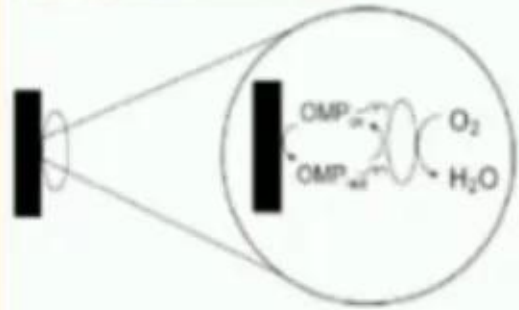


## Hypotheses

- Through a direct enzymatic attack on mineral surfaces, FeOB contribute to the rapid weathering of the Rio Blanco Quartz Diorite
- Metagenomic characterization of the *in situ* community will provide insight into potential lithotrophic pathways
- Native microbial communities will selectively colonize and utilize Fe(II) bearing mineral phases



provide insight into potential lithotrophic pathways

- Native microbial communities will selectively colonize and utilize Fe(II) bearing mineral phases

1  
00:00:10,250 --> 00:00:09,049  
yes I apologize it's a very very long

2  
00:00:11,390 --> 00:00:10,260  
title so I'm not going to read it in

3  
00:00:15,369 --> 00:00:11,400  
waste my time we'll just call it

4  
00:00:18,080 --> 00:00:15,379  
microbes that eat rock underground so

5  
00:00:22,000 --> 00:00:18,090  
this is not my title my advisor likes to

6  
00:00:24,500 --> 00:00:22,010  
be very descriptive so we'll move on so

7  
00:00:26,330 --> 00:00:24,510  
just as a general introduction we all

8  
00:00:29,419 --> 00:00:26,340  
know that the earth is you know cut

9  
00:00:32,060 --> 00:00:29,429  
composed of igneous rocks that are rich

10  
00:00:35,870 --> 00:00:32,070  
in reduced compounds such as reduced

11  
00:00:37,760 --> 00:00:35,880  
iron and this iron is a essentially a

12  
00:00:42,290 --> 00:00:37,770  
very vast energy reservoir for

13  
00:00:44,750 --> 00:00:42,300

microorganisms and so there's been a lot

14

00:00:46,819 --> 00:00:44,760

of work recently really focusing on the

15

00:00:50,090 --> 00:00:46,829

ability of microorganisms to use

16

00:00:52,549 --> 00:00:50,100

structural iron in in silicate minerals

17

00:00:55,189 --> 00:00:52,559

as an energy source and I've just

18

00:01:01,279 --> 00:00:55,199

highlighted 22 studies here that a kind

19

00:01:02,569 --> 00:01:01,289

of basis of this work where my fingers

20

00:01:07,039 --> 00:01:02,579

in the right spot look at this I could

21

00:01:11,149 --> 00:01:07,049

follow directions is so in this study by

22

00:01:12,380 --> 00:01:11,159

Alexis well Bailey and you know so

23

00:01:14,480 --> 00:01:12,390

Alexis Templeton here this is actually

24

00:01:16,700 --> 00:01:14,490

an isolate that I have that I'm trying

25

00:01:19,880 --> 00:01:16,710

to play with a little bit they've

26

00:01:21,380 --> 00:01:19,890

demonstrated on this is actually an

27

00:01:24,620 --> 00:01:21,390

amorphous it's not a you know

28

00:01:27,410 --> 00:01:24,630

crystalline mineral but definitely

29

00:01:28,990 --> 00:01:27,420

increased cell densities so they

30

00:01:32,090 --> 00:01:29,000

demonstrated in both of these cases

31

00:01:36,399 --> 00:01:32,100

colonization of either an amorphous or a

32

00:01:39,770 --> 00:01:36,409

kristalyn iron iron bearing compound and

33

00:01:42,170 --> 00:01:39,780

this is great work but what it doesn't

34

00:01:44,210 --> 00:01:42,180

really tell us is anything about the

35

00:01:45,859 --> 00:01:44,220

mineralogy or about what's happening to

36

00:01:48,260 --> 00:01:45,869

the mineral or how is this actually

37

00:01:50,330 --> 00:01:48,270

working yes we've demonstrated that we

38

00:01:52,999 --> 00:01:50,340

do definitely see colonization by

39

00:01:56,170 --> 00:01:53,009

microorganisms but we have to go a step

40

00:01:59,149 --> 00:01:56,180

further beyond that and actually

41

00:02:00,260 --> 00:01:59,159

synthesize this in doing more coherent

42

00:02:03,709 --> 00:02:00,270

picture we have to look at more than

43

00:02:06,999 --> 00:02:03,719

just cell numbers right so in this study

44

00:02:09,949 --> 00:02:07,009

