

LITHOFACIES

Silt/claystone

- Laminated
- Bioturbated (bedding destroyed)
- Vuggy

Sandstone

- Lenticular
- Cross-bedded
- Bioturbated

Conglomerate

- Thickly bedded
- Lenticular



Silt

Claystone

- Laminated
- Massive
- Vuggy
- Ropy

Sandstone

- Cross-bedding
- Laminated to thickly bedded

Conglomerate



1
00:00:14,520 --> 00:00:11,090
so we're going to move into the dress

2
00:00:17,010 --> 00:00:14,530
how do I advance this there we go so

3
00:00:20,190 --> 00:00:17,020
today first I'm going to talk about the

4
00:00:22,370 --> 00:00:20,200
purpose of this study and some of the

5
00:00:26,010 --> 00:00:22,380
applications i'm going to go over the

6
00:00:29,310 --> 00:00:26,020
areas i studied and then i'm going to

7
00:00:32,100 --> 00:00:29,320
kind of compare things to Mars so I'm

8
00:00:35,509 --> 00:00:32,110
looking at rocks Jurassic age rocks on

9
00:00:38,160 --> 00:00:35,519
the Colorado Plateau as an analog for

10
00:00:40,969 --> 00:00:38,170
Mars sedimentary rocks at Gale Crater

11
00:00:43,469 --> 00:00:40,979
okay I'm going to go through some data

12
00:00:46,799 --> 00:00:43,479
hopefully not too much Sen is just

13
00:00:48,810 --> 00:00:46,809

pictures photography as pictures so it

14

00:00:51,450 --> 00:00:48,820

won't be to date a heavy but and so

15

00:00:57,840 --> 00:00:51,460

hopefully I don't lose it lose the crowd

16

00:01:01,289 --> 00:00:57,850

here so the purpose of this was to look

17

00:01:05,399 --> 00:01:01,299

at how microbial fossils are preserved

18

00:01:08,310 --> 00:01:05,409

over geologic time and that that's a

19

00:01:11,099 --> 00:01:08,320

question and that really hasn't been

20

00:01:15,170 --> 00:01:11,109

answered and to do this I'm going to

21

00:01:17,910 --> 00:01:15,180

look at modern microbial mats that have

22

00:01:19,950 --> 00:01:17,920

ancient terraces so hundred thousand

23

00:01:21,810 --> 00:01:19,960

year old terraces in this from the same

24

00:01:25,349 --> 00:01:21,820

system and then I'm going to look at

25

00:01:29,249 --> 00:01:25,359

Jurassic rocks and compare these 2 c1

26
00:01:32,300 --> 00:01:29,259
how they're changing and then to what

27
00:01:35,489 --> 00:01:32,310
kinds of chemical and mineralogical

28
00:01:40,050 --> 00:01:35,499
signatures are persisting over geologic

29
00:01:42,450 --> 00:01:40,060
time so you might say this is a this is

30
00:01:44,880 --> 00:01:42,460
an these rocks that i showed a picture

31
00:01:47,789 --> 00:01:44,890
of last night they're from an alkylene

32
00:01:50,660 --> 00:01:47,799
saline lake and you might say are you

33
00:01:53,399 --> 00:01:50,670
comparing apples and oranges here and

34
00:01:56,160 --> 00:01:53,409
not really they're both have abundance

35
00:01:58,499 --> 00:01:56,170
biotic features they're both alkaline

36
00:02:04,499 --> 00:01:58,509
saline groundwater fed systems so there

37
00:02:06,779 --> 00:02:04,509
are some similarities okay so i'm using

38
00:02:10,080 --> 00:02:06,789

this as an analog to the rocks at gale

39

00:02:11,840 --> 00:02:10,090

crater which are very similar it's been

40

00:02:13,940 --> 00:02:11,850

suggested that these are

41

00:02:17,120 --> 00:02:13,950

lacoste written in origin or were

42

00:02:26,000 --> 00:02:17,130

deposited in a lake system is this too

43

00:02:28,100 --> 00:02:26,010

loud it seems really loud okay okay so

44

00:02:31,820 --> 00:02:28,110

anyway the rocks of Gale Crater were

45

00:02:36,290 --> 00:02:31,830

possibly a deposited in a lake system

46

00:02:39,050 --> 00:02:36,300

similar to the lake system of the brushy

47

00:02:40,460 --> 00:02:39,060

Basin formation they're iron and clay

48

00:02:45,410 --> 00:02:40,470

rich sediments we've heard a lot about

49

