Minerals

- Siderite: $Fe^{2+}CO_3$
  - Source of energy (Fe^{2+}) and C for biomass
  - Present on Mars
- Vivianite: $Fe^{2+}_3(PO_4)_2 \cdot 8H_2O$
  - Source of energy (Fe^{2+}) and P
  - Possible, but not confirmed on Mars
- On Earth, both can be found associated with fossils

Image source: Public domain

1
00:00:05,430 --> 00:00:03,270
hello my name is gabriel gonzalf silva

2
00:00:07,829 --> 00:00:05,440
and i'm going to present my current work

3
00:00:10,310 --> 00:00:07,839
called biogenicity influences in

4
00:00:11,830 --> 00:00:10,320
iron ii bearing minerals by extremely

5
00:00:14,709 --> 00:00:11,840
acidophilic bacterium

6
00:00:15,509 --> 00:00:14,719
acetobacillus feroxides this work was

7
00:00:17,590 --> 00:00:15,519
developed

8
00:00:19,590 --> 00:00:17,600
in the chemistry laboratory at the

9
00:00:21,830 --> 00:00:19,600
campus institute of the university of

10
00:00:25,029 --> 00:00:21,840
sao paulo brazil

11
00:00:27,589 --> 00:00:25,039
so let's begin in this work

12
00:00:28,710 --> 00:00:27,599
we used the microorganism acetobacillus

13
00:00:31,189 --> 00:00:28,720

peroxidants

14
00:00:32,069 --> 00:00:31,199
a chemical trophic bacterium that is

15
00:00:34,709 --> 00:00:32,079
able to gain

16
00:00:35,990 --> 00:00:34,719
energy from the oxidation of inorganic

17
00:00:38,790 --> 00:00:36,000
substances

18
00:00:40,630 --> 00:00:38,800
in this case it can use the oxidation of

19
00:00:43,670 --> 00:00:40,640
iron and sulfur

20
00:00:45,990 --> 00:00:43,680
and the energy produced is used to fix

21
00:00:47,430 --> 00:00:46,000
carbon dioxide for the production of

22
00:00:50,630 --> 00:00:47,440
biomass

23
00:00:51,830 --> 00:00:50,640
all of this can happen in a very acidic

24
00:00:55,590 --> 00:00:51,840
environments

25
00:00:57,910 --> 00:00:55,600
with a ph as low as 1.8

26
00:00:58,869 --> 00:00:57,920
we choose to use two minerals on this

27
00:01:02,310 --> 00:00:58,879
study

28
00:01:05,590 --> 00:01:02,320
city right and visionite sterite is an

29
00:01:06,390 --> 00:01:05,600
iron carbonate can be used as source of

30
00:01:09,510 --> 00:01:06,400
energy

31
00:01:11,910 --> 00:01:09,520
to the presence of iron to iron

32
00:01:14,230 --> 00:01:11,920
and carbonate that can be used as a

33
00:01:16,230 --> 00:01:14,240
source of carbon for biomass production

34
00:01:18,789 --> 00:01:16,240
for the microorganism

35
00:01:20,310 --> 00:01:18,799
this mineral was already confirmed on

36
00:01:23,510 --> 00:01:20,320
mars

37
00:01:25,270 --> 00:01:23,520
vivianite is an iron phosphate it can be

38
00:01:26,469 --> 00:01:25,280

used as a source of energy for the

39
00:01:29,749 --> 00:01:26,479
microorganism

40
00:01:32,469 --> 00:01:29,759
and is also a source of phosphorus

41
00:01:34,630 --> 00:01:32,479
among the many elements used by life

42
00:01:35,270 --> 00:01:34,640
phosphorus is the less common boat on

43
00:01:37,990 --> 00:01:35,280
mars

44
00:01:39,270 --> 00:01:38,000
and on earth the presence of this

45
00:01:41,910 --> 00:01:39,280
mineral was

46
00:01:43,350 --> 00:01:41,920
not confirmed on mars but it's possible

47
00:01:45,990 --> 00:01:43,360
that it can be found

48
00:01:47,429 --> 00:01:46,000
on phosphorus-rich patches found on the

49
00:01:50,310 --> 00:01:47,439
planet

50
00:01:52,149 --> 00:01:50,320
on earth both minerals can be found

51
00:01:54,630 --> 00:01:52,159
associated with life

52
00:01:55,190 --> 00:01:54,640
for example both minerals are already

53
00:01:58,310 --> 00:01:55,200
found in

54
00:02:00,870 --> 00:01:58,320
different kinds of fossils after the

