



**AB  
GRAD  
CON 23**

1  
00:00:04,230 --> 00:00:11,290

[Music]

2  
00:00:16,609 --> 00:00:14,330

so hi I'm Zoe havlina I am a PhD

3  
00:00:17,990 --> 00:00:16,619

candidate from New Mexico Tech

4  
00:00:20,450 --> 00:00:18,000

um and I would like to just jump right

5  
00:00:21,310 --> 00:00:20,460

in and introduce my field site for this

6  
00:00:25,310 --> 00:00:21,320

project

7  
00:00:27,230 --> 00:00:25,320

which are two cave systems located in

8  
00:00:28,370 --> 00:00:27,240

central Italy so pictured here they're

9  
00:00:31,370 --> 00:00:28,380

very pretty

10  
00:00:32,930 --> 00:00:31,380

and what I can hopefully show you

11  
00:00:35,510 --> 00:00:32,940

um I'm going to take us on a quick field

12  
00:00:37,910 --> 00:00:35,520

trip there is why these are potentially

13  
00:00:41,810 --> 00:00:37,920

very compelling sites for astrobiology

14

00:00:45,530 --> 00:00:41,820

or for geomicrobiologists such as myself

15

00:00:47,750 --> 00:00:45,540

and so these caves form through a

16

00:00:50,810 --> 00:00:47,760

somewhat rare mechanism which is known

17

00:00:53,330 --> 00:00:50,820

as sulfuric acid speleogenesis so this

18

00:00:56,930 --> 00:00:53,340

is a cave building process that's seen

19

00:00:58,790 --> 00:00:56,940

only in a handful of caves worldwide and

20

00:01:00,889 --> 00:00:58,800

only only a fraction of those can we

21

00:01:03,770 --> 00:01:00,899

actually access those caves and see this

22

00:01:05,570 --> 00:01:03,780

process actively happening today and so

23

00:01:07,070 --> 00:01:05,580

that's what I'm showing you here so

24

00:01:09,050 --> 00:01:07,080

these are all images from one of my

25

00:01:09,890 --> 00:01:09,060

field sites which is a Versace cave

26

00:01:12,109 --> 00:01:09,900

system

27

00:01:14,450 --> 00:01:12,119

and what you're looking at in this image

28

00:01:17,270 --> 00:01:14,460

here on the left this is a stream this

29

00:01:19,190 --> 00:01:17,280

is the groundwater level of the cave and

30

00:01:21,410 --> 00:01:19,200

it's enriched in hydrogen sulfide and

31

00:01:23,210 --> 00:01:21,420

this hydrogen sulfide degases where

32

00:01:26,510 --> 00:01:23,220

there's voids in the host Rock of the

33

00:01:29,330 --> 00:01:26,520

cave and this hydrogen sulfide fuels

34

00:01:31,310 --> 00:01:29,340

very a robust microbial communities that

35

00:01:33,289 --> 00:01:31,320

are thriving off of the energy in this

36

00:01:36,050 --> 00:01:33,299

otherwise very leukotrophic environment

37

00:01:38,749 --> 00:01:36,060

and this is seen kind of conspicuously

38

00:01:42,530 --> 00:01:38,759

in the forms of these charismatically

39

00:01:44,929 --> 00:01:42,540

named snodite biofilms which proliferate

40

00:01:46,310 --> 00:01:44,939

in these areas of the cave here's

41

00:01:48,289 --> 00:01:46,320

another picture of what they look like

42

00:01:51,350 --> 00:01:48,299

and we also sometimes see if you can see

43

00:01:53,510 --> 00:01:51,360

the yellow dots native sulfur that can

44

00:01:56,170 --> 00:01:53,520

precipitate in these areas as well

45

00:01:58,550 --> 00:01:56,180

and these are primarily composed of

46

00:02:01,069 --> 00:01:58,560

citythial bacillus which is a sulfur

47

00:02:03,109 --> 00:02:01,079

oxidizing bacteria but what I'm

48

00:02:06,289 --> 00:02:03,119

interested in for the context of my

49

00:02:07,609 --> 00:02:06,299

project are all of these white I don't

50

00:02:10,729 --> 00:02:07,619

know if you can see my pointer here

51  
00:02:12,830 --> 00:02:10,739  
these white clumpy minerals here and

52  
00:02:15,650 --> 00:02:12,840  
