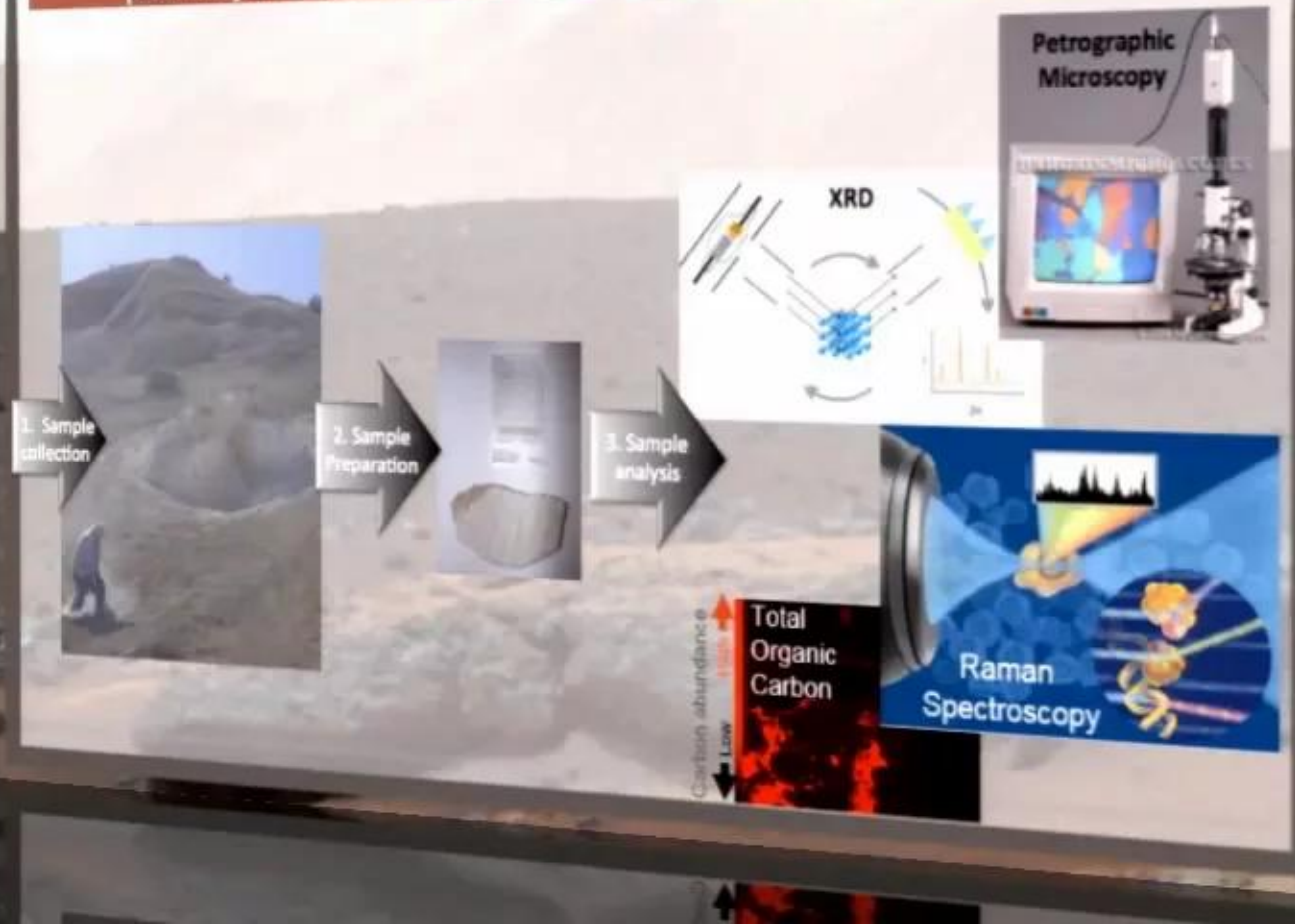
Approach

Goal: Understand the long-term preservation potential across diagenetic pathways in Verde Formation integrating multiple techniques.