55
00:02:01,109 --> 00:02:00,880
microorganism grows we look for signals

56
00:02:03,910 --> 00:02:01,119
of

57
00:02:05,910 --> 00:02:03,920
bacteria activity in the minerals to

58
00:02:07,749 --> 00:02:05,920
differentiate physical and chemical

59
00:02:09,029 --> 00:02:07,759
alterations from biological

60
00:02:11,029 --> 00:02:09,039
modifications

61
00:02:12,309 --> 00:02:11,039
we use the biogenesis criteria to

62
00:02:15,589 --> 00:02:12,319
identify the

63
00:02:17,510 --> 00:02:15,599

so-called biosignatures those build

64
00:02:19,110 --> 00:02:17,520
signatures can be mechanical

65
00:02:21,589 --> 00:02:19,120
like the disruption of the mineral

66
00:02:23,030 --> 00:02:21,599
grains or biochemical

67
00:02:25,430 --> 00:02:23,040
these include productions of

68
00:02:28,390 --> 00:02:25,440
nanocoatings from for example

69
00:02:30,229 --> 00:02:28,400
the position of eps extracellular

70
00:02:33,270 --> 00:02:30,239
polymeric substance

71
00:02:34,309 --> 00:02:33,280
that after drying can form desiccation

72
00:02:37,030 --> 00:02:34,319
cracks

73
00:02:38,309 --> 00:02:37,040
other biochemical signatures include

74
00:02:41,270 --> 00:02:38,319
micro topographic

75
00:02:41,990 --> 00:02:41,280
changes like beating itching information

76
00:02:45,030 --> 00:02:42,000
of path

77
00:02:46,869 --> 00:02:45,040
by moving cells enhancing enhancing

78
00:02:47,589 --> 00:02:46,879
dissolution of the minerals and

79
00:02:51,830 --> 00:02:47,599
production

80
00:02:54,390 --> 00:02:51,840
or precipitation of secondary minerals

81
00:02:56,790 --> 00:02:54,400
the study of possible few signatures in

82
00:02:59,990 --> 00:02:56,800
rocks and minerals in a martian contest

83
00:03:03,509 --> 00:03:00,000
is recent very important work published

84
00:03:06,550 --> 00:03:03,519
in 2021 used a thermoacetophilic

85
00:03:09,670 --> 00:03:06,560
organism called methylospherocetal

86
00:03:11,270 --> 00:03:09,680
growing over a martian meteorite but

87
00:03:14,070 --> 00:03:11,280
focuses in the formation of

88
00:03:16,630 --> 00:03:14,080

intracellular vulneralization and other

89
00:03:18,630 --> 00:03:16,640
molecular build signatures

90
00:03:20,309 --> 00:03:18,640
our work started with the first

91
00:03:22,550 --> 00:03:20,319
investigation of the growth passage

92
00:03:23,830 --> 00:03:22,560
basils for accidents on city right in

93
00:03:26,149 --> 00:03:23,840
vivianite

94
00:03:28,470 --> 00:03:26,159
the very first results of this work were

95
00:03:31,270 --> 00:03:28,480
present in the last upgrade cone

96
00:03:32,070 --> 00:03:31,280
by our colleague roberto vicenzi and now

97
00:03:35,190 --> 00:03:32,080
the manuscript

98
00:03:38,390 --> 00:03:35,200
is in the last stages of preparation

99
00:03:40,869 --> 00:03:38,400
so what is our goal in this work

100
00:03:43,190 --> 00:03:40,879
in this study we evaluated different

101
00:03:46,229 --> 00:03:43,200
biogenicity criteria

102
00:03:48,470 --> 00:03:46,239
as biomechanical and biochemical changes

103
00:03:49,270 --> 00:03:48,480
abused signatures on the minerals

104
00:03:52,229 --> 00:03:49,280
ciliarite

105
00:03:53,350 --> 00:03:52,239
and vivianite exposed to an acidic

106
00:03:56,229 --> 00:03:53,360
medium

107
00:03:57,190 --> 00:03:56,239
in different conditions as abiotic and

108
00:03:59,350 --> 00:03:57,200
biotic

109
00:04:00,789 --> 00:03:59,360
with the presence of the microorganism

110
00:04:03,830 --> 00:04:00,799
as a type of cells

111
00:04:07,750 --> 00:04:03,840
for oxidants to do so

112
00:04:08,869 --> 00:04:07,760
