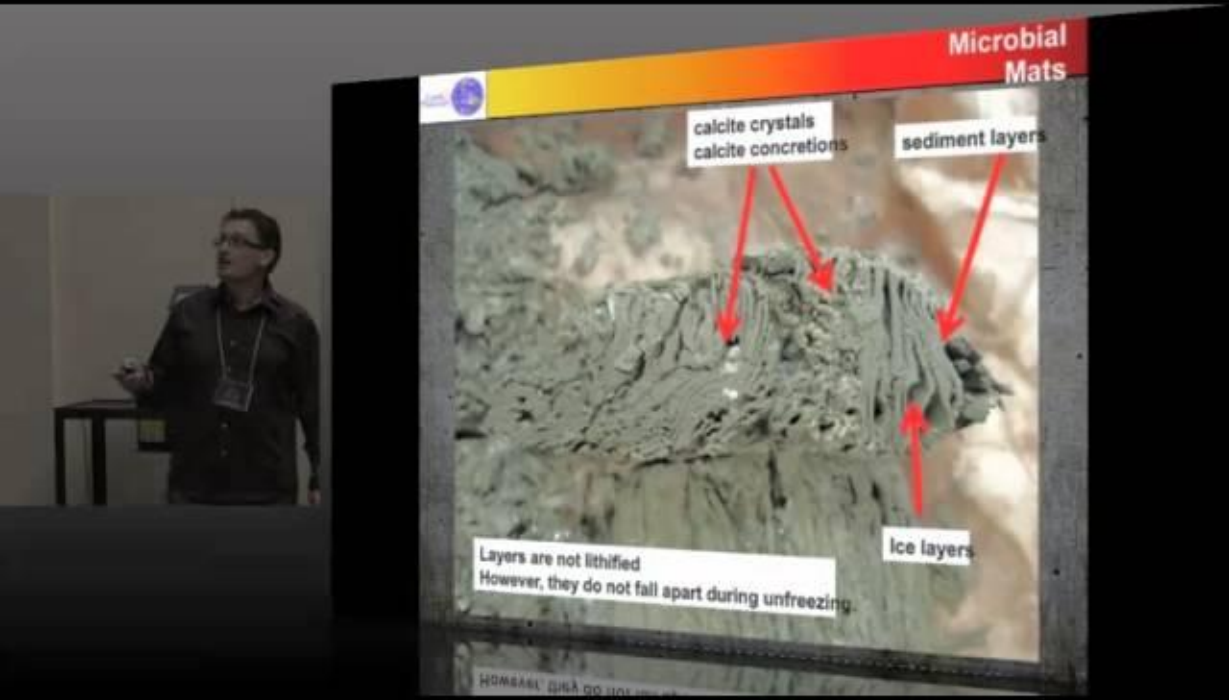
Microbial Mats
calcite crystals
calcite concretions
sediment layers
Ice layers
Layers are not lithified
However, they do not fall apart during unfreezing