00:02:48,470 --> 00:02:45,420

clays and these this has application for

50

00:02:50,660 --> 00:02:48,480

obviously looking for biosignatures in

51
00:02:52,310 --> 00:02:50,670
these rocks at Gale Crater but also for

52
00:02:55,040 --> 00:02:52,320
terrestrial origin of life studies

53
00:02:57,050 --> 00:02:55,050
because we have heard already today that

54
00:03:00,080 --> 00:02:57,060
there is some Stillson question on how

55
00:03:05,450 --> 00:03:00,090
to really pin down what an actual bio

56
00:03:08,450 --> 00:03:05,460
signature is so so the other the other

57
00:03:10,580 --> 00:03:08,460
big thing is just understanding the

58
00:03:12,980 --> 00:03:10,590
basic sedimentology of Gale Crater like

59
00:03:14,960 --> 00:03:12,990
how did these rocks form and what kinds

60
00:03:18,890 --> 00:03:14,970
of environments where they formed in and

61
00:03:21,310 --> 00:03:18,900
what is the history of the rocks of so

62
00:03:24,170 --> 00:03:21,320
diagenesis is a word that I will use

63
00:03:26,390 --> 00:03:24,180

diagenesis basically means the process

64

00:03:30,140 --> 00:03:26,400

by which sediments become sedimentary

65

00:03:33,410 --> 00:03:30,150

rocks so sediments are deposited they

66

00:03:36,740 --> 00:03:33,420

get buried water and sometimes on well

67

00:03:39,020 --> 00:03:36,750

on earth biota begin to interact and and

68

00:03:40,760 --> 00:03:39,030

they become sedimentary rocks so that

69

00:03:43,900 --> 00:03:40,770

that's all I mean when I say diagenesis

70

00:03:47,300 --> 00:03:43,910

but that's a that's a very big process

71

00:03:51,100 --> 00:03:47,310

that we need to under better understand

72

00:03:53,990 --> 00:03:51,110

for Gale Crater alright so here's my

73

00:03:57,380 --> 00:03:54,000

cold spring system it's in 10 miles

74

00:04:00,080 --> 00:03:57,390

Robin which is in southern Utah in the

75

00:04:06,130 --> 00:04:00,090

United States it's a it's a cold spring

76
00:04:10,070 --> 00:04:06,140
system it's got co2 and hydrocarbon and

77
00:04:14,200 --> 00:04:10,080
it's been it's been in existence for at

78
00:04:17,810 --> 00:04:14,210
least 400,000 years there are abundant

79
00:04:19,700 --> 00:04:17,820
tufa terraces that very conveniently

80
00:04:22,730 --> 00:04:19,710
somebody else went out dated so I know

81
00:04:24,890 --> 00:04:22,740
exactly how old these days are so it's

82
00:04:26,659 --> 00:04:24,900
been in existence for 400,000 years I

83
00:04:29,420 --> 00:04:26,669
elected a hundred thousand year old to

84
00:04:31,610 --> 00:04:29,430
fight Arastoo to study as well as modern

85
00:04:34,460 --> 00:04:31,620
Springs and these are my daughters and

86
00:04:36,170 --> 00:04:34,470
and today is their 15th birthday and

87
00:04:39,860 --> 00:04:36,180
they're there watching so I have to say

88
00:04:48,560 --> 00:04:39,870

happy birthday Lily Anne and Alexis want

89

00:04:50,990 --> 00:04:48,570

to hear your birth story okay all right

90

00:04:52,580 --> 00:04:51,000

and so then the brushy Basin member of

91

00:04:55,400 --> 00:04:52,590

the Morrison Formation those are the

92

00:04:57,560 --> 00:04:55,410

Jurassic rocks i'm looking at and these

93

00:04:59,990 --> 00:04:57,570

were deposited as i've said in an

94

00:05:02,360 --> 00:05:00,000

alkaline saline groundwater fed system

95

00:05:04,070 --> 00:05:02,370

that centered on the Four Corners region

96

00:05:07,930 --> 00:05:04,080

at the Colorado Plateau so here's

97

00:05:10,490 --> 00:05:07,940

Colorado New Mexico Arizona and Utah and

98

00:05:13,520 --> 00:05:10,500

it's been named in the lid in the

99

00:05:16,490 --> 00:05:13,530

literature Lake to DG which is a navajo

100

00:05:18,760 --> 00:05:16,500

word meaning bitter water because the