this is actually microcrystalline gypsum

53  
00:02:17,510 --> 00:02:15,660  
this precipitates in part kind of as a

54  
00:02:19,910 --> 00:02:17,520  
consequence of this microbial activity

55  
00:02:21,890 --> 00:02:19,920  
because the sulfur oxidizers are

56  
00:02:24,830 --> 00:02:21,900  
producing sulfuric acid which is

57  
00:02:27,470 --> 00:02:24,840  
obviously highly corrosive when you have

58  
00:02:29,809 --> 00:02:27,480  
a carbonate host Rock and so this gypsum

59  
00:02:33,170 --> 00:02:29,819  
is precipitating as a replacement as

60  
00:02:36,890 --> 00:02:33,180  
this host Rocks corroded

61  
00:02:40,130 --> 00:02:36,900  
and it's highly acidic so pH is usually

62  
00:02:42,170 --> 00:02:40,140  
zero to one and what happens is that

63  
00:02:44,930 --> 00:02:42,180

this gypsum can build up in these cave

64

00:02:46,670 --> 00:02:44,940

systems and remain there essentially as

65

00:02:48,350 --> 00:02:46,680

long as you don't have any Waters that

66

00:02:50,390 --> 00:02:48,360

come in and wash it away and so that's

67

00:02:52,190 --> 00:02:50,400

what I'm showing on this image on the

68

00:02:55,190 --> 00:02:52,200

far right here this is one of these like

69

00:02:57,770 --> 00:02:55,200

massive gypsum deposits that exists in a

70

00:02:59,690 --> 00:02:57,780

part of the Versace cave that hasn't

71

00:03:02,270 --> 00:02:59,700

been exposed to this active sulfide

72

00:03:04,070 --> 00:03:02,280

degassing for maybe a hundred to two

73

00:03:07,910 --> 00:03:04,080

hundred thousand years

74

00:03:10,430 --> 00:03:07,920

and so we see sulfates and gypsum on

75

00:03:12,890 --> 00:03:10,440

other locations notably the surface of

76

00:03:14,949 --> 00:03:12,900

Mars so I'm showing you data here as it

77

00:03:17,509 --> 00:03:14,959

relates to the Gale crater

78

00:03:20,570 --> 00:03:17,519

and there's some evidence or some

79

00:03:22,490 --> 00:03:20,580

thinking that this sulfates could have

80

00:03:25,369 --> 00:03:22,500

also precipitated under acidic

81

00:03:26,930 --> 00:03:25,379

conditions so potentially these are

82

00:03:29,089 --> 00:03:26,940

thought of as

83

00:03:32,030 --> 00:03:29,099

places where we might look for for

84

00:03:34,369 --> 00:03:32,040

evidence of life and on the Earth's

85

00:03:35,869 --> 00:03:34,379

surface the analogs that we have there

86

00:03:37,309 --> 00:03:35,879

are several and these have been well

87

00:03:40,910 --> 00:03:37,319

studied by other teams of

88

00:03:42,710 --> 00:03:40,920

astrobiologists but what is novel um or

89

00:03:46,490 --> 00:03:42,720

the argument I'm making for these caves

90

00:03:48,530 --> 00:03:46,500

is that this is an ecosystem that as I

91

00:03:51,170 --> 00:03:48,540

just showed you is fueled by chemo litho

92

00:03:53,390 --> 00:03:51,180

autotrophy so these kind of alternative

93

00:03:56,330 --> 00:03:53,400

Lifestyles and so potentially studying

94

00:03:57,970 --> 00:03:56,340

the gypsum and its ability to preserve

95

00:04:01,070 --> 00:03:57,980

or not preserve

96

00:04:03,890 --> 00:04:01,080

biosignatures is is kind of a novel

97

00:04:05,750 --> 00:04:03,900

aspect and gets away from surface world

98

00:04:08,030 --> 00:04:05,760

where we sometimes see the signatures

99

00:04:10,429 --> 00:04:08,040

mostly of things that are photosynthetic

100

00:04:12,289 --> 00:04:10,439

and so in the context of this talk when

101

00:04:14,149 --> 00:04:12,299

I'm talking about life detection or I'm

102

00:04:16,909 --> 00:04:14,159

talking about signatures I'm talking

103