1
00:00:12,629 --> 00:00:09,960
okay so we will move away from sunny

2
00:00:19,769 --> 00:00:12,639
California to a slightly colder

3
00:00:23,269 --> 00:00:19,779
environment we go just south of Cape

4
00:00:26,760 --> 00:00:23,279
Town and in Antarctica and there is an

5
00:00:31,260 --> 00:00:26,770
in the air to a call to running mode

6
00:00:32,970 --> 00:00:31,270
land and that's the Norwegian claim part

7
00:00:35,729 --> 00:00:32,980
of the Antarctica and there isn't no

8
00:00:39,420 --> 00:00:35,739
ases an oasis is an area in Africa where

9
00:00:42,439 --> 00:00:39,430
you have no ice and that is called the

10
00:00:45,569 --> 00:00:42,449
auto funk ruble mountains so in these

11
00:00:48,389 --> 00:00:45,579
these mountains and these two lakes ever

12
00:00:52,889 --> 00:00:48,399
discovered from bio in German expedition

13
00:00:54,389 --> 00:00:52,899

and 1936 and there are two legs one is

14
00:00:57,329 --> 00:00:54,399
called Lake undersea and the other one

15
00:00:59,639 --> 00:00:57,339
is called Lake oversee and and they are

16
00:01:01,560 --> 00:00:59,649
apparently ice-covered lakes and they

17
00:01:05,670 --> 00:01:01,570
are the largest lakes in the in this

18
00:01:08,070 --> 00:01:05,680
part of the eastern Antarctica and there

19
00:01:10,290 --> 00:01:08,080
are two glaciers that terminate in that

20
00:01:12,660 --> 00:01:10,300
Lake the large circulation dunoon

21
00:01:16,160 --> 00:01:12,670
leisure and a smaller without named

22
00:01:18,450 --> 00:01:16,170
pleasure and all is all these rocks

23
00:01:23,880 --> 00:01:18,460
these other from Kreuger mountains are

24
00:01:26,280 --> 00:01:23,890
made of honor of your side these are

25
00:01:27,960 --> 00:01:26,290
some photographs of these lakes they

26
00:01:29,880 --> 00:01:27,970
have problem with the ice-covered here

27
00:01:34,440 --> 00:01:29,890
geophys mountains here and here's the

28
00:01:36,870 --> 00:01:34,450
camp from my colleagues who got some

29
00:01:39,480 --> 00:01:36,880
beautiful images from underneath the

30
00:01:43,260 --> 00:01:39,490
eyes they're so the camp was situated

31
00:01:45,660 --> 00:01:43,270
here and they basically drilled or

32
00:01:48,450 --> 00:01:45,670
melted the whole the dipole in that Lake

33
00:01:53,730 --> 00:01:48,460
it's three meters ice cover in order to

34
00:01:55,530 --> 00:01:53,740
get down with diving equipment so here

35
00:01:59,040 --> 00:01:55,540
you can see as a paper map of that lake

36
00:02:02,060 --> 00:01:59,050
and a cross section so the lake has

37
00:02:06,110 --> 00:02:02,070
basically two basins a larger Basin with

38
00:02:09,930 --> 00:02:06,120

toxic water it's super saturated with

39
00:02:12,300 --> 00:02:09,940
dissolved oxygen and has a ph of more

40
00:02:16,620 --> 00:02:12,310
than ten point four it's very alkaline

41
00:02:19,290 --> 00:02:16,630
and a smaller anoxic base and the upper

42
00:02:19,950 --> 00:02:19,300
water part of that base mr. Locke sick

43
00:02:22,500 --> 00:02:19,960
but then

44
00:02:25,170 --> 00:02:22,510
down to 90 meters you have an anoxic

45
00:02:29,160 --> 00:02:25,180
water and a huge concentration of

46
00:02:31,020 --> 00:02:29,170
methane in that in that Lakes basically

47
00:02:35,420 --> 00:02:31,030
the highest concentration of methane of

48
00:02:39,150 --> 00:02:35,430
any body of water on earth in that Lake

49
00:02:42,240 --> 00:02:39,160
so this the lake floor is basically

50
00:02:45,210 --> 00:02:42,250
covered by microbial mats down to 99

51
00:02:47,610 --> 00:02:45,220
meters this is how deep the drop camera

52
00:02:50,130 --> 00:02:47,620
were able to go so maybe it's either and