101

00:05:21,200 --> 00:05:18,770

water must have been quite bitter and

102

00:05:23,629 --> 00:05:21,210

and we won't go into it but there are

103

00:05:25,219 --> 00:05:23,639

these clay minerals own so I'm not going

104

00:05:28,010 --> 00:05:25,229

to go into depth about the clay

105

00:05:33,830 --> 00:05:28,020

mineralogy there's also abundant biotic

106

00:05:36,939 --> 00:05:33,840

influence in this system which I'm not

107

00:05:40,189 --> 00:05:36,949

going to talk about too much either so

108

00:05:42,260 --> 00:05:40,199

so here's a comparison of the litho

109

00:05:46,550 --> 00:05:42,270

faces so little faces is just a fancy

110

00:05:51,409 --> 00:05:46,560

word that means a rock-type and and so

111

00:05:53,659 --> 00:05:51,419

we have basically three main rock types

112

00:05:56,180 --> 00:05:53,669

there's a silt stone clay stone and

113

00:05:57,770 --> 00:05:56,190

these are both for on Mars and in the

114

00:06:00,529 --> 00:05:57,780

brushy basis so there's a silt stone

115

00:06:03,350 --> 00:06:00,539

clay stone faces that can be laminated

116

00:06:08,839 --> 00:06:03,360

which means typically means it's deposit

117

00:06:13,010 --> 00:06:08,849

deposited in standing water in in in

118

00:06:14,719 --> 00:06:13,020

Colorado it's it's biota beta door and

119

00:06:16,879 --> 00:06:14,729

can be the bedding can be completely

120

00:06:18,710 --> 00:06:16,889

destroyed in massive and that's due to

121

00:06:21,860 --> 00:06:18,720

bioturbation there's also a massive

122

00:06:24,320 --> 00:06:21,870

faces on Mars which may not be dieter

123

00:06:27,649 --> 00:06:24,330

baited you can get massive faces other

124

00:06:30,920 --> 00:06:27,659

ways and then as I mentioned last night

125

00:06:32,899 --> 00:06:30,930

in my presentation there are there is a

126

00:06:36,170 --> 00:06:32,909

silt stone clay stone faces that is

127

00:06:37,990 --> 00:06:36,180

buggy so bug bug is a word that just

128

00:06:43,690 --> 00:06:38,000

means void space

129

00:06:47,200 --> 00:06:43,700

and in Colorado this is interpreted as a

130

00:06:51,580 --> 00:06:47,210

Kara fight or care fidic texture which a

131

00:06:55,620 --> 00:06:51,590

caer fight is an algal mat and it leaves

132

00:06:58,810 --> 00:06:55,630

this kind of buggy texture in the rocks

133

00:07:01,660 --> 00:06:58,820

there's there are sandstone faces that

134

00:07:03,760 --> 00:07:01,670

exhibit cross bedding a little small

135

00:07:07,360 --> 00:07:03,770

scale cross wedding here and and there

136

00:07:12,550 --> 00:07:07,370

on Mars it can be biochar baited as well

137

00:07:15,370 --> 00:07:12,560

in in Utah or in Colorado and these are

138

00:07:18,600 --> 00:07:15,380

lenticular sandstones which suggests a

139

00:07:21,730 --> 00:07:18,610

fluvial river system so these are river

140

00:07:24,430 --> 00:07:21,740

deposited in a river conglomerates as

141

00:07:25,960 --> 00:07:24,440

well exhibit imbrication which means

142

00:07:28,120 --> 00:07:25,970

they're tilted in the direction of

143

00:07:30,880 --> 00:07:28,130

current which suggests also that they

144

00:07:34,480 --> 00:07:30,890

were deposited in a river so which is

145

00:07:36,370 --> 00:07:34,490

not not inconsistent with the lake so

146

00:07:38,110 --> 00:07:36,380

you're thinking you said lake now you're

147

00:07:39,760 --> 00:07:38,120

talking about a river well if you've got

148

00:07:41,560 --> 00:07:39,770

a lake system that's periodically

149

00:07:44,159 --> 00:07:41,570

desiccating and you've got rivers

150

00:07:49,300 --> 00:07:44,169

feeding it during flood times think

151
00:07:52,620 --> 00:07:49,310
think app you know Sahara Serengeti in