this is out of my group at Matt

45

00:02:13,270 --> 00:02:09,959

but before my time so this is this

46

00:02:15,949 --> 00:02:13,280

predates me but this is really a

47

00:02:19,640 --> 00:02:15,959

fundamental component to what I want to

48

00:02:21,440 --> 00:02:19,650

do and in addition to just tracking yes

49

00:02:23,000 --> 00:02:21,450

cells are increasing that's good your

50

00:02:25,550 --> 00:02:23,010

cells are growing but we're also

51  
00:02:28,250 --> 00:02:25,560  
tracking a loss of iron from the mineral

52  
00:02:32,510 --> 00:02:28,260  
so iron that's good the irons going away

53  
00:02:35,390 --> 00:02:32,520  
and this is a nitrate reducing condition

54  
00:02:37,190 --> 00:02:35,400  
so you're losing nitrate so synthesizing

55  
00:02:39,500 --> 00:02:37,200  
all of these things together not only do

56  
00:02:41,090 --> 00:02:39,510  
we just see higher cell densities but we

57  
00:02:44,870 --> 00:02:41,100  
also see a loss of iron from the mineral

58  
00:02:46,460 --> 00:02:44,880  
structure and then by really

59  
00:02:49,550 --> 00:02:46,470  
interrogating the mineral so this is the

60  
00:02:51,860 --> 00:02:49,560  
mineral biotite we're actually seeing

61  
00:02:53,860 --> 00:02:51,870  
mineralogical changes in the presence of

62  
00:02:57,110 --> 00:02:53,870  
these bacteria and you can track that

63  
00:02:59,060 --> 00:02:57,120

the increase of potassium the culture

64

00:03:01,100 --> 00:02:59,070

that's expulsion of your inner layer

65

00:03:03,140 --> 00:03:01,110

cations do the oxidation of the

66

00:03:04,699 --> 00:03:03,150

structural iron in this mineral so

67

00:03:07,430 --> 00:03:04,709

that's another piece of evidence that

68

00:03:09,979 --> 00:03:07,440

we're having mineralogical alteration in

69

00:03:14,180 --> 00:03:09,989

the presence of these bacteria so this

70

00:03:16,280 --> 00:03:14,190

is really cool and based on all of that

71

00:03:20,479 --> 00:03:16,290

evidence we have this proposed mechanism

72

00:03:22,009 --> 00:03:20,489

behind the structural oxidation in in a

73

00:03:24,979 --> 00:03:22,019

very simple scenario you could just

74

00:03:29,210 --> 00:03:24,989

imagine you have some mineral abiotic ly

75

00:03:31,009 --> 00:03:29,220

dissolving right just poop the the

76

00:03:34,250 --> 00:03:31,019

reduced iron pops out of the mineral

77

00:03:37,610 --> 00:03:34,260

through a abiotic process the micro says

78

00:03:42,170 --> 00:03:37,620

yum that's delicious and then you know

79

00:03:45,050 --> 00:03:42,180

oxidizes it however this previous

80

00:03:47,289 --> 00:03:45,060

experiment was done under a circle

81

00:03:50,120 --> 00:03:47,299

neutral pH and these minerals are not

82

00:03:51,680 --> 00:03:50,130

you know the dissolution is not that

83

00:03:55,819 --> 00:03:51,690

rapid they're essentially they just set

84

00:03:57,860 --> 00:03:55,829

there so you could think of another

85

00:04:01,099 --> 00:03:57,870

situation which is a which is our kind

86

00:04:03,650 --> 00:04:01,109

of favored hypothesis is this is a

87

00:04:05,870 --> 00:04:03,660

direct enzymatic attack on the mineral

88

00:04:09,349 --> 00:04:05,880

surface and this is not that far-fetched

89

00:04:11,030 --> 00:04:09,359

we see this in iron reducers you know

90

00:04:13,340 --> 00:04:11,040

you can think everybody's favorite iron

91

00:04:16,099 --> 00:04:13,350

reducer geobacter right you can think

92

00:04:18,439 --> 00:04:16,109

they have this it's a direct enzymatic

93

00:04:19,890 --> 00:04:18,449

attack right these outer membrane

94

00:04:24,330 --> 00:04:19,900

proteins that's what the OM

95

00:04:26,760 --> 00:04:24,340