00:04:19,009 --> 00:04:16,919

about lipid biomarkers specifically and

104

00:04:20,270 --> 00:04:19,019

so what I'm showing you here are some

105

00:04:22,550 --> 00:04:20,280

types of these they were kind of

106

00:04:24,650 --> 00:04:22,560

explained earlier these ones on the left

107

00:04:27,110 --> 00:04:24,660

which are those hopenoids so these are

108

00:04:29,870 --> 00:04:27,120

produced by bacteria and these can be

109

00:04:31,870 --> 00:04:29,880

functionalized and then they have this

110

00:04:35,270 --> 00:04:31,880

very recalcitrant

111

00:04:37,490 --> 00:04:35,280

backbone structure this hoping that is

112

00:04:39,590 --> 00:04:37,500

this diagenetic structure that can

113

00:04:41,930 --> 00:04:39,600

persist in some terrestrial environments

114

00:04:44,469 --> 00:04:41,940

for potentially millions of years and

115

00:04:47,030 --> 00:04:44,479

then on the right these are

116

00:04:50,390 --> 00:04:47,040

gdgts from archaea so kind of a similar

117

00:04:52,370 --> 00:04:50,400

lipid biomarker and the these specific

118

00:04:54,710 --> 00:04:52,380

structures that I'm showing you are ones

119

00:04:57,710 --> 00:04:54,720

that have been classified from those

120

00:04:59,210 --> 00:04:57,720

snodite biofilms that I showed you in

121

00:05:01,430 --> 00:04:59,220

their earlier image

122

00:05:03,890 --> 00:05:01,440

and so knowing what we already know

123

00:05:06,409 --> 00:05:03,900

about these cave systems which is that

124

00:05:08,930 --> 00:05:06,419

we have gypsum that is precipitating in

125

00:05:12,050 --> 00:05:08,940

in very close association with microbial

126

00:05:14,749 --> 00:05:12,060

activity that's kind of these microbes

127

00:05:17,390 --> 00:05:14,759

that are using an alternative lifestyle

128

00:05:19,610 --> 00:05:17,400

and we know that some of these organisms

129

00:05:21,290 --> 00:05:19,620

like that aciditythyl bacillus are

130

00:05:24,710 --> 00:05:21,300

capable of producing these lipid

131

00:05:27,890 --> 00:05:24,720

biomarkers and this gypsum is kicking

132

00:05:30,590 --> 00:05:27,900

around in this cave for a little bit of

133

00:05:32,689 --> 00:05:30,600

time we sort of used what we know to

134

00:05:34,010 --> 00:05:32,699

form these questions about things that

135

00:05:35,990 --> 00:05:34,020

we don't know

136

00:05:38,210 --> 00:05:36,000

um we don't actually know or going into

137

00:05:40,550 --> 00:05:38,220

the study no one had ever looked at what

138

00:05:42,050 --> 00:05:40,560

microbes are colonizing the surface of

139

00:05:44,270 --> 00:05:42,060

the gypsum itself

140

00:05:47,810 --> 00:05:44,280

and we don't know if those organisms

141

00:05:50,150 --> 00:05:47,820

produce their own lipid biomarker Suite

142

00:05:52,430 --> 00:05:50,160

if we'll be able to characterize that or

143

00:05:55,189 --> 00:05:52,440

detect it in the gypsum at all and then

144

00:05:57,590 --> 00:05:55,199

if we do does that persist in this

145

00:06:00,650 --> 00:05:57,600

gypsum that has been existing in this

146

00:06:03,409 --> 00:06:00,660

cave for a longer period of time

147

00:06:05,270 --> 00:06:03,419

and so I won't go into the Weeds on

148

00:06:07,249 --> 00:06:05,280

these methods here but I just want to

149

00:06:09,230 --> 00:06:07,259

highlight that we're using kind of a few

150

00:06:11,570 --> 00:06:09,240

different approaches to answer some of

151

00:06:13,749 --> 00:06:11,580

these questions so using some sort of

152

00:06:16,490 --> 00:06:13,759

classic molecular biology techniques

153

00:06:18,230 --> 00:06:16,500