152
00:07:55,270 --> 00:07:52,630
the Africa or in Western Australia the

153
00:07:57,159 --> 00:07:55,280
acid saline lakes and things that you

154
00:08:01,690 --> 00:07:57,169
have periodic floods that come in and

155
00:08:03,510 --> 00:08:01,700
and and deposit fluvial sediments and

156
00:08:09,450 --> 00:08:03,520
then you have other times where lake is

157
00:08:14,230 --> 00:08:09,460
the lake waters is deeper and standing

158
00:08:16,690 --> 00:08:14,240
okay so as I said in in the brushy Basin

159
00:08:20,890 --> 00:08:16,700
member there's a abundant macroscopic

160
00:08:23,080 --> 00:08:20,900
biotic influence okay I've talked about

161
00:08:26,290 --> 00:08:23,090
the bugs the Kara Finnick texture these

162
00:08:29,560 --> 00:08:26,300
are reduction halos around root traces

163
00:08:32,620 --> 00:08:29,570

so very often you get paleosols which

164

00:08:35,980 --> 00:08:32,630

are fossil soils and you have evidence

165

00:08:38,469 --> 00:08:35,990

of roots and burrows in those and the

166

00:08:41,440 --> 00:08:38,479

the organic matter degrades and creates

167

00:08:43,870 --> 00:08:41,450

these reduction halos this is a highly

168

00:08:47,170 --> 00:08:43,880

burrowed rock here and this is a

169

00:08:48,820 --> 00:08:47,180

dinosaur femur and as I'm saying as I

170

00:08:51,340 --> 00:08:48,830

said last night I'm not suggesting

171

00:08:55,270 --> 00:08:51,350

they're dinosaurs on

172

00:08:58,390 --> 00:08:55,280

or were dinosaurs on Mars but we did we

173

00:09:01,990 --> 00:08:58,400

did have them here in the Jurassic and

174

00:09:05,380 --> 00:09:02,000

we do find evidence of that so for this

175

00:09:10,360 --> 00:09:05,390

study I used criteria for Biogenicity

176
00:09:13,300 --> 00:09:10,370
from sherry Katie 2001 and just you know

177
00:09:20,290 --> 00:09:13,310
to to have some sort of starting point

178
00:09:22,480 --> 00:09:20,300
okay so two to prove Biogen icity it has

179
00:09:24,580 --> 00:09:22,490
to be in a thin section so it has to be

180
00:09:27,090 --> 00:09:24,590
you have to show that it's actually not

181
00:09:29,860 --> 00:09:27,100
contamination it's actually in the rock

182
00:09:32,770 --> 00:09:29,870
it has to be a sedimentary or low-grade

183
00:09:36,030 --> 00:09:32,780
metamorphic rock because like we've

184
00:09:40,990 --> 00:09:36,040
discussed I mean if it's a in a in a

185
00:09:45,970 --> 00:09:41,000
lava it's you know unless it's not Cyn

186
00:09:50,200 --> 00:09:45,980
Cyn genetic it you know lava burns it up

187
00:09:52,840 --> 00:09:50,210
okay it needs to be the same size as

188
00:09:55,600 --> 00:09:52,850

life as we know it it needs to have

189

00:09:58,390 --> 00:09:55,610

carriage in it needs to be with others

190

00:10:00,720 --> 00:09:58,400

of similar morphology so it can't be you

191

00:10:05,020 --> 00:10:00,730

know can't just be one isolated feature

192

00:10:06,940 --> 00:10:05,030

it has to be living in a community needs

193

00:10:11,230 --> 00:10:06,950

to be hollow and have cellular

194

00:10:13,930 --> 00:10:11,240

complexity and then she set up this kind

195

00:10:16,570 --> 00:10:13,940

of criteria so if it meets wonderful one

196

00:10:20,590 --> 00:10:16,580

to four of these at sudo it's a pseudo

197

00:10:27,250 --> 00:10:20,600

fossil 125 it's possible and 127 it's

198

00:10:31,510 --> 00:10:27,260

probable okay oh my god alright so I'm

199

00:10:36,520 --> 00:10:31,520

going to go fast all right let's just

200

00:10:38,770 --> 00:10:36,530

look at these pictures these are so this

201
00:10:40,900 --> 00:10:38,780
is the modern spring this is the ancient

202
00:10:44,050 --> 00:10:40,910
spring you can see that these these

203