53
00:02:52,920 --> 00:02:50,140
at ninety nine meters you have still we

54
00:02:55,050 --> 00:02:52,930
have only point one percent of the light

55
00:02:57,030 --> 00:02:55,060
that goes that goes through these three

56
00:03:03,360 --> 00:02:57,040
media is cover two to three meter ice

57
00:03:05,370 --> 00:03:03,370
cover if you dive down there you see

58
00:03:09,930 --> 00:03:05,380
these pew you see these beautiful

59
00:03:12,360 --> 00:03:09,940
microbial mats and you have smaller map

60
00:03:14,010 --> 00:03:12,370
pro strat mats these are these little

61
00:03:19,160 --> 00:03:14,020
pinnacles in between and then you have

62
00:03:21,420 --> 00:03:19,170
up to 50 centimeter large tall chronicle

63
00:03:24,120 --> 00:03:21,430

microbial mats you're not calling it

64
00:03:26,280 --> 00:03:24,130
maybe not from a delights because this

65
00:03:29,400 --> 00:03:26,290
stuff is not leather fight because if

66
00:03:31,620 --> 00:03:29,410
you go back here the only source of

67
00:03:33,660 --> 00:03:31,630
water that gets in that Lake is subtly

68
00:03:36,960 --> 00:03:33,670
she'll melt water from the onion jingle

69
00:03:41,100 --> 00:03:36,970
Asia and with that water comes collation

70
00:03:43,650 --> 00:03:41,110
flower so fine sediment that is eroded

71
00:03:49,650 --> 00:03:43,660
by the glacier from the country rock

72
00:03:53,040 --> 00:03:49,660
from darn auto site so if you cut

73
00:03:56,430 --> 00:03:53,050
through such an and microbial mat it's

74
00:04:00,150 --> 00:03:56,440
like you have layers of sediment non

75
00:04:02,760 --> 00:04:00,160
little fight silt clay sediments and in

76
00:04:04,830 --> 00:04:02,770
between you have layers of organic

77
00:04:09,020 --> 00:04:04,840
matter and it's like a pudding that

78
00:04:11,760 --> 00:04:09,030
shakes and you have different kinds of

79
00:04:15,450 --> 00:04:11,770
cyanobacteria species in between these

80
00:04:16,950 --> 00:04:15,460
cones and then in the pinnacles named

81
00:04:18,360 --> 00:04:16,960
cones and enter pinnacles they're

82
00:04:21,630 --> 00:04:18,370
different types and here you see an

83
00:04:23,670 --> 00:04:21,640
image of the cyanobacteria well this is

84
00:04:27,290 --> 00:04:23,680
the mat that I have so it's raveled from

85
00:04:32,159 --> 00:04:29,370
two-seater Institute in the United

86
00:04:33,510 --> 00:04:32,169
States and then to McGill and it's what

87
00:04:37,890 --> 00:04:33,520
I have in my freezer

88
00:04:40,320 --> 00:04:37,900

and so the organics are more or less gun

89
00:04:42,990 --> 00:04:40,330
you see these empty empty spaces here

90
00:04:46,290 --> 00:04:43,000
but you have still something left a lot

91
00:04:49,830 --> 00:04:46,300
of extra polymeric similar substances

92
00:04:51,629 --> 00:04:49,840
are helding these these they held

93
00:04:53,339 --> 00:04:51,639
together the disclaimer roles and the

94
00:04:57,390 --> 00:04:53,349
suit part and the other particles or

95
00:04:59,550 --> 00:04:57,400
rock fragments so if you embed these

96
00:05:03,089 --> 00:04:59,560
parts of these mats and you look at the

97
00:05:06,240 --> 00:05:03,099
sem we also did t but i only show sem

98
00:05:08,159 --> 00:05:06,250
images today you see here these fine

99
00:05:10,439 --> 00:05:08,169
grade sediments and this is the epoxy

100
00:05:13,080 --> 00:05:10,449
resin so this was basically before the

101
00:05:16,080 --> 00:05:13,090
organic material this is the empty space

102
00:05:18,719 --> 00:05:16,090
now so we did a lot of mineral

103
00:05:21,510 --> 00:05:18,729
mineralogy TM lattice fringe images but

104
00:05:23,700 --> 00:05:21,520
here on this very bad sem backscattering