amplicon sequencing and metagenomics to

154

00:06:20,990 --> 00:06:18,240

characterize those microbial communities

155

00:06:23,510 --> 00:06:21,000

and then using some organic geochemical

156

00:06:25,730 --> 00:06:23,520

techniques to try to characterize those

157

00:06:28,730 --> 00:06:25,740

lipid biomarkers

158

00:06:31,490 --> 00:06:28,740

and so some of the data that I've had

159

00:06:34,129 --> 00:06:31,500

um is that these gypsum surfaces are in

160

00:06:35,990 --> 00:06:34,139

fact colonized by microbes and so what

161

00:06:38,510 --> 00:06:36,000

I'm showing you here is amplicon

162

00:06:41,330 --> 00:06:38,520

sequencing data so that's 16sr in our

163

00:06:43,850 --> 00:06:41,340

sequencing that tells us who's there

164

00:06:45,590 --> 00:06:43,860

and what I want you to take away from

165

00:06:48,110 --> 00:06:45,600

this graph is that I'm plotting two

166

00:06:50,390 --> 00:06:48,120

things here on the left to this access

167

00:06:52,610 --> 00:06:50,400

and the blue dots is showing the percent

168

00:06:55,610 --> 00:06:52,620

of that acid ethyl bacillus so that's

169

00:06:57,950 --> 00:06:55,620

that main sulfur at oxidizing bacteria

170

00:07:00,110 --> 00:06:57,960

that we see in those snodite biofilms

171

00:07:02,450 --> 00:07:00,120

and then on the right I'm showing in

172

00:07:05,150 --> 00:07:02,460

this orange I'm showing you the overall

173

00:07:07,730 --> 00:07:05,160

diversity of these samples and so all of

174

00:07:10,370 --> 00:07:07,740

these dots are gypsum samples that we're

175

00:07:12,950 --> 00:07:10,380

taking at kind of varying distances from

176  
00:07:14,270 --> 00:07:12,960  
that active lead degassing sulfate

177  
00:07:17,870 --> 00:07:14,280  
extreme

178  
00:07:19,550 --> 00:07:17,880  
and just a reminder so these biofilms

179  
00:07:22,189 --> 00:07:19,560  
that have been previously characterized

180  
00:07:24,290 --> 00:07:22,199  
are around 70 percent of citythal

181  
00:07:27,290 --> 00:07:24,300  
bacillus and so the main takeaway is

182  
00:07:29,450 --> 00:07:27,300  
that are samples of gypsum are far more

183  
00:07:31,249 --> 00:07:29,460  
diverse than that you know even at this

184  
00:07:33,230 --> 00:07:31,259  
kind of like best case scenario where

185  
00:07:35,749 --> 00:07:33,240  
we're the closest to the sulfate extreme

186  
00:07:38,689 --> 00:07:35,759  
we're really not seeing anywhere near 70

187  
00:07:40,969 --> 00:07:38,699  
percent of city-thal bacillus and so

188  
00:07:43,010 --> 00:07:40,979

this is data from that other cave that

189

00:07:44,749 --> 00:07:43,020

I've studied and I don't have that nice

190

00:07:46,370 --> 00:07:44,759

distance gradient but again it's

191

00:07:48,050 --> 00:07:46,380

plotting the same things and I've just

192

00:07:50,150 --> 00:07:48,060

kind of broadly lumped these samples

193

00:07:53,210 --> 00:07:50,160

together in terms of like high level of

194

00:07:55,730 --> 00:07:53,220

sulfide medium level lower levels and

195

00:07:58,490 --> 00:07:55,740

again we see a similar Trend we also see

196

00:08:00,589 --> 00:07:58,500

low levels of acetyl bacillus and in

197

00:08:03,290 --> 00:08:00,599

fact we see a heck of a lot of archaea

198

00:08:05,210 --> 00:08:03,300

too so some of these samples were almost

199

00:08:07,610 --> 00:08:05,220

entirely archaea

200

00:08:09,110 --> 00:08:07,620

and why I talk about acetyl bacillus and

201

00:08:11,570 --> 00:08:09,120

I talk about the diversity of these

202

00:08:13,730 --> 00:08:11,580

samples is that you know we know acetyl

203

00:08:16,969 --> 00:08:13,740