he is here that engage in the shuttling

96

00:04:28,860 --> 00:04:26,770

of electrons so these are genomic Lee

97

00:04:30,990 --> 00:04:28,870

encoded outer membrane proteins that are

98

00:04:33,689 --> 00:04:31,000

involved in the extracellular electron

99

00:04:35,610 --> 00:04:33,699

transport of iron so this is this is the

100

00:04:37,710 --> 00:04:35,620

idea based on the evidence we don't

101  
00:04:39,719 --> 00:04:37,720  
think these are abiotic processes that

102  
00:04:43,110 --> 00:04:39,729  
just a biotic dissolution coupled to

103  
00:04:47,279 --> 00:04:43,120  
iron oxidation we think that it's it's a

104  
00:04:48,659 --> 00:04:47,289  
direct enzymatic attack so this of

105  
00:04:51,180 --> 00:04:48,669  
course i have to i do have to give my

106  
00:04:53,040 --> 00:04:51,190  
nod to astrobiology right so there's all

107  
00:04:57,000 --> 00:04:53,050  
urine on Mars or something someone tells

108  
00:04:58,500 --> 00:04:57,010  
me that um so I've heard I've heard this

109  
00:05:02,879 --> 00:04:58,510  
rumor that there's a you know iron on

110  
00:05:04,860 --> 00:05:02,889  
Mars so this this really cool paper here

111  
00:05:07,500 --> 00:05:04,870  
just theoretically crunching the numbers

112  
00:05:10,129 --> 00:05:07,510  
based on iron iron based Litha trophy

113  
00:05:12,480 --> 00:05:10,139

alone could have given us just 20

114

00:05:14,310 --> 00:05:12,490

approximately 20 grams per per

115

00:05:15,930 --> 00:05:14,320

centimeter of biota over the course of

116

00:05:17,999 --> 00:05:15,940

Martian history just based on the

117

00:05:23,790 --> 00:05:18,009

alteration of of the iron bearing

118

00:05:26,250 --> 00:05:23,800

mineral phases so cool right so there's

119

00:05:29,189 --> 00:05:26,260

there's your relevance but what we

120

00:05:32,370 --> 00:05:29,199

really want to do is is test this in a

121

00:05:35,700 --> 00:05:32,380

field setting right so these laboratory

122

00:05:38,159 --> 00:05:35,710

studies and theoretical calculations are

123

00:05:39,930 --> 00:05:38,169

great but we want to take it to quote

124

00:05:42,689 --> 00:05:39,940

nature right let's let's go let's go to

125

00:05:44,730 --> 00:05:42,699

nature and I tell you this was terrible

126

00:05:47,040 --> 00:05:44,740

this was a terrible place to go so I

127

00:05:49,170 --> 00:05:47,050

just got back so I don't really have a

128

00:05:51,089 --> 00:05:49,180

lot of really cool data for you but so

129

00:05:52,800 --> 00:05:51,099

we went to the leaky amount lens or I

130

00:05:55,110 --> 00:05:52,810

went to the leaky Oh mountains in Puerto

131

00:05:57,990 --> 00:05:55,120

Rico this is a critical zone observatory

132

00:05:59,790 --> 00:05:58,000

and I know it's not a basalt so please

133

00:06:01,950 --> 00:05:59,800

don't give me grief about that okay I

134

00:06:05,219 --> 00:06:01,960

realize this is not a basalt this is a

135

00:06:06,930 --> 00:06:05,229

grano diorite and but it does have an

136

00:06:08,600 --> 00:06:06,940

appreciable way percent of iron varying

137

00:06:12,420 --> 00:06:08,610

phases such as biotite and hornblende

138

00:06:14,129 --> 00:06:12,430

the really really remarkable thing about

139

00:06:18,659 --> 00:06:14,139

this is how fast this thing is

140

00:06:21,330 --> 00:06:18,669

weathering this is the most well one of

141

00:06:23,189 --> 00:06:21,340

the most rapid weathering waits for a

142

00:06:25,350 --> 00:06:23,199

granitic material that's ever been

143

00:06:26,939 --> 00:06:25,360

recorded this thing the separately

144

00:06:29,519 --> 00:06:26,949

advance rate on this thing is on the

145

