214
00:09:06,790 --> 00:09:04,640
after adjusting the reactor powdered

215
00:09:09,590 --> 00:09:06,800
chimney samples were put into glass

216
00:09:11,910 --> 00:09:09,600
vials that went into the reactor

217
00:09:12,949 --> 00:09:11,920
then liquid co2 was poured into the

218
00:09:14,070 --> 00:09:12,959
reactor

219
00:09:15,990 --> 00:09:14,080
and they're

220
00:09:18,710 --> 00:09:16,000
stabilized for one day

221
00:09:21,990 --> 00:09:18,720
elementary recovered using these tubes

222
00:09:25,350 --> 00:09:22,000
as previous experience did and analyzed

223
00:09:27,509 --> 00:09:25,360
by icp oes

224
00:09:29,670 --> 00:09:27,519
the analyze elements are shown in

225
00:09:32,470 --> 00:09:29,680
colored squares those that were not

226
00:09:34,630 --> 00:09:32,480
detected at all is shown gray and those

227
00:09:36,470 --> 00:09:34,640
that were detected in any of the samples

228
00:09:39,590 --> 00:09:36,480
are shown in orange

229
00:09:41,750 --> 00:09:39,600
so these are some resultants experiment

230
00:09:44,470 --> 00:09:41,760
the red circle implies the concentration

231
00:09:47,590 --> 00:09:44,480
of the element found in liquid co2 while

232
00:09:50,310 --> 00:09:47,600
triangle and diamond implied controls

233
00:09:51,670 --> 00:09:50,320
before and after the extraction of

234
00:09:54,710 --> 00:09:51,680
element

235
00:09:57,269 --> 00:09:54,720
if the red circle is above both controls

236
00:10:00,470 --> 00:09:57,279
we defined that to be dissolved

237
00:10:03,509 --> 00:10:00,480
and elements on analyzed silver calcium

238
00:10:05,430 --> 00:10:03,519

copper iron magnesium nickel and zinc

239
00:10:07,030 --> 00:10:05,440
were detected from at least one of the

240
00:10:08,949 --> 00:10:07,040
chimney samples

241
00:10:11,590 --> 00:10:08,959
these elements are classified as

242
00:10:13,910 --> 00:10:11,600
transition metals which is known to form

243
00:10:15,990 --> 00:10:13,920
a complex more than other elements

244
00:10:19,750 --> 00:10:16,000
suggesting that dissolution might have

245
00:10:21,430 --> 00:10:19,760
happened due to forming complex with co2

246
00:10:24,230 --> 00:10:21,440
next results show

247
00:10:26,949 --> 00:10:24,240
elements that were constantly detected

248
00:10:29,590 --> 00:10:26,959
from liquid co2 extraction samples

249
00:10:31,350 --> 00:10:29,600
regardless of chimney powders

250
00:10:34,069 --> 00:10:31,360
we think that these elements were

251
00:10:36,470 --> 00:10:34,079
dissolved in liquid co2 from the tank

252
00:10:38,870 --> 00:10:36,480
they are classified as boron group which

253
00:10:42,550 --> 00:10:38,880
is known to form complex with alkali

254
00:10:46,870 --> 00:10:42,560
eons co2 may have formed a complex by

255
00:10:47,990 --> 00:10:46,880
being the alkyl form two three two minus

256
00:10:49,829 --> 00:10:48,000
so

257
00:10:50,949 --> 00:10:49,839
according to the result from this

258
00:10:53,430 --> 00:10:50,959
research

259
00:10:55,670 --> 00:10:53,440
liquid co2 seems to dissolve low amount

260
00:10:58,630 --> 00:10:55,680
of simple elements from the chimney or

261
00:11:01,430 --> 00:10:58,640
distribute major ians from seawater

262
00:11:04,150 --> 00:11:01,440
it suggests that zco2 might provide low

263
00:11:05,269 --> 00:11:04,160

metal environment in the hadiya neon of

264
00:11:07,750 --> 00:11:05,279
the ocean

265
00:11:09,829 --> 00:11:07,760
providing unique environment for

266
00:11:11,829 --> 00:11:09,839
probiotic chemistry as a reserve and

267
00:11:13,990 --> 00:11:11,839
reaction solvent

268
00:11:16,470 --> 00:11:14,000
further experiments on various solutes

269
00:11:19,030 --> 00:11:16,480
and analysis of liquid co2 near

270
00:11:21,750 --> 00:11:19,040
hydrosomal vent in today's ocean

271
00:11:24,710 --> 00:11:21,760
is needed to elucidate the row of liquid

272
00:11:27,110 --> 00:11:24,720
co2 as a solvent

273
00:11:29,910 --> 00:11:27,120
so for future works we must conduct

274
00:11:32,470 --> 00:11:29,920
experiments with longer time force even

275
00:11:34,550 --> 00:11:32,480
though low solubility was observed we do

276
00:11:37,509 --> 00:11:34,560
not know the reaction time was enough to

277
00:11:40,069 --> 00:11:37,519
reach equilibrium

278
00:11:42,470 --> 00:11:40,079
also we are working on to analyze the

279
00:11:45,670 --> 00:11:42,480
solubility of organic molecules such as

280
00:11:48,150 --> 00:11:45,680
amino acids in liquid co2 so we hope to

281
00:11:50,629 --> 00:11:48,160
report that in future research

282
00:11:52,470 --> 00:11:50,639
so that's all for my research

283
00:11:55,030 --> 00:11:52,480
and these are the people