1
00:00:11,660 --> 00:00:08,690
so I'm interested in Mars bio signatures

2
00:00:14,900 --> 00:00:11,670
and in this study i'm looking at bio

3
00:00:16,849 --> 00:00:14,910
signature preservation potential in an

4
00:00:18,460 --> 00:00:16,859
interesting field site not far from

5
00:00:20,689 --> 00:00:18,470
where i work at arizona state university

6
00:00:23,390 --> 00:00:20,699
called verde valley and so i'll try to

7
00:00:26,630 --> 00:00:23,400
put a little bit of a definition to that

8
00:00:31,160 --> 00:00:26,640
very nebulous concept of bio signature

9
00:00:33,530 --> 00:00:31,170
preservation potential if you've looked

10
00:00:36,590 --> 00:00:33,540
at some of the nasa documents that talk

11
00:00:39,459 --> 00:00:36,600
about priorities for the next decade of

12
00:00:42,650 --> 00:00:39,469
mars science like the decade-old survey

13
00:00:45,170 --> 00:00:42,660

like the astrobiology roadmap and like

14
00:00:47,270 --> 00:00:45,180
the mars exploration group the me pag

15
00:00:49,729 --> 00:00:47,280
document you'll see that they emphasize

16
00:00:52,600 --> 00:00:49,739
sort of the same themes you know

17
00:00:54,950 --> 00:00:52,610
characterizing aqueous environments

18
00:00:57,049 --> 00:00:54,960
understanding their habitability looking

19
00:00:58,910 --> 00:00:57,059
at bio signature preservation potential

20
00:01:03,070 --> 00:00:58,920
they don't really define it let alone

21
00:01:05,539 --> 00:01:03,080
put constraints on that concept and

22
00:01:08,000 --> 00:01:05,549
using instruments that are going to be

23
00:01:10,460 --> 00:01:08,010
on you know Mars rovers doing this kind

24
00:01:13,570 --> 00:01:10,470
of science remotely and so these are the

25
00:01:16,820 --> 00:01:13,580
kind of themes that motivated this study

26
00:01:18,560 --> 00:01:16,830
and if you've looked at the science the

27
00:01:20,630 --> 00:01:18,570
Mars Science program in the last decade

28
00:01:23,240 --> 00:01:20,640
or so you'll see that it's been largely

29
00:01:24,530 --> 00:01:23,250
characterized by following the water so

30
00:01:28,340 --> 00:01:24,540
you know look understanding these

31
00:01:29,600 --> 00:01:28,350
aqueous habitable environments and it's

32
00:01:30,950 --> 00:01:29,610
funny some of the press releases you

33
00:01:33,499 --> 00:01:30,960
know you'll see that come out of this

34
00:01:36,140 --> 00:01:33,509
topic like oh you know near neutral pH

35
00:01:37,880 --> 00:01:36,150
found in Gale Crater things like that

36
00:01:39,920 --> 00:01:37,890
and some of my favorite social media

37
00:01:41,690 --> 00:01:39,930
responses to these have been things like

38
00:01:44,870 --> 00:01:41,700

how many times in a week are we going to

39
00:01:46,850 --> 00:01:44,880
find water on Mars not that it's not

40
00:01:48,460 --> 00:01:46,860
very important to understand you know

41
00:01:51,380 --> 00:01:48,470
habitability in terms of aqueous

42
00:01:52,850 --> 00:01:51,390
environments because i'll talk more

43
00:01:57,260 --> 00:01:52,860
about why that's important on the next

44
00:01:59,600 --> 00:01:57,270
slide but I I think we we should be sort

45
00:02:02,600 --> 00:01:59,610
of thinking about the next phase in Mars

46
00:02:04,819 --> 00:02:02,610
a bio signature detection so I propose

47
00:02:09,020 --> 00:02:04,829
that we should be following the

48
00:02:10,639 --> 00:02:09,030
preservation and the reason why I say

49
00:02:13,220 --> 00:02:10,649
that is because my favorite bio

50
00:02:13,850 --> 00:02:13,230
signature is fossil bio signature called

51
00:02:17,630 --> 00:02:13,860
carriages

52
00:02:19,490 --> 00:02:17,640
so caradin is basically what happens to

53
00:02:21,890 --> 00:02:19,500
carbon when it gets fossilized and

54
00:02:24,770 --> 00:02:21,900
preserved in sediment terrestrial

55
00:02:27,140 --> 00:02:24,780