00:06:31,230 --> 00:06:29,529

order of 58 meters per million years if

146

00:06:33,360 --> 00:06:31,240

you aren't familiar with weathering

147

00:06:35,610 --> 00:06:33,370

rates that's an order of magnitude

148

00:06:37,680 --> 00:06:35,620

ster than the global average for for a

149

00:06:39,810 --> 00:06:37,690

granitic system and that's partially

150

00:06:41,670 --> 00:06:39,820

attributed to climate illogical

151  
00:06:43,409 --> 00:06:41,680  
variables high temperature high

152  
00:06:47,879 --> 00:06:43,419  
precipitation this is a rain forest

153  
00:06:50,100 --> 00:06:47,889  
after all and as well as topography but

154  
00:06:53,040 --> 00:06:50,110  
what you see you know so it's weathering

155  
00:06:55,200 --> 00:06:53,050  
typical typical granite weather's like

156  
00:06:58,320 --> 00:06:55,210  
an onion skins periodically and that's

157  
00:07:00,420 --> 00:06:58,330  
driven by the initial oxidation of the

158  
00:07:04,350 --> 00:07:00,430  
structural iron in biotype and that

159  
00:07:06,240 --> 00:07:04,360  
leads to expansion of the the D layer so

160  
00:07:07,980 --> 00:07:06,250  
you get eventually fracturing and then

161  
00:07:09,629 --> 00:07:07,990  
it's just a runaway process from there

162  
00:07:11,689 --> 00:07:09,639  
but the initial step in this weathering

163  
00:07:14,040 --> 00:07:11,699

is actually the oxidation of biotite and

164

00:07:16,980 --> 00:07:14,050

then the rapid dissolution of the other

165

00:07:22,620 --> 00:07:16,990

by other iron bearing phase which is

166

00:07:25,469 --> 00:07:22,630

hornblende so there's evidence that not

167

00:07:28,500 --> 00:07:25,479

only is this you know weathering very

168

00:07:30,930 --> 00:07:28,510

quickly because it is that microbes may

169

00:07:33,830 --> 00:07:30,940

be playing a role here and this was

170

00:07:37,920 --> 00:07:33,840

essentially this 2005 paper was my Bible

171

00:07:41,430 --> 00:07:37,930

so my my entire work thus far is based

172

00:07:43,830 --> 00:07:41,440

on this kind of theoretical paper that

173

00:07:46,469 --> 00:07:43,840

maybe maybe it's microbes so what you're

174

00:07:49,379 --> 00:07:46,479

looking at is you see a loss of iron so

175

00:07:52,170 --> 00:07:49,389

at depth this okay so this is a let me

176

00:07:53,670 --> 00:07:52,180

back up this is a surficial expression

177

00:07:55,469 --> 00:07:53,680

of what's happening underground there's

178

00:07:58,279 --> 00:07:55,479

a recent landslides that exposed this

179

00:08:01,020 --> 00:07:58,289

normally this is the the saprolite

180

00:08:04,700 --> 00:08:01,030

bedrock interface is variable but

181

00:08:08,250 --> 00:08:04,710

usually five to eight meters depth so

182

00:08:10,020 --> 00:08:08,260

yeah should clarify so this is at five

183

00:08:11,850 --> 00:08:10,030

meters and then you see up through the

184

00:08:14,580 --> 00:08:11,860

sap relay you see a depletion and iron

185

00:08:15,900 --> 00:08:14,590

but what's really interesting is the the

186

00:08:19,920 --> 00:08:15,910

cell count so you have high cell

187

00:08:21,839 --> 00:08:19,930

densities at the surface right okay no

188

00:08:23,969 --> 00:08:21,849

big deal and then you move down through

189

00:08:25,860 --> 00:08:23,979

the saprolite you see this wiggle right

190

00:08:28,140 --> 00:08:25,870

here I'll talk about that in just a

191

00:08:30,270 --> 00:08:28,150

second but down again right here so this

192

00:08:32,040 --> 00:08:30,280

is DNA counts or DNA yield and direct

193

00:08:34,199 --> 00:08:32,050

counts you start getting close to that

194

00:08:37,199 --> 00:08:34,209