bacillus is capable of producing lipid

204

00:08:19,189 --> 00:08:16,979

biomarkers but it's one of the bacteria

205

00:08:21,230 --> 00:08:19,199

that can and in fact a lot of them can't

206

00:08:24,469 --> 00:08:21,240

and so this potentially has implications

207

00:08:26,390 --> 00:08:24,479

when we think about you know are there

208

00:08:28,369 --> 00:08:26,400

things that is in this gypsum that is

209

00:08:29,390 --> 00:08:28,379

producing lipid biomarkers or aren't

210

00:08:32,409 --> 00:08:29,400

there

211

00:08:35,389 --> 00:08:32,419

and we can kind of get at this um

212

00:08:37,370 --> 00:08:35,399

indirectly through metagenomics and so

213

00:08:38,930 --> 00:08:37,380

again metagenomics is looking at all of

214

00:08:41,570 --> 00:08:38,940

the genes that are present in a

215

00:08:43,790 --> 00:08:41,580

particular environmental sample and so

216

00:08:45,470 --> 00:08:43,800

far I have only reconstructed a single

217

00:08:48,590 --> 00:08:45,480

metagenome and this is from a native

218

00:08:49,970 --> 00:08:48,600

sulfur deposit but I did do some Gene

219

00:08:52,490 --> 00:08:49,980

searching and I was looking for this

220

00:08:54,530 --> 00:08:52,500

squally and hoping cyclase Gene which

221

00:08:57,170 --> 00:08:54,540

forms a critical precursor to making

222

00:08:59,750 --> 00:08:57,180

those hopenoid lipid biomarkers and I

223

00:09:01,970 --> 00:08:59,760

did find some copies of that but again I

224

00:09:04,370 --> 00:09:01,980

also found a ton of archaea and two of

225

00:09:07,430 --> 00:09:04,380

the high quality bins that I was able to

226

00:09:09,110 --> 00:09:07,440

assemble were these two kind of Novel

227

00:09:11,690 --> 00:09:09,120

archaea that have potentially an

228

00:09:13,310 --> 00:09:11,700

interesting symbiotic relationship and I

229

00:09:15,530 --> 00:09:13,320

would love to talk about that more but

230

00:09:16,970 --> 00:09:15,540

that's kind of a whole other talk so I'm

231

00:09:19,670 --> 00:09:16,980

just going to leave it at that with this

232

00:09:20,630 --> 00:09:19,680

complicated figure here on the right

233

00:09:23,810 --> 00:09:20,640

um

234

00:09:25,850 --> 00:09:23,820

so it you might be guessing or kind of

235

00:09:28,610 --> 00:09:25,860

wondering why I've only gotten one

236

00:09:30,710 --> 00:09:28,620

metagenome so far and really it's

237

00:09:33,769 --> 00:09:30,720

because the overall biomass in these

238

00:09:36,290 --> 00:09:33,779

gypsum samples is very low and so what

239

00:09:38,509 --> 00:09:36,300

I'm showing you in this picture here so

240

00:09:41,389 --> 00:09:38,519

this is microscopy this is dappy

241

00:09:44,030 --> 00:09:41,399

staining so looking at cells and so you

242

00:09:47,389 --> 00:09:44,040

see hopefully you can see just a few

243

00:09:50,030 --> 00:09:47,399

blue dots those are cells and on the

244

00:09:52,670 --> 00:09:50,040

right this is showing them sitting in a

245

00:09:54,949 --> 00:09:52,680

in a bathtub full of gypsum micro

246

00:09:57,710 --> 00:09:54,959

crystals and so when you just kind of

247

00:10:00,410 --> 00:09:57,720

contextualize this low number of cells

248

00:10:02,210 --> 00:10:00,420

in in the vast array of all of these

249

00:10:04,250 --> 00:10:02,220

minerals

250

00:10:05,930 --> 00:10:04,260

there's not a whole lot going on and in

251  
00:10:08,389 --> 00:10:05,940  
fact some of our preliminary total

252  
00:10:11,090 --> 00:10:08,399  
organic carbon measurements are less

253  
00:10:13,790 --> 00:10:11,100  
than one percent or even a fraction of a