sediment if you count the carbon atoms

56
00:02:30,410 --> 00:02:27,150
that are you know that exists in like

57
00:02:32,270 --> 00:02:30,420
living biota today versus the carbon

58
00:02:34,820 --> 00:02:32,280
atoms that are preserved in sediment

59
00:02:37,580 --> 00:02:34,830
over time you'll see that there are

60
00:02:39,920 --> 00:02:37,590
about 10,000 times more carbon atoms in

61
00:02:42,290 --> 00:02:39,930
the sediment so just statistically alone

62
00:02:45,260 --> 00:02:42,300
it's kind of one good reason why I like

63
00:02:47,890 --> 00:02:45,270

the fossil bio signatures and so this

64
00:02:51,380 --> 00:02:47,900
diagram is kind of a generalized

65
00:02:53,870 --> 00:02:51,390
schematic of how kerogen this fossil

66
00:02:56,510 --> 00:02:53,880
organics evolves over time it's not a

67
00:02:59,750 --> 00:02:56,520
very linear process but thanks to the

68
00:03:01,870 --> 00:02:59,760
petroleum industry who's motivated by

69
00:03:05,090 --> 00:03:01,880
organics and sediment for other reasons

70
00:03:07,699 --> 00:03:05,100
we understand a lot about this kind of

71
00:03:10,220 --> 00:03:07,709
fossil bio signature so basically that's

72
00:03:12,380 --> 00:03:10,230
this is why the Mars community cares

73
00:03:13,729 --> 00:03:12,390
about aqueous environments because they

74
00:03:16,430 --> 00:03:13,739
sort of you know deliver these

75
00:03:18,770 --> 00:03:16,440
microorganisms to their final resting

76
00:03:21,770 --> 00:03:18,780
spot so to say in sediment kind of

77
00:03:23,390 --> 00:03:21,780
concentrate them like in a delta sort of

78
00:03:25,340 --> 00:03:23,400
a water delta environment or something

79
00:03:26,870 --> 00:03:25,350
similar and if they're lucky enough to

80
00:03:30,080 --> 00:03:26,880
be in a certain kind of environment they

81
00:03:33,110 --> 00:03:30,090
get buried and preserved and over time

82
00:03:35,630 --> 00:03:33,120
with increasing temperature depth and

83
00:03:38,590 --> 00:03:35,640
burial over geological time over

84
00:03:42,410 --> 00:03:38,600
diagenesis which is basically you know

85
00:03:44,810 --> 00:03:42,420
the evolving geological environment in a

86
00:03:48,800 --> 00:03:44,820
certain area you'll get basically this

87
00:03:50,630 --> 00:03:48,810
general trend of the carbon atoms what

88
00:03:52,520 --> 00:03:50,640

they want to do is form these six carbon

89
00:03:55,130 --> 00:03:52,530
rings and they want to compact and layer

90
00:03:56,390 --> 00:03:55,140
themselves like the mineral graphite and

91
00:03:58,340 --> 00:03:56,400
so that's why this process is called

92
00:04:00,380 --> 00:03:58,350
graphitization so the more mature

93
00:04:02,449 --> 00:04:00,390
carriage and we'll look we'll actually

94
00:04:04,280 --> 00:04:02,459
resemble the mineral graphite whereas

95
00:04:05,870 --> 00:04:04,290
some of the younger stuff will have more

96
00:04:07,820 --> 00:04:05,880
of the different functional groups in it

97
00:04:09,500 --> 00:04:07,830
and like I said carriage is really you

98
00:04:13,009 --> 00:04:09,510
know it could be any evolution stage

99
00:04:15,620 --> 00:04:13,019
along this process that's just kind of

100
00:04:18,650 --> 00:04:15,630
an idea of what happens to the organics

101
00:04:20,509 --> 00:04:18,660
and environments like evaporating

102
00:04:22,750 --> 00:04:20,519
environments are known to have high bio

103
00:04:25,250 --> 00:04:22,760
signature preservation potential

104
00:04:27,710 --> 00:04:25,260
minerals like gypsum which is calcium

105
00:04:30,560 --> 00:04:27,720
sulfate Hey light which is

106
00:04:32,300 --> 00:04:30,570
CL salt are thought to have good bio

107
00:04:34,130 --> 00:04:32,310
signature preservation potential and so

108
00:04:37,220 --> 00:04:34,140
it's not surprising that those are the

109
00:04:39,860 --> 00:04:37,230