rock and you start seeing increased cell

195

00:08:39,800 --> 00:08:37,209

densities again and these are also have

196

00:08:43,110 --> 00:08:39,810

those little I Bart's their deeds

197

00:08:45,420 --> 00:08:43,120

biogeochemical tests or biochemical

198

00:08:45,940 --> 00:08:45,430

tests for iron related bacteria how much

199

00:08:48,340 --> 00:08:45,950

stock you

200

00:08:50,440 --> 00:08:48,350

but in those I'm not really sure but

201  
00:08:52,780 --> 00:08:50,450  
taken together this suggests that we

202  
00:08:54,970 --> 00:08:52,790  
have this conceptual model again

203  
00:08:57,880 --> 00:08:54,980  
surficial expression of a subsurface

204  
00:09:00,190 --> 00:08:57,890  
process this is a road cut so this would

205  
00:09:02,260 --> 00:09:00,200  
be a coarse tone of the grano diorite

206  
00:09:04,810 --> 00:09:02,270  
it's fractured because it was blessed

207  
00:09:06,670 --> 00:09:04,820  
with dynamite to make the road but on

208  
00:09:08,620 --> 00:09:06,680  
top of it you see the dinner plate

209  
00:09:09,910 --> 00:09:08,630  
stacked like Ryan lids that are

210  
00:09:13,060 --> 00:09:09,920  
associated with the spheroid of

211  
00:09:14,140 --> 00:09:13,070  
weathering and then conceptually you

212  
00:09:16,360 --> 00:09:14,150  
know so you have the bedrock you have

213  
00:09:19,270 --> 00:09:16,370

the reignwood sown and then you're

214

00:09:21,340 --> 00:09:19,280

separated so you can calculate the

215

00:09:23,710 --> 00:09:21,350

amount of biomass based on the free

216

00:09:26,470 --> 00:09:23,720

energy and you can actually produce more

217

00:09:28,510 --> 00:09:26,480

cells at depth based on the upward flux

218

00:09:31,320 --> 00:09:28,520

of iron out of the rock then you can buy

219

00:09:35,980 --> 00:09:31,330

the downward flux of carbon so these are

220

00:09:38,620 --> 00:09:35,990

probably with the tropes so um that's

221

00:09:40,690 --> 00:09:38,630

our hypothesis is that through a direct

222

00:09:42,640 --> 00:09:40,700

enzymatic attack on the mineral surface

223

00:09:44,440 --> 00:09:42,650

these microbes these iron oxidizing

224

00:09:45,970 --> 00:09:44,450

bacteria are going to play a direct role

225

00:09:48,760 --> 00:09:45,980

in the rapid weathering of the sport's

226

00:09:50,500 --> 00:09:48,770

diorite and metagenomic characterization

227

00:09:52,600 --> 00:09:50,510

of the Institute community is going to

228

00:09:55,230 --> 00:09:52,610

lend insight into this process and we're

229

00:09:58,540 --> 00:09:55,240

also going to do some culturing to

230

00:10:00,640 --> 00:09:58,550

determine you know or to show a

231

00:10:02,530 --> 00:10:00,650

selective colonization of the the

232

00:10:04,930 --> 00:10:02,540

mineral surfaces so this is the real

233

00:10:06,580 --> 00:10:04,940

rock this one doesn't exist anymore I

234

00:10:08,620 --> 00:10:06,590

crust it with the old s wing and threw

235

00:10:14,050 --> 00:10:08,630

it in some artificial ground water but

236

00:10:15,670 --> 00:10:14,060

so we took three cores again the

237

00:10:18,610 --> 00:10:15,680

separate light is variable in thickness

238

00:10:23,020 --> 00:10:18,620

basically did this with the hand auger

239

00:10:25,300 --> 00:10:23,030

until you couldn't go anymore and so

240

00:10:27,070 --> 00:10:25,310

again it's variable but we sampled

241

00:10:30,400 --> 00:10:27,080

periodically down through the satellite

242

00:10:33,220 --> 00:10:30,410

profile aseptic Lee for microbiologic

243

00:10:35,350 --> 00:10:33,230

and genomic analysis in what I'm doing

244

00:10:37,090 --> 00:10:35,360

right now is I set up in Richmond

245

00:10:38,980 --> 00:10:37,100