we use the following in the futures we

113
00:04:12,309 --> 00:04:08,879

use the

114
00:04:15,509 --> 00:04:12,319
lr strain of the stubacious feroxides

115
00:04:17,830 --> 00:04:15,519
growing the modified tnk medium

116
00:04:21,030 --> 00:04:17,840
with the addition of the mineral as the

117
00:04:22,469 --> 00:04:21,040
only source of energy for the organism

118
00:04:24,310 --> 00:04:22,479
the creatures were made in two

119
00:04:27,909 --> 00:04:24,320
conditions biotic

120
00:04:29,990 --> 00:04:27,919
and abiotic as a control always in a ph

121
00:04:33,430 --> 00:04:30,000
of about 1.8

122
00:04:34,230 --> 00:04:33,440
at 30 degrees in the incubator shaker

123
00:04:38,070 --> 00:04:34,240
table

124
00:04:41,430 --> 00:04:38,080
at 180 rpm for each future

125
00:04:43,749 --> 00:04:41,440
it was added about five millimole of

126
00:04:45,189 --> 00:04:43,759
community and shifted scissorid or

127
00:04:47,510 --> 00:04:45,199
vivianite

128
00:04:49,350 --> 00:04:47,520
the analytical methods employed to stir

129
00:04:52,950 --> 00:04:49,360
the minerals were

130
00:04:57,590 --> 00:04:52,960
sim scanning electron microscope

131
00:05:02,550 --> 00:04:57,600
ids energy dispersive x-ray spectroscopy

132
00:05:06,790 --> 00:05:02,560
rayman and xrd the x-ray diffraction

133
00:05:09,749 --> 00:05:06,800
so these are the results we obtained

134
00:05:10,070 --> 00:05:09,759
first the citrite on the left one can

135
00:05:13,029 --> 00:05:10,080
see

136
00:05:15,350 --> 00:05:13,039
an sim image of a typical grain of the

137
00:05:17,830 --> 00:05:15,360
mineral before the experiment

138
00:05:19,029 --> 00:05:17,840

a large piece is covered by smaller and

139
00:05:21,590 --> 00:05:19,039
sharper grains

140
00:05:22,710 --> 00:05:21,600
broken during the mineral grinding

141
00:05:24,550 --> 00:05:22,720
unfortunately

142
00:05:26,950 --> 00:05:24,560
this is right was almost completely

143
00:05:29,350 --> 00:05:26,960
dissolved in the apic acid

144
00:05:30,230 --> 00:05:29,360
however on the right one can see the

145
00:05:33,430 --> 00:05:30,240
result of the

146
00:05:36,390 --> 00:05:33,440
biotic assay on the first victory

147
00:05:39,430 --> 00:05:36,400
we can see a formation of paths left by

148
00:05:40,710 --> 00:05:39,440
the cells they have a richer signature

149
00:05:43,350 --> 00:05:40,720
in carbon

150
00:05:45,189 --> 00:05:43,360
showing red probably by the position of

151
00:05:47,189 --> 00:05:45,199
the eps

152
00:05:49,830 --> 00:05:47,199
the second picture one can see the

153
00:05:51,029 --> 00:05:49,840
desiccated eps forming contractions

154
00:05:53,670 --> 00:05:51,039
cracks

155
00:05:56,790 --> 00:05:53,680
the mineral is under the eps and can be

156
00:05:59,990 --> 00:05:56,800
reorganized by the presence of magnesium

157
00:06:02,230 --> 00:06:00,000
show it in yellow or the eps

158
00:06:03,590 --> 00:06:02,240
are amorphous grains probably

159
00:06:06,070 --> 00:06:03,600
schwarzmanite

160
00:06:06,870 --> 00:06:06,080
a bureau precipitate formed from the

161
00:06:09,749 --> 00:06:06,880
iron iii

162
00:06:10,390 --> 00:06:09,759
produced by the microorganism the last

163
00:06:12,070 --> 00:06:10,400

picture

164
00:06:16,629 --> 00:06:12,080
gives a better perspective of the

165
00:06:18,469 --> 00:06:16,639
desiccated eps chlorine acetylene grain

166
00:06:21,350 --> 00:06:18,479
the vivian knight shows a similar

167
00:06:22,309 --> 00:06:21,360
pattern in this case we have on the left

168
00:06:25,990 --> 00:06:22,319
the result of

169
00:06:28,550 --> 00:06:26,000