105
00:05:27,570 --> 00:05:23,710
image you can basically see that you

106
00:05:30,270 --> 00:05:27,580
have sodium larger glass but and calcium

107
00:05:32,550 --> 00:05:30,280
pelagic glasses in there and you have

108
00:05:36,809 --> 00:05:32,560
k-feldspar all from this on auto side

109
00:05:41,189 --> 00:05:36,819
rock called side some call side pyro

110
00:05:45,770 --> 00:05:41,199
come on people and maybe some pyroxenes

111
00:05:49,080 --> 00:05:45,780
appetite and of course a lot of classes

112
00:05:52,350 --> 00:05:49,090
you have autogenic clay minerals and and

113
00:05:54,149 --> 00:05:52,360

tempt a tribal phyllosilicates that we

114
00:05:56,670 --> 00:05:54,159
figured out by looking at the lattice

115
00:06:01,430 --> 00:05:56,680
French images and TM images and TM

116
00:06:05,969 --> 00:06:01,440
images so this is how this the wireless

117
00:06:08,550 --> 00:06:05,979
devices like that outline well if you

118
00:06:12,360 --> 00:06:08,560
would have a leg in equilibrium with the

119
00:06:15,719 --> 00:06:12,370
atmosphere the the pH would be buffered

120
00:06:19,499 --> 00:06:15,729
around 8.3 and you would have called

121
00:06:24,089 --> 00:06:19,509
side precipitation and and so but since

122
00:06:26,610 --> 00:06:24,099
you have since since you have a nice

123
00:06:29,640 --> 00:06:26,620
nice cover on that Lake and you have

124
00:06:32,390 --> 00:06:29,650
bloody glass weathering in that Lake you

125
00:06:36,180 --> 00:06:32,400
you supply the water with a lot of

126
00:06:41,089 --> 00:06:36,190
calcium sodium ions and you increase the

127
00:06:45,529 --> 00:06:41,099
alkalinity and all the the all this co2

128
00:06:47,279 --> 00:06:45,539
bicarbonate gets co 3 2 minus gets

129
00:06:52,049 --> 00:06:47,289
basically precipitate

130
00:06:54,149 --> 00:06:52,059
in to call side and gets extract that's

131
00:06:57,139 --> 00:06:54,159
why you have highly elevated the

132
00:07:00,719 --> 00:06:57,149
alkalinity there so it's a closed system

133
00:07:03,089 --> 00:07:00,729
so they basically the water is almost

134
00:07:08,309 --> 00:07:03,099
it's depleted on dissolved inorganic

135
00:07:10,739 --> 00:07:08,319
carbon yes as you can see here this is a

136
00:07:19,019 --> 00:07:10,749
basically a bed of feldspar the pledge

137
00:07:21,299 --> 00:07:19,029
of glass probably here you can see clay

138
00:07:22,799 --> 00:07:21,309

a new formation of new clay minerals or

139
00:07:29,969 --> 00:07:22,809
the clinic clay minerals sitting on it

140
00:07:33,899 --> 00:07:29,979
on such an head Spock Spock rain so but

141
00:07:35,549 --> 00:07:33,909
you you also can see microbial borings

142
00:07:37,709 --> 00:07:35,559
in these mats so you see these clay

143
00:07:41,549 --> 00:07:37,719
minerals held together by by extra

144
00:07:44,519 --> 00:07:41,559
polymeric subsidy PS and if you look

145
00:07:48,769 --> 00:07:44,529
into that into these holes you see these

146
00:07:52,949 --> 00:07:48,779
strings of eps going around here and

147
00:07:57,689 --> 00:07:52,959
coating everything but in these mats you

148
00:07:59,159 --> 00:07:57,699
also have these white dots in here if

149
00:08:00,959 --> 00:07:59,169
you look at at the cross section of

150
00:08:03,269 --> 00:08:00,969
these mats and these are called site

151
00:08:05,070 --> 00:08:03,279
crystals and calcite concretions do

152
00:08:07,589 --> 00:08:05,080
another part of the mat which you can

153
00:08:10,799 --> 00:08:07,599
see here you have cut side concretions

154
00:08:14,489 --> 00:08:10,809
and if you go further down you have only

155
00:08:16,409 --> 00:08:14,499