cultures this is a very wordy slide I

246

00:10:41,770 --> 00:10:38,990

realize that but we're using an

247

00:10:44,680 --> 00:10:41,780

artificial ground water so they all they

248

00:10:47,500 --> 00:10:44,690

get they get water they get minerals and

249

00:10:50,140 --> 00:10:47,510

they get co2 that is it that's all they

250

00:10:53,830 --> 00:10:50,150

have in nature so that's all they're

251  
00:10:55,360 --> 00:10:53,840  
getting here and so I did I actually use

252  
00:10:57,400 --> 00:10:55,370  
the parent material the grano diorite

253  
00:10:58,060 --> 00:10:57,410  
and because it's a very trendy thing to

254  
00:11:00,790 --> 00:10:58,070  
do I did

255  
00:11:02,500 --> 00:11:00,800  
deconstructed menu where I took the the

256  
00:11:04,990 --> 00:11:02,510  
grand old IRA and split it into its

257  
00:11:08,260 --> 00:11:05,000  
components the hornblende of biotite

258  
00:11:11,460 --> 00:11:08,270  
that elbaite courts and these are this

259  
00:11:13,930 --> 00:11:11,470  
muscovites of control for another reason

260  
00:11:15,220 --> 00:11:13,940  
but so we're just monitoring them over

261  
00:11:17,560 --> 00:11:15,230  
time their illicit ropes they grow

262  
00:11:18,940 --> 00:11:17,570  
slowly I don't have any evidence that

263  
00:11:23,020 --> 00:11:18,950

they're growing at all right now but

264

00:11:24,370 --> 00:11:23,030

it's only been maybe a month so at the

265

00:11:26,470 --> 00:11:24,380

end of the day we are going to go after

266

00:11:28,420 --> 00:11:26,480

them and hopefully they're going to grow

267

00:11:33,400 --> 00:11:28,430

right cheer them on say please grow

268

00:11:35,080 --> 00:11:33,410

please grow oh okay and then also the

269

00:11:37,060 --> 00:11:35,090

really kind of cool part about this the

270

00:11:40,360 --> 00:11:37,070

part that I hope to tell you more about

271

00:11:41,710 --> 00:11:40,370

later is the meta genomics and what we

272

00:11:43,780 --> 00:11:41,720

want to do remember this direct

273

00:11:46,450 --> 00:11:43,790

enzymatic attack these are genomically

274

00:11:48,910 --> 00:11:46,460

encoded extracellular on transport jeans

275

00:11:52,750 --> 00:11:48,920

and so we know how do we know how to

276

00:11:55,780 --> 00:11:52,760

find these right these this is these

277

00:11:57,730 --> 00:11:55,790

diagrams are from Xiaomei shamans paper

278

00:12:00,160 --> 00:11:57,740

she's in our research group to actually

279

00:12:02,260 --> 00:12:00,170

mine these genomes and look for these

280

00:12:04,360 --> 00:12:02,270

types of extracellular electron

281

00:12:06,670 --> 00:12:04,370

transport pathways that will tell us

282

00:12:09,280 --> 00:12:06,680

hopefully that yes you are right we are

283

00:12:11,800 --> 00:12:09,290

with the troves so this is this is

284

00:12:13,990 --> 00:12:11,810

ongoing work that I'm trying to do right

285

00:12:16,330 --> 00:12:14,000

now it's kind of hard to get a lot of

286

00:12:17,920 --> 00:12:16,340

good high quality genomic DNA out of

287

00:12:21,160 --> 00:12:17,930

something that's loaded up with kale and

288

00:12:25,210 --> 00:12:21,170

I in iron oxide and is low biomass to

289

00:12:27,790 --> 00:12:25,220

begin with so here's hoping all right so

290

00:12:34,200 --> 00:12:27,800

some conclusions and in the interest of

291

00:12:39,130 --> 00:12:34,210

time I'm still working on it and so

292

00:12:41,890 --> 00:12:39,140

thank you especially NASA NSF in this

293

00:12:49,600 --> 00:12:41,900

ezo program and my collaborators and

294

00:13:04,880 --> 00:13:01,490

questions for Stephanie so I'm just

295

00:13:06,500 --> 00:13:04,890