abiotic attack on the vivianite again

170
00:06:30,150 --> 00:06:28,560
one can see sharp pieces of mineral

171
00:06:33,110 --> 00:06:30,160
while on the right

172
00:06:34,469 --> 00:06:33,120
the biotic experiments produced eps

173
00:06:37,590 --> 00:06:34,479
curved grains

174
00:06:40,150 --> 00:06:37,600
with contractions cracks once again

175
00:06:41,029 --> 00:06:40,160
it was found around amorphous minerals

176
00:06:43,990 --> 00:06:41,039
curving

177
00:06:46,230 --> 00:06:44,000
the vivianite however this time their

178
00:06:49,350 --> 00:06:46,240
composition wasn't compatible with the

179
00:06:52,390 --> 00:06:49,360
mineral schwarzmanite

180
00:06:56,150 --> 00:06:52,400
using raymond we compared our pure

181
00:06:56,550 --> 00:06:56,160
vivianite market sv with the vivianite

182
00:06:59,830 --> 00:06:56,560
left

183
00:07:03,909 --> 00:06:59,840
after the abiotic antibiotic experiments

184
00:07:06,150 --> 00:07:03,919
respectively market as va and vb

185
00:07:07,909 --> 00:07:06,160
we also use the data from the literature

186
00:07:10,550 --> 00:07:07,919
for mere vivianite

187
00:07:11,350 --> 00:07:10,560
a natural slightly oxidized fibunite

188
00:07:14,469 --> 00:07:11,360

phase

189
00:07:15,749 --> 00:07:14,479
whose peaks are market as mv and pure

190
00:07:19,270 --> 00:07:15,759
vivianite

191
00:07:21,110 --> 00:07:19,280
market as v-star we also collected data

192
00:07:23,670 --> 00:07:21,120
for santa barbarite

193
00:07:26,070 --> 00:07:23,680
an amorphous iron iii phosphate

194
00:07:27,909 --> 00:07:26,080
considered a completely oxidized phase

195
00:07:30,230 --> 00:07:27,919
of the vivianite

196
00:07:31,589 --> 00:07:30,240
our initial vivianite shows some peaks

197
00:07:34,790 --> 00:07:31,599
of both vivianite

198
00:07:37,670 --> 00:07:34,800
and metavivianite but both

199
00:07:39,350 --> 00:07:37,680
biotic and abiotic show it some decrease

200
00:07:42,870 --> 00:07:39,360
of amorphous phases

201
00:07:44,950 --> 00:07:42,880
similar to the center barbarite

202
00:07:46,950 --> 00:07:44,960
to better evaluate the hypothesis of the

203
00:07:47,749 --> 00:07:46,960
formation of a sentence barbarity in the

204
00:07:51,350 --> 00:07:47,759
cultures

205
00:07:54,150 --> 00:07:51,360
we made a xrd with our pure vivianite

206
00:07:56,309 --> 00:07:54,160
a pure sample of santa barbarite and the

207
00:07:56,950 --> 00:07:56,319
material left after the abiotic and

208
00:08:00,230 --> 00:07:56,960
biarch

209
00:08:02,469 --> 00:08:00,240
cultures the graphic a shows again that

210
00:08:05,110 --> 00:08:02,479
our initial material is a mixture of

211
00:08:07,670 --> 00:08:05,120
vivianite with metavivianite

212
00:08:09,350 --> 00:08:07,680
the graphic b shows a highly amount of

213
00:08:11,670 --> 00:08:09,360

santa barbarite

214
00:08:12,469 --> 00:08:11,680
the graphic c shows some degree of

215
00:08:14,469 --> 00:08:12,479
amorphism

216
00:08:16,869 --> 00:08:14,479
but the vivianite peaks are strong and

217
00:08:17,909 --> 00:08:16,879
easily identifiable in the abiotic

218
00:08:23,510 --> 00:08:17,919
sample

219
00:08:24,469 --> 00:08:23,520
is highly amorphous show a good

220
00:08:27,110 --> 00:08:24,479
similarity

221
00:08:27,909 --> 00:08:27,120
to the center barbaric cooperating with

222
00:08:29,749 --> 00:08:27,919
the idea

223
00:08:31,830 --> 00:08:29,759
that the microorganism induces the

224
00:08:34,310 --> 00:08:31,840
formation of santa barbarite as

225
00:08:36,630 --> 00:08:34,320
the bioprecipitation instead of the

226
00:08:39,990 --> 00:08:36,640