254  
00:10:16,070 --> 00:10:13,800  
percent and so

255  
00:10:17,630 --> 00:10:16,080  
that all leads to kind of some

256  
00:10:19,730 --> 00:10:17,640  
complications with trying to actually

257  
00:10:22,009 --> 00:10:19,740  
extract some of these lipid biomarkers

258  
00:10:24,530 --> 00:10:22,019  
and so this side of the project is still

259  
00:10:26,750 --> 00:10:24,540  
an active protocol development we

260  
00:10:28,370 --> 00:10:26,760  
haven't seen anything yet

261  
00:10:31,070 --> 00:10:28,380  
um and so we've had to kind of scale up

262  
00:10:33,829 --> 00:10:31,080  
our extraction we're hoping to extract a

263  
00:10:35,269 --> 00:10:33,839

lot more gypsum and and I'm hoping that

264

00:10:37,550 --> 00:10:35,279

that's something I'll be able to talk

265

00:10:39,470 --> 00:10:37,560

about more in the future but I just want

266

00:10:42,829 --> 00:10:39,480

to return to sort of The Guiding

267

00:10:45,350 --> 00:10:42,839

question of this of this study which is

268

00:10:46,850 --> 00:10:45,360

you know looking at these

269

00:10:49,850 --> 00:10:46,860

very

270

00:10:52,550 --> 00:10:49,860

um interesting microbial Dynamics the

271

00:10:55,430 --> 00:10:52,560

way that the stripsum is formed we see a

272

00:10:57,710 --> 00:10:55,440

lot of we see biofilms existing where

273

00:10:58,670 --> 00:10:57,720

where the gypsum is forming but we don't

274

00:11:01,310 --> 00:10:58,680

know

275

00:11:03,769 --> 00:11:01,320

if there's biomarkers that are preserved

276

00:11:06,110 --> 00:11:03,779

or not and I have to leave that question

277

00:11:08,090 --> 00:11:06,120

open at this time

278

00:11:08,870 --> 00:11:08,100

um but hopefully I can answer it in the

279

00:11:11,329 --> 00:11:08,880

future

280

00:11:13,069 --> 00:11:11,339

so I think I will just leave off there

281

00:11:15,050 --> 00:11:13,079

and

282

00:11:17,630 --> 00:11:15,060

um I wouldn't be able to do this work

283

00:11:20,329 --> 00:11:17,640

without I have a lot of very fantastic

284

00:11:21,889 --> 00:11:20,339

collaborators and funding sources and I

285

00:11:24,170 --> 00:11:21,899

would especially like to thank all the

286

00:11:27,889 --> 00:11:24,180

folks at the astrobiology analytical

287

00:11:29,630 --> 00:11:27,899

laboratory at Goddard and I think that I

288

00:11:32,269 --> 00:11:29,640

have some time for questions so thank

289

00:11:50,150 --> 00:11:34,900

foreign

290

00:11:55,850 --> 00:11:53,090

hey I'm bunny Chase I'm from the jet

291

00:11:57,650 --> 00:11:55,860

propulsion laboratory I really love this

292

00:11:59,210 --> 00:11:57,660

question you're asking and like the way

293

00:12:00,590 --> 00:11:59,220

that you're trying to attack it and I

294

00:12:03,829 --> 00:12:00,600

was wondering

295

00:12:06,829 --> 00:12:03,839

a lot of the lipid biomarkers that you

296

00:12:08,630 --> 00:12:06,839

talked about looking for they as you

297

00:12:10,910 --> 00:12:08,640

said can be preserved for a few millions

298

00:12:12,829 --> 00:12:10,920

of years but what about the more stable

299

00:12:14,870 --> 00:12:12,839

versions like looking for her pains

300

00:12:17,569 --> 00:12:14,880

rather than hope Knowles are you also

301  
00:12:18,530 --> 00:12:17,579  
looking for those yeah yeah we are I

302  
00:12:20,509 --> 00:12:18,540  
didn't really

303  
00:12:22,550 --> 00:12:20,519  
explain that super well but we are

304  
00:12:26,870 --> 00:12:22,560  
hoping to look for helping hoping to

305  
00:12:30,290 --> 00:12:26,880  
look for Hope pains as well yeah

306  
00:12:32,269 --> 00:12:30,300  