kinds of environments that my field site

110
00:04:42,560 --> 00:04:39,870
is attempting to study in my study is

111
00:04:45,500 --> 00:04:42,570
attempting to learn more about in the

112
00:04:47,330 --> 00:04:45,510
field site so we are attempting to

113
00:04:48,770 --> 00:04:47,340

address some of these ideas about

114
00:04:51,440 --> 00:04:48,780
preservation potential through

115
00:04:54,020 --> 00:04:51,450
diagenesis in this field site which is

116
00:04:55,850 --> 00:04:54,030
called Verde Valley Arizona like I said

117
00:04:59,360 --> 00:04:55,860
it's a couple hours away from Arizona

118
00:05:01,370 --> 00:04:59,370
State University until a Custer an

119
00:05:03,080 --> 00:05:01,380
environment which means it was once a

120
00:05:06,250 --> 00:05:03,090
standing body of water a lake

121
00:05:09,740 --> 00:05:06,260
essentially high in these evaporite

122
00:05:11,720 --> 00:05:09,750
minerals and it's conveniently very

123
00:05:14,210 --> 00:05:11,730
similar to where we are right now with

124
00:05:16,340 --> 00:05:14,220
the Mars Science Laboratory on Gale

125
00:05:19,100 --> 00:05:16,350
Crater Mars and that little star there

126
00:05:20,750 --> 00:05:19,110
and the Mars community has also been

127
00:05:23,000 --> 00:05:20,760
telling us for quite some time you know

128
00:05:25,040 --> 00:05:23,010
they've been recommending going to these

129
00:05:28,210 --> 00:05:25,050
evaporate rich lacustrine environments

130
00:05:30,260 --> 00:05:28,220
because they they seem to be good

131
00:05:34,700 --> 00:05:30,270
environments to study for bio signature

132
00:05:38,960 --> 00:05:34,710
preservation potential so what we wanted

133
00:05:41,810 --> 00:05:38,970
to do in our study is kind of define

134
00:05:43,490 --> 00:05:41,820
this long-term model of bio signature

135
00:05:46,070 --> 00:05:43,500
preservation potential and how it

136
00:05:48,380 --> 00:05:46,080
changes over time in one of these

137
00:05:51,530 --> 00:05:48,390
environments that has undergone a lot of

138
00:05:53,210 --> 00:05:51,540

die genetic alteration and see if we can

139
00:05:55,670 --> 00:05:53,220
actually you know create a model of this

140
00:05:57,800 --> 00:05:55,680
system so we've been out to the field a

141
00:05:59,990 --> 00:05:57,810
couple times that's my advisor Jack

142
00:06:01,790 --> 00:06:00,000
farmer climbing up a little hill like a

143
00:06:05,810 --> 00:06:01,800
kid in a candy store looking at all the

144
00:06:07,010 --> 00:06:05,820
exciting evaporating minerals we took

145
00:06:08,860 --> 00:06:07,020
the samples back to the lab of course

146
00:06:10,850 --> 00:06:08,870
every technique that we exposed them to

147
00:06:12,830 --> 00:06:10,860
requires different sample preparation

148
00:06:15,290 --> 00:06:12,840
and unfortunately I can't get into the

149
00:06:17,210 --> 00:06:15,300
details of all of that but the point is

150
00:06:19,610 --> 00:06:17,220
we exposed it to actually five our

151
00:06:22,550 --> 00:06:19,620
samples to actually five techniques so

152
00:06:24,070 --> 00:06:22,560
petrographic microscopy is basically

153
00:06:26,060 --> 00:06:24,080
when you have a thin section of your

154
00:06:29,180 --> 00:06:26,070
sample and you look at it under a

155
00:06:31,219 --> 00:06:29,190
petrographic microscope which allows you

156
00:06:33,500 --> 00:06:31,229
to see really pretty minerals and colors

157
00:06:35,990 --> 00:06:33,510
and textures and you can use different

158
00:06:37,730 --> 00:06:36,000
filters to basically understand how the

159
00:06:40,400 --> 00:06:37,740
minerals interact with each other and

160
00:06:41,450 --> 00:06:40,410
how the organics are actually preserved

161
00:06:43,490 --> 00:06:41,460
within those

162
00:06:45,920 --> 00:06:43,500
and so what you know how that system

163
00:06:48,469 --> 00:06:45,930