calcite crystals and so the conclusions

156
00:08:18,420 --> 00:08:16,419
they are the most of them are spherical

157
00:08:21,749 --> 00:08:18,430
but some of them look very funny handle

158
00:08:26,459 --> 00:08:21,759
shape concretions up to 1.5 centimeters

159
00:08:28,139 --> 00:08:26,469
and this is an image backscattering in

160
00:08:30,659 --> 00:08:28,149
which you see these concretions outside

161
00:08:35,309 --> 00:08:30,669
concretions and some of the sediment

162
00:08:37,699 --> 00:08:35,319
that it sits around that material and it

163
00:08:40,769 --> 00:08:37,709

is a small conclusion and you see these

164
00:08:44,040 --> 00:08:40,779
microbial these microbial borings around

165
00:08:51,329 --> 00:08:44,050
them and they are covered by external

166
00:08:55,199 --> 00:08:51,339
eps if you go closer you see the cps

167
00:08:57,540 --> 00:08:55,209
covering okay so while i do further you

168
00:09:00,809 --> 00:08:57,550
see the CBS covering these these cults

169
00:09:01,140 --> 00:09:00,819
ice crystals but if you look in the car

170
00:09:03,000 --> 00:09:01,150
in this

171
00:09:06,630 --> 00:09:03,010
outside concretions you see these

172
00:09:08,430 --> 00:09:06,640
beautiful borings of yeah microbial

173
00:09:11,100 --> 00:09:08,440
borings in there they are covered with

174
00:09:13,410 --> 00:09:11,110
an with a new precipitated occult site

175
00:09:17,850 --> 00:09:13,420
cement and the cold side of the

176
00:09:20,250 --> 00:09:17,860
concretion is still totally dissolved if

177
00:09:24,480 --> 00:09:20,260
they are sticking out their mineral lyst

178
00:09:26,670 --> 00:09:24,490
balls of these of these new pills and so

179
00:09:29,810 --> 00:09:26,680
they did the formation of these tubules

180
00:09:33,750 --> 00:09:29,820
here's a model that came out 2010 and

181
00:09:36,800 --> 00:09:33,760
basically these cyanobacteria they are

182
00:09:40,470 --> 00:09:36,810
creating an environment it they take up

183
00:09:42,480 --> 00:09:40,480
outside from from the substrate created

184
00:09:44,400 --> 00:09:42,490
is it Luke equilibrium and you have

185
00:09:46,590 --> 00:09:44,410
disillusion on this under on the bottom

186
00:09:49,050 --> 00:09:46,600
so this stuff get the occult side gets

187
00:09:50,520 --> 00:09:49,060
transported on the surface and you still

188
00:09:52,730 --> 00:09:50,530

have to buy carbonate here so the

189
00:09:55,440 --> 00:09:52,740
calcite gets back and you have a

190
00:09:58,080 --> 00:09:55,450
precipitation of the calcite on the

191
00:10:00,150 --> 00:09:58,090
walls of these of these tuples and this

192
00:10:02,580 --> 00:10:00,160
is basically what we see is the proof of

193
00:10:06,000 --> 00:10:02,590
their if their claims in that paper

194
00:10:08,310 --> 00:10:06,010
basically and antics will further down

195
00:10:13,620 --> 00:10:08,320
you have calcite crystals and they shown

196
00:10:16,740 --> 00:10:13,630
absolutely no no bio bio to do pills buy

197
00:10:19,020 --> 00:10:16,750
out your pills in there and if you look

198
00:10:21,540 --> 00:10:19,030
at the carbon isotopes and the oxygen

199
00:10:24,420 --> 00:10:21,550
isotopes you can see the concretions

200
00:10:28,830 --> 00:10:24,430
they have a pretty widespread here

201
00:10:32,850 --> 00:10:28,840
between the oxygen minus 39 to minus 35

202
00:10:36,330 --> 00:10:32,860
and ending it and the crystals they are

203
00:10:39,830 --> 00:10:36,340
pretty very close close together and the

204
00:10:42,270 --> 00:10:39,840
idea is that these concretions basically

205
00:10:45,180 --> 00:10:42,280
dissolve in the upper part of these mats

206
00:10:47,420 --> 00:10:45,190