um what do you think like the Pres

307  
00:12:34,670 --> 00:12:32,279  
the precious in this cave would be for

308  
00:12:38,150 --> 00:12:34,680  
the molecules and how similar is that to

309  
00:12:40,790 --> 00:12:38,160  
Mars yeah I think that that is kind of

310  
00:12:43,730 --> 00:12:40,800  
the key question for sure

311  
00:12:48,650 --> 00:12:45,670  
I don't know if that's something that I

312  
00:12:50,030 --> 00:12:48,660  
want to dive into right now but I think

313  
00:12:51,769 --> 00:12:50,040

we should talk about it later for sure

314

00:12:52,910 --> 00:12:51,779

I'm curious to hear your thoughts on it

315

00:12:55,009 --> 00:12:52,920

as well

316

00:12:59,150 --> 00:12:55,019

um obviously this is a oxidizing

317

00:13:02,150 --> 00:12:59,160

environment it's it's acidic it's wet so

318

00:13:04,190 --> 00:13:02,160

it has a lot that could maybe not be

319

00:13:05,569 --> 00:13:04,200

preserving things but

320

00:13:07,990 --> 00:13:05,579

um you know certainly folks have done

321

00:13:11,210 --> 00:13:08,000

similar research and and have found

322

00:13:13,370 --> 00:13:11,220

biomarkers in in Gypsum and other

323

00:13:19,910 --> 00:13:13,380

environments on Earth so

324

00:13:25,190 --> 00:13:23,389

any last questions for Zoe

325

00:13:30,769 --> 00:13:25,200

okay thank you so much oh wait there's

326

00:13:34,310 --> 00:13:32,329

hey so I have a question about the

327

00:13:36,829 --> 00:13:34,320

microcrystalline nature of that gypsum

328

00:13:39,110 --> 00:13:36,839

so what do you think that might what's

329

00:13:41,210 --> 00:13:39,120

your hypothesis for structurally how

330

00:13:42,650 --> 00:13:41,220

that might affect preservation of Bio

331

00:13:44,090 --> 00:13:42,660

signatures as opposed to other kinds of

332

00:13:47,629 --> 00:13:44,100

gypsum that might happen on the surface

333

00:13:49,490 --> 00:13:47,639

yeah I think that's a really question

334

00:13:52,009 --> 00:13:49,500

um

335

00:13:53,389 --> 00:13:52,019

I guess you know off the top of my head

336

00:13:55,190 --> 00:13:53,399

I would say that

337

00:13:57,410 --> 00:13:55,200

I don't know if we're gonna get it like

338

00:13:58,970 --> 00:13:57,420

doesn't really layer I think necessarily

339

00:14:01,009 --> 00:13:58,980

in the way that we see in like

340

00:14:03,110 --> 00:14:01,019

evaporated gypsum

341

00:14:05,509 --> 00:14:03,120

um how that may or may not you know

342

00:14:07,190 --> 00:14:05,519

factor into biosignature preservation I

343

00:14:08,509 --> 00:14:07,200

don't I can't really speak to that but

344

00:14:10,910 --> 00:14:08,519

it is I think it's definitely a really

345

00:14:12,530 --> 00:14:10,920

interesting difference

346

00:14:13,670 --> 00:14:12,540

um that we see in the strips on for sure

347

00:14:16,550 --> 00:14:13,680

and it's like

348

00:14:18,050 --> 00:14:16,560

it's I didn't really show any of the

349

00:14:20,090 --> 00:14:18,060

like there's that one picture that I

350

00:14:22,550 --> 00:14:20,100

showed of the gypsum but it's it's crazy

351

00:14:23,870 --> 00:14:22,560

it's like you know we call it Rock in

352

00:14:26,090 --> 00:14:23,880

name only

353

00:14:27,889 --> 00:14:26,100

um it's it's like goo

354

00:14:29,690 --> 00:14:27,899

um you go to sample it and it's almost

355

00:14:31,250 --> 00:14:29,700

like a non-Newtonian fluid it like just

356

00:14:34,790 --> 00:14:31,260

kind of like oozes

357

00:14:36,350 --> 00:14:34,800

um which is super wild and and it's kind

358

00:14:40,009 --> 00:14:36,360

of difficult to work with to be honest