evolves over time what came first you

164
00:06:50,629 --> 00:06:48,479
know what mineral became altered to

165
00:06:53,480 --> 00:06:50,639
something else and what the organics are

166
00:06:55,400 --> 00:06:53,490
in and I'll show you another example of

167
00:06:58,850 --> 00:06:55,410
that on the next slide but it's actually

168
00:07:02,540 --> 00:06:58,860
a powerful technique x-ray diffraction

169
00:07:05,779 --> 00:07:02,550
xrd is a bulk mineralogy technique which

170
00:07:07,879 --> 00:07:05,789
basically allows you to get the main

171
00:07:12,260 --> 00:07:07,889
components mineralogical components of

172
00:07:14,839 --> 00:07:12,270
your system and raman spectroscopy now

173
00:07:16,310 --> 00:07:14,849
that's an important one because we are

174
00:07:18,770 --> 00:07:16,320
actually going to be sending not one but

175
00:07:22,150 --> 00:07:18,780
two raman instruments for the first time

176
00:07:25,460 --> 00:07:22,160
to Mars and the upcoming couple years

177
00:07:28,760 --> 00:07:25,470
european space agency's XO mars rover is

178
00:07:30,950 --> 00:07:28,770
going to have a raman instrument and i

179
00:07:34,610 --> 00:07:30,960
believe that's going up in 2018 and then

180
00:07:36,770 --> 00:07:34,620
the nasa 2020 Mars rover is going to

181
00:07:39,800 --> 00:07:36,780
have a similar type of instrument a UV

182
00:07:42,320 --> 00:07:39,810
robin going up for the first well for

183
00:07:43,700 --> 00:07:42,330
the second time to Mars so it now is a

184
00:07:46,370 --> 00:07:43,710
really good time to do these types of

185
00:07:48,560 --> 00:07:46,380
analogs that he's looking at you know

186
00:07:50,420 --> 00:07:48,570
Mars analog environments and exposing

187
00:07:51,620 --> 00:07:50,430
them to Raman spectroscopy and

188
00:07:54,920 --> 00:07:51,630

understanding these kinds of questions

189
00:07:57,379 --> 00:07:54,930
and if you want to look at bio signature

190
00:07:59,930 --> 00:07:57,389
preservation good general technique is

191
00:08:02,209 --> 00:07:59,940
also doing total organic carbon content

192
00:08:04,370 --> 00:08:02,219
and basically what you do is you combust

193
00:08:07,070 --> 00:08:04,380
your sample and you count the carbon

194
00:08:08,899 --> 00:08:07,080
atoms that come off and you can you know

195
00:08:11,089 --> 00:08:08,909
look at the different phases and you're

196
00:08:12,830 --> 00:08:11,099
in your system and compare like use it

197
00:08:15,499 --> 00:08:12,840
as a comparative technique to say you

198
00:08:17,480 --> 00:08:15,509
know this mineral phase has higher lower

199
00:08:19,070 --> 00:08:17,490
total organic carbon to your see then

200
00:08:22,459 --> 00:08:19,080
then another one so that's a good way of

201
00:08:24,379 --> 00:08:22,469
kind of gauging relatively and with that

202
00:08:27,439 --> 00:08:24,389
picture is actually under the TOC is is

203
00:08:30,860 --> 00:08:27,449
an electro electron microprobe carbon

204
00:08:33,350 --> 00:08:30,870
map so electron microprobe allows you to

205
00:08:36,050 --> 00:08:33,360
map two-dimensional surfaces on a thin

206
00:08:37,909 --> 00:08:36,060
section and basically get elemental

207
00:08:40,370 --> 00:08:37,919
abundances so that's a carbon map so the

208
00:08:43,490 --> 00:08:40,380
red areas are lighting up and high in

209
00:08:45,440 --> 00:08:43,500
carbon and so I kind of want a couple

210
00:08:46,990 --> 00:08:45,450
these techniques integrated produce

211
00:08:48,800 --> 00:08:47,000
integrated data sweet looking at

212
00:08:51,079 --> 00:08:48,810
preservation potential along the

213
00:08:53,300 --> 00:08:51,089

different and member phases in my system

214
00:08:55,130 --> 00:08:53,310
and see if they compared to the TOC s

215
00:08:58,340 --> 00:08:55,140
that we're getting

216
00:09:00,770 --> 00:08:58,350
I'm still kind of working on that and so