curious the enzymatic attack is

296

00:13:09,140 --> 00:13:06,510

contributing to the fast weathering Greg

297

00:13:12,020 --> 00:13:09,150

that's that's the idea idea yeah okay

298

00:13:14,360 --> 00:13:12,030

but they're growing extremely slow so

299

00:13:18,230 --> 00:13:14,370

how do you reconcile that so okay so

300

00:13:21,290 --> 00:13:18,240

this is based on ok so I'm geologic time

301  
00:13:22,910 --> 00:13:21,300  
I'd be so I'm growing in 50 grams right

302  
00:13:25,520 --> 00:13:22,920  
but you have I don't know what the

303  
00:13:27,170 --> 00:13:25,530  
volumetric equivalent or what it would

304  
00:13:30,770 --> 00:13:27,180  
be on this on this pluton I have no idea

305  
00:13:32,540 --> 00:13:30,780  
volumetrically how big it is but if they

306  
00:13:34,940 --> 00:13:32,550  
turn over if there's a lot of them and

307  
00:13:37,040 --> 00:13:34,950  
they turn over maybe once a month or

308  
00:13:39,110 --> 00:13:37,050  
even once every two weeks which elicits

309  
00:13:42,170 --> 00:13:39,120  
rows are slow growers yeah it's not

310  
00:13:44,390 --> 00:13:42,180  
entirely unreasonable and I've also just

311  
00:13:46,520 --> 00:13:44,400  
kind of at a first pass level done a

312  
00:13:48,800 --> 00:13:46,530  
little bit of like reactor transport

313  
00:13:52,010 --> 00:13:48,810

modeling and based on like just general

314

00:13:53,870 --> 00:13:52,020

dissolution rates I would have to I have

315

00:13:56,210 --> 00:13:53,880

to do something very crazy that I just

316

00:13:58,880 --> 00:13:56,220

don't think is geologically appropriate

317

00:14:00,790 --> 00:13:58,890

to actually try to fit a match to the

318

00:14:03,320 --> 00:14:00,800

observed weathering right we see here so

319

00:14:06,620 --> 00:14:03,330

we don't unfortunately have a number we

320

00:14:10,190 --> 00:14:06,630

can plug in there's no iron oxidizing

321

00:14:15,110 --> 00:14:10,200

like go this fast to throw into a model

322

00:14:17,360 --> 00:14:15,120

unfortunately a quick follow-up so are

323

00:14:18,920 --> 00:14:17,370

there like biofilms growing on the

324

00:14:22,610 --> 00:14:18,930

surfaces of the rocks like what's this

325

00:14:26,660 --> 00:14:22,620

obviously um some of the other work that

326

00:14:29,810 --> 00:14:26,670

I didn't show here is there's holy site

327

00:14:31,460 --> 00:14:29,820

nano tubules there there's microbes you

328

00:14:34,730 --> 00:14:31,470

can see cells associated with the

329

00:14:36,140 --> 00:14:34,740

mineral phases but in the interest of

330

00:14:39,650 --> 00:14:36,150

time I didn't drag you through all of

331

00:14:44,360 --> 00:14:39,660

the background information so you got

332

00:14:47,000 --> 00:14:44,370

one back there does an increase of the

333

00:14:49,130 --> 00:14:47,010

thought raphy of actually a mineral

334

00:14:54,380 --> 00:14:49,140

consumption mean an increase of micro

335

00:14:57,680 --> 00:14:54,390

production so in increase in with the

336

00:14:59,910 --> 00:14:57,690

trophy and then an increase in cells is

337

00:15:01,800 --> 00:14:59,920

that is a question basically just be

338

00:15:03,449 --> 00:15:01,810

there's more of an iron source does that

339

00:15:05,519 --> 00:15:03,459

mean is that doesn't mean we'll find

340

00:15:07,050 --> 00:15:05,529

these there'll be more microbes yeah so

341

00:15:09,810 --> 00:15:07,060

just simple free energy right so if you

342

00:15:11,600 --> 00:15:09,820

have more more iron to oxidize you can

343

00:15:13,650 --> 00:15:11,610

build more cells just at the most basic

344

00:15:19,829 --> 00:15:13,660

thermodynamic level then yes that would