00:10:48,060 --> 00:10:44,060
features of the cyanobacteria are

204
00:10:50,560 --> 00:10:48,070
diffuse their recrystallizing over time

205
00:10:51,880 --> 00:10:50,570
one interesting thing is that there's

206
00:10:57,850 --> 00:10:51,890
very high drive somebody yesterday

207
00:10:59,350 --> 00:10:57,860
talked about out of unusual minerals and

208
00:11:01,870 --> 00:10:59,360
and things that are that are

209
00:11:03,850 --> 00:11:01,880
thermodynamically unstable and why are

210
00:11:04,569 --> 00:11:03,860
they present so why is very hydrate

211
00:11:07,949 --> 00:11:04,579
present in

212
00:11:11,259 --> 00:11:07,959
hundred thousand year old microbial mat

213
00:11:13,299 --> 00:11:11,269

probably it's it's it very hydrides a

214

00:11:15,100 --> 00:11:13,309

mineral that recrystallize us to more

215

00:11:16,900 --> 00:11:15,110

stable phases within weeks in a

216

00:11:19,239 --> 00:11:16,910

laboratory so the fact that it's there

217

00:11:22,389 --> 00:11:19,249

is very unusual fact that it's there and

218

00:11:24,309 --> 00:11:22,399

it's that old is very unusual alright

219

00:11:29,710 --> 00:11:24,319

these are these bugs we're going to just

220

00:11:32,499 --> 00:11:29,720

skip that and so here are the brushy

221

00:11:34,419 --> 00:11:32,509

basin or I'm sorry this is the modern

222

00:11:36,729 --> 00:11:34,429

spring and this is the brushy Basin

223

00:11:41,199 --> 00:11:36,739

member and we see some similar features

224

00:11:45,519 --> 00:11:41,209

these branching filaments Fran Boyd's

225

00:11:47,530 --> 00:11:45,529

and spheroids which are have been in the

226

00:11:49,419 --> 00:11:47,540

literature have been noted to be

227

00:11:51,999 --> 00:11:49,429

possible by 0 signatures these are

228

00:11:55,150 --> 00:11:52,009

associated with these tests of diatoms

229

00:12:00,879 --> 00:11:55,160

and there's diatoms present in both of

230

00:12:05,229 --> 00:12:00,889

them ok I'm going to skip over that all

231

00:12:07,840 --> 00:12:05,239

right so to go to just the biogenesis

232

00:12:11,619 --> 00:12:07,850

v's are so what I do is I dissolve these

233

00:12:16,840 --> 00:12:11,629

in hydrofluoric acid and found algo

234

00:12:22,809 --> 00:12:16,850

fossils in the in the bugs all right

235

00:12:25,059 --> 00:12:22,819

we're going to skip this whoops alright

236

00:12:29,619 --> 00:12:25,069

well we'll go here so anyway bottom line

237

00:12:32,139 --> 00:12:29,629

is I did look at I looked at all of

238

00:12:34,619 --> 00:12:32,149

these features and they're segmented

239

00:12:37,650 --> 00:12:34,629

stocks and those are probable fossils

240

00:12:41,949 --> 00:12:37,660

according to these according to these

241

00:12:45,069 --> 00:12:41,959

criteria those branching filaments are

242

00:12:49,090 --> 00:12:45,079

possible fossils the tests of this got

243

00:12:52,030 --> 00:12:49,100

messed up here probable fossils that soy

244

00:12:57,759 --> 00:12:52,040

del those Spears those iron oxide

245

00:13:02,710 --> 00:12:57,769

spheres or probable fossils and anyway

246

00:13:05,559 --> 00:13:02,720

so the conclusions are that these

247

00:13:07,780 --> 00:13:05,569

microbial fossils are associated with

248

00:13:09,970 --> 00:13:07,790

these macroscopic trace fossils these

249

00:13:11,590 --> 00:13:09,980

kara fight molds and so that's really

250

00:13:13,779 --> 00:13:11,600

the point I wanted to make here is that

251

00:13:17,550 --> 00:13:13,789

I think that those rocks on Mars bear

252

00:13:20,010 --> 00:13:17,560

further investigation and

253

00:13:29,420 --> 00:13:20,020

there's my daughter's again and there's

254

00:13:34,740 --> 00:13:32,370

Thank You Sally we have about a minute