schwarzmanite

227
00:08:42,310 --> 00:08:40,000
so to conclude first

228
00:08:44,470 --> 00:08:42,320
we were able to identify many biogenic

229
00:08:46,710 --> 00:08:44,480
criteria in our mineral samples

230
00:08:48,310 --> 00:08:46,720
to be used as biosignatures of the

231
00:08:49,269 --> 00:08:48,320
growth of the association basil's for

232
00:08:51,509 --> 00:08:49,279
oxidants

233
00:08:53,269 --> 00:08:51,519
these blue signatures can be used while

234
00:08:56,389 --> 00:08:53,279
looking for old life signals

235
00:08:57,910 --> 00:08:56,399
both on mars and on earth also

236
00:08:59,670 --> 00:08:57,920
we have strong evidence of the

237
00:09:00,790 --> 00:08:59,680
production of center barbarite a

238
00:09:02,870 --> 00:09:00,800

biomineral that

239
00:09:04,230 --> 00:09:02,880
unlikely survives menite was never

240
00:09:06,310 --> 00:09:04,240
described but for creatures of

241
00:09:07,990 --> 00:09:06,320
satubacious fluorescence

242
00:09:09,910 --> 00:09:08,000
these and other discoveries will be

243
00:09:12,230 --> 00:09:09,920
included in another manuscript that is

244
00:09:16,070 --> 00:09:12,240
also in preparation

245
00:09:18,070 --> 00:09:16,080
open questions and future work this work

246
00:09:19,910 --> 00:09:18,080
opens paths for mark questions that

247
00:09:22,310 --> 00:09:19,920
could be addressed

248
00:09:24,550 --> 00:09:22,320
are there other biogenic mineral phases

249
00:09:26,790 --> 00:09:24,560
that could be found on mars

250
00:09:29,430 --> 00:09:26,800
what other minerals can be a source of

251
00:09:32,230 --> 00:09:29,440
iron too from microorganisms like

252
00:09:33,670 --> 00:09:32,240
accidents for accidents in a martian

253
00:09:35,509 --> 00:09:33,680
contest

254
00:09:38,470 --> 00:09:35,519
how these new signatures could be

255
00:09:40,550 --> 00:09:38,480
affected in a more complex context

256
00:09:42,949 --> 00:09:40,560
like in the presence of brains and the

257
00:09:45,910 --> 00:09:42,959
ancient mars

258
00:09:48,150 --> 00:09:45,920
also to complete this work we need to

259
00:09:50,070 --> 00:09:48,160
find the definitive identification

260
00:09:51,430 --> 00:09:50,080
of the phosphor bearing amorphous

261
00:09:53,670 --> 00:09:51,440
mineral phase

262
00:09:54,949 --> 00:09:53,680
found in the biotic creatures of

263
00:09:58,550 --> 00:09:54,959

vivianite

264
00:10:01,110 --> 00:09:58,560
it is it really sunset barbarite

265
00:10:02,870 --> 00:10:01,120
we also want to do more research to

266
00:10:04,230 --> 00:10:02,880
better understand the development of

267
00:10:07,030 --> 00:10:04,240
these signatures of

268
00:10:09,910 --> 00:10:07,040
iron ii bare minerals mix it with

269
00:10:12,470 --> 00:10:09,920
different kinds of sediments

270
00:10:15,430 --> 00:10:12,480
and last we need more research of the

271
00:10:18,310 --> 00:10:15,440
view signatures of iron to bearing rocks

272
00:10:19,350 --> 00:10:18,320
as models of martian lithologies like

273
00:10:22,150 --> 00:10:19,360
for example

274
00:10:24,230 --> 00:10:22,160
the use of more complex rocks like

275
00:10:26,470 --> 00:10:24,240
basalt

276
00:10:28,389 --> 00:10:26,480
to finish i'd like to thank all the

277
00:10:29,670 --> 00:10:28,399
collaborators and colleagues that helped

278
00:10:31,590 --> 00:10:29,680
within this study

279
00:10:33,990 --> 00:10:31,600
and the agencies that contributed to

280
00:10:36,470 --> 00:10:34,000
have the work done

281
00:10:37,110 --> 00:10:36,480
please feel free to contact me with

282
00:10:39,910 --> 00:10:37,120
questions