217
00:09:02,510 --> 00:09:00,780
even though this is preliminary we're

218
00:09:05,690 --> 00:09:02,520
already seeing a very complex diagenetic

219
00:09:07,250 --> 00:09:05,700
sequence in this environment what we

220
00:09:09,770 --> 00:09:07,260
knew about it was that there was a

221
00:09:13,100 --> 00:09:09,780
volcano that damned the Verde River

222
00:09:16,490 --> 00:09:13,110
which then produced the lacustrine area

223
00:09:18,470 --> 00:09:16,500
that might that the very basin is in the

224
00:09:20,060 --> 00:09:18,480
first minerals to come out of that

225
00:09:21,890 --> 00:09:20,070
system were to precipitate were

226
00:09:23,660 --> 00:09:21,900
carbonates so when we put those

227
00:09:26,600 --> 00:09:23,670
carbonates which is which are these like

228
00:09:28,160 --> 00:09:26,610
darker areas when we looked at them

229
00:09:30,800 --> 00:09:28,170
under the petrographic microscope we

230
00:09:34,150 --> 00:09:30,810
were seeing these regions here which are

231
00:09:36,470 --> 00:09:34,160
actually gypsum so calcium sulfate

232
00:09:37,910 --> 00:09:36,480
interacting with these veins of some

233
00:09:40,340 --> 00:09:37,920
fluid that went through the system and

234
00:09:42,260 --> 00:09:40,350
then when we looked a little closer at

235
00:09:46,070 --> 00:09:42,270
those cavities we were actually seeing

236
00:09:48,110 --> 00:09:46,080
these recrystallized smaller sulfates

237
00:09:51,350 --> 00:09:48,120
within that system so that's actually

238
00:09:54,230 --> 00:09:51,360

telling us that the gypsum that was

239
00:09:56,540 --> 00:09:54,240
primarily there was dissolved and then

240
00:09:58,960 --> 00:09:56,550
something some other sulfates

241
00:10:01,220 --> 00:09:58,970
recrystallized in the place of these

242
00:10:03,650 --> 00:10:01,230
previous gypsum areas in these cavities

243
00:10:05,780 --> 00:10:03,660
so again we're seeing alteration but

244
00:10:08,990 --> 00:10:05,790
then when we put these little areas

245
00:10:11,840 --> 00:10:09,000
under the raman system we were actually

246
00:10:14,150 --> 00:10:11,850
seeing interesting excess trace elements

247
00:10:15,980 --> 00:10:14,160
specifically strontium in our system and

248
00:10:17,750 --> 00:10:15,990
we think they're forming some sort of

249
00:10:20,840 --> 00:10:17,760
solid solution with some of the other

250
00:10:23,300 --> 00:10:20,850
sulfates and and and there of course

251
00:10:24,890 --> 00:10:23,310
other diagenetic pathways but the

252
00:10:27,140 --> 00:10:24,900
question is can we model you know

253
00:10:32,210 --> 00:10:27,150
carriage and preservation through these

254
00:10:33,410 --> 00:10:32,220
different types of sequences and so

255
00:10:35,960 --> 00:10:33,420
another interesting thing about the

256
00:10:37,850 --> 00:10:35,970
raman analysis was that when i looked at

257
00:10:39,830 --> 00:10:37,860
that region within the cavity that i

258
00:10:41,330 --> 00:10:39,840
just showed you on the tube so when I

259
00:10:44,300 --> 00:10:41,340
looked at it under ROM and I saw

260
00:10:46,520 --> 00:10:44,310
something like this the two dark spectra

261
00:10:49,310 --> 00:10:46,530
are my that same area and they're the

262
00:10:51,590 --> 00:10:49,320
same spectra I'm just sort of splitting

263
00:10:53,090 --> 00:10:51,600

up the the raman plot into two so you

264
00:10:54,770 --> 00:10:53,100
can see the different vibrational modes

265
00:10:56,720 --> 00:10:54,780
raman gives you information about

266
00:10:59,000 --> 00:10:56,730
basically the components in your system

267
00:11:02,060 --> 00:10:59,010
based on their vibrational modes so i'm

268
00:11:04,460 --> 00:11:02,070
in part of the spectrum i'm seeing more

269
00:11:08,780 --> 00:11:04,470
of a sulfate i'm sorry a calcium sodium

270
00:11:10,220 --> 00:11:08,790