and you still have this material in the

207
00:10:49,290 --> 00:10:47,430
in the lower you still have that in the

208
00:10:50,760 --> 00:10:49,300
disillusion in the post ways and you

209
00:10:53,700 --> 00:10:50,770
precipitate these crystals at the lower

210
00:10:59,130 --> 00:10:53,710
part and I would have expected some

211
00:11:02,940 --> 00:10:59,140
lower carbon values here minus 10-15 but

212
00:11:06,030 --> 00:11:02,950
I thought first all this this bio

213
00:11:08,250 --> 00:11:06,040

biogenic is this carbon but it seems

214
00:11:10,650 --> 00:11:08,260
that is some input from the still some

215
00:11:14,460 --> 00:11:10,660
input from the lake despite low DIC

216
00:11:17,019 --> 00:11:14,470
values there so what we can say is that

217
00:11:19,900 --> 00:11:17,029
the precipitation of these concretions

218
00:11:24,360 --> 00:11:19,910
and the crystal suggests that there is a

219
00:11:26,920 --> 00:11:24,370
carbon source within within the mats and

220
00:11:28,360 --> 00:11:26,930
the preservative concretions

221
00:11:30,699 --> 00:11:28,370
precipitating the upper part of the

222
00:11:33,249 --> 00:11:30,709
crystals in the lower part and the

223
00:11:37,689 --> 00:11:33,259
source of the co2 seems to be a mixture

224
00:11:40,420 --> 00:11:37,699
of the microbial activity and and some

225
00:11:42,389 --> 00:11:40,430
some other source probably out of that

226
00:11:45,100 --> 00:11:42,399
comes out of the lake water or

227
00:11:54,999 --> 00:11:45,110
weathering of some mineral particles in

228
00:11:56,650 --> 00:11:55,009
there and okay with that I thank you by

229
00:11:59,499 --> 00:11:56,660
the way since I forgot to introduce him

230
00:12:16,079 --> 00:11:59,509
this is Dirk Schumann from McGill do we

231
00:12:20,290 --> 00:12:18,430
what is the DIC of the lake did you

232
00:12:24,579 --> 00:12:20,300
already say that ur yeah there's only

233
00:12:27,070 --> 00:12:24,589
one value and and it's a four point two

234
00:12:38,590 --> 00:12:27,080
nine okay has only won one value of this

235
00:12:44,390 --> 00:12:41,510
okay I was wondering do you know her the

236
00:12:45,580 --> 00:12:44,400
microbial species in the lake unique to

237
00:12:49,250 --> 00:12:45,590
that environment or they found in other

238
00:12:52,670 --> 00:12:49,260

cold environments well there's some

239
00:12:54,650 --> 00:12:52,680
other lakes in the victoria land and

240
00:12:56,450 --> 00:12:54,660
other part of the antarctica they had

241
00:12:58,990 --> 00:12:56,460
McMurdo Dry Valleys and there are also

242
00:13:02,930 --> 00:12:59,000
lakes and they also have microbial mats

243
00:13:05,360 --> 00:13:02,940
but none of these mats look like these

244
00:13:08,470 --> 00:13:05,370
ones they look more like legal pinnacles

245
00:13:10,850 --> 00:13:08,480
and I think these these cyanobacteria

246
00:13:12,680 --> 00:13:10,860
the most of them are also there and

247
00:13:17,360 --> 00:13:12,690
while I'm not a biologist but I think

248
00:13:20,030 --> 00:13:17,370
they are also there yeah but the this

249
00:13:23,090 --> 00:13:20,040
structure is very unique to that special

250
00:13:25,670 --> 00:13:23,100
lake they look really like the the old

251
00:13:38,450 --> 00:13:25,680
stromatolites you have in there you can

252
00:13:43,700 --> 00:13:38,460
see na kyun rocks while they're there is

253
00:13:45,850 --> 00:13:43,710
a paper in the geobiology and and there

254
00:13:49,700 --> 00:13:45,860
are some growth rates in there but I

255
00:13:53,710 --> 00:13:49,710
don't remember and I think that was it's

256
00:13:57,020 --> 00:13:53,720
even wrong I mean there are some some I