strontium sulfate system and the

271
00:11:12,920 --> 00:11:10,230
because the green the colored ones are

272
00:11:15,620 --> 00:11:12,930
the database matches so that's matching

273
00:11:17,570 --> 00:11:15,630
closer to that whereas the same sample

274
00:11:19,880 --> 00:11:17,580
and other spots of the spectrum matches

275
00:11:21,890 --> 00:11:19,890
more of sodium sulfate system which is

276
00:11:23,840 --> 00:11:21,900
again saying something about the Paleo

277
00:11:26,930 --> 00:11:23,850
environment and the question is what and

278
00:11:30,470 --> 00:11:26,940
can rum and be used as a proxy for paleo

279
00:11:33,020 --> 00:11:30,480
environments so that's sort of the next

280
00:11:35,030 --> 00:11:33,030
step of this study to investigate that a

281
00:11:36,860 --> 00:11:35,040
little more and to recommend to the

282
00:11:39,170 --> 00:11:36,870
community doing studies like this you

283
00:11:42,170 --> 00:11:39,180
know we should be using more non end

284
00:11:44,180 --> 00:11:42,180
member non pure pure sodium or pure

285
00:11:47,030 --> 00:11:44,190
strontium sulfate systems but you know

286
00:11:49,670 --> 00:11:47,040
solid solution system something more in

287
00:11:52,430 --> 00:11:49,680
between to look at realistic data sets

288
00:11:57,800 --> 00:11:52,440

in preparation for ramen studies on Mars

289
00:11:59,840 --> 00:11:57,810
and I'm going to leave my summary

290
00:12:23,100 --> 00:11:59,850
conclusions up while I take questions

291
00:12:30,550 --> 00:12:26,830
really no one so this is really

292
00:12:32,200 --> 00:12:30,560
interesting and I'm curious so you're

293
00:12:35,680 --> 00:12:32,210
talking about the the preservation of

294
00:12:38,800 --> 00:12:35,690
these sort of diagenetic well through

295
00:12:40,540 --> 00:12:38,810
die genesis these signatures do you have

296
00:12:43,810 --> 00:12:40,550
so you showed some of the preliminary

297
00:12:45,310 --> 00:12:43,820
sort of steps as what this sample goes

298
00:12:48,430 --> 00:12:45,320
through do you have some preliminary

299
00:12:50,260 --> 00:12:48,440
results but like I guess you do see

300
00:12:54,670 --> 00:12:50,270
kerogen in these samples and you do have

301
00:12:57,210 --> 00:12:54,680
preservation so we actually did the TOC

302
00:13:00,250 --> 00:12:57,220
through the combustion technique and

303
00:13:02,020 --> 00:13:00,260
along this whole system of samples that

304
00:13:04,870 --> 00:13:02,030
we've collected we're actually seeing

305
00:13:07,200 --> 00:13:04,880
the most preservation the highest TOC in

306
00:13:10,020 --> 00:13:07,210
the carbonates so in the surrounding

307
00:13:12,220 --> 00:13:10,030
matrix where all of these different

308
00:13:14,710 --> 00:13:12,230
sulfates and other evaporates are

309
00:13:16,780 --> 00:13:14,720
crystallizing with it which isn't really

310
00:13:20,830 --> 00:13:16,790
surprising I guess the hypothesis there

311
00:13:22,390 --> 00:13:20,840
would be as these these other evaporated

312
00:13:24,100 --> 00:13:22,400
phases are crystallizing and

313
00:13:27,660 --> 00:13:24,110

recrystallizing within the carbonates

314
00:13:29,980 --> 00:13:27,670
they're actually encapsulating less

315
00:13:32,380 --> 00:13:29,990
organics and so the organics are

316
00:13:35,740 --> 00:13:32,390
actually you know staying remained in

317
00:13:38,500 --> 00:13:35,750
the in the carbonates so that's the

318
00:13:39,730 --> 00:13:38,510
place to look for the bio signatures so

319
00:13:44,470 --> 00:13:39,740
where would be fun where would we find

320
00:13:47,860 --> 00:13:44,480
the carbonates on Mars yeah that's kind

321
00:13:49,680 --> 00:13:47,870
of a trick question um that's still

322
00:13:53,800 --> 00:13:49,690
under sorry 23 under the bus on that one

323
00:13:56,740 --> 00:13:53,810
hahaha to find a carbonates on bars any