Explorigins 2022 Colloquium

Feb. 17th

Poster session

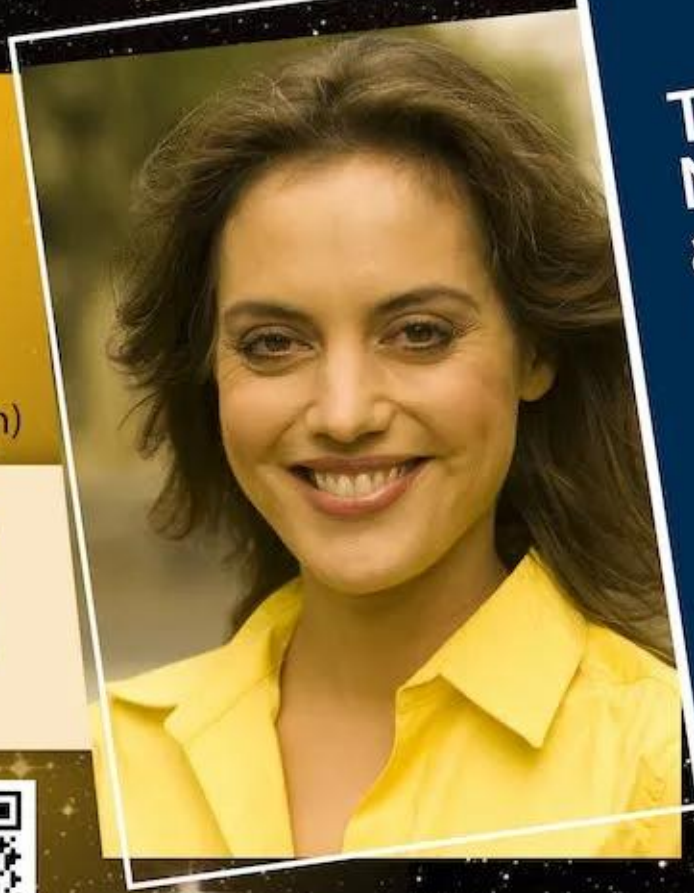
5 - 6 p.m. EST
MoSE 3rd & 4th fl. atriums

Feb. 18th

Oral Session

10 a.m. - 3:45 p.m. EST
BlueJeans (virtual) and
Suddath Rm, IBB (GA Tech)

Come hear from early carreer individuals who explore, conceptualize, celebrate, and discover pieces of space, life's origins, and astrobiology



Keynote:

Dr. **Amy Mainzer**
U. Arizona

Talk: "Don't Look Up: Near-Earth Asteroids and Comets"

Feb. 18th, virtual, 1-2 p.m. EST

- PI of NASA's Near-Earth Wide-Field Infrared Survey Explorer (NEOWISE)
- Lead of NASA's Near-Earth Object (NEO) Surveyor
- Netflix's *Don't Look Up* Science Consultant
- PBS's *Ready Jet Go!* host and executive producer

<<< Register

Schedule and more info >>>

Georgia Tech Astrobiology | C-STAR

1
00:00:03,110 --> 00:00:01,670
really cool opportunity for anyone who's

2
00:00:04,870 --> 00:00:03,120
interested in astrobiology here at

3
00:00:05,749 --> 00:00:04,880
georgia tech and i highly encourage you

4
00:00:07,269 --> 00:00:05,759
all

5
00:00:09,589 --> 00:00:07,279
to apply if that's what you're

6
00:00:12,470 --> 00:00:09,599
interested in

7
00:00:14,629 --> 00:00:12,480
all right so this is our program uh for

8
00:00:16,310 --> 00:00:14,639
the day uh we're going to be having a

9
00:00:17,510 --> 00:00:16,320
few sections of talks with breaks in

10
00:00:19,109 --> 00:00:17,520
between

11
00:00:21,189 --> 00:00:19,119
we'll have a lunch break and then a

12
00:00:23,990 --> 00:00:21,199
keynote talk and then later in the

13
00:00:26,230 --> 00:00:24,000

afternoon we'll have a third

14
00:00:28,310 --> 00:00:26,240
section of talks followed by

15
00:00:29,509 --> 00:00:28,320
our astrobiology certificate ceremony

16
00:00:31,830 --> 00:00:29,519
and closing

17
00:00:33,750 --> 00:00:31,840
so just to talk a little bit about that

18
00:00:37,190 --> 00:00:33,760
the astrobiology certificate is an

19
00:00:39,030 --> 00:00:37,200
academic certificate that you can obtain

20
00:00:39,830 --> 00:00:39,040
as a graduate student here at georgia

21
00:00:40,790 --> 00:00:39,840
tech

22
00:00:42,470 --> 00:00:40,800
and

23
00:00:44,310 --> 00:00:42,480
we have several people who have

24
00:00:46,389 --> 00:00:44,320
completed that process over the past

25
00:00:49,670 --> 00:00:46,399
year or so we're starting to use this

26
00:00:51,510 --> 00:00:49,680
colloquium as an opportunity to

27
00:00:53,110 --> 00:00:51,520
recognize those who have completed that

28
00:00:55,029 --> 00:00:53,120
certificate so

29
00:00:55,910 --> 00:00:55,039
that will be happening at the end of the

30
00:00:59,830 --> 00:00:55,920
event

31
00:01:01,510 --> 00:00:59,840
we'll have uh several talks here some of

32
00:01:03,910 --> 00:01:01,520
which are virtual some of which are in

33
00:01:06,310 --> 00:01:03,920
person and for those who of you who are

34
00:01:08,310 --> 00:01:06,320
joining us online uh we welcome you and

35
00:01:10,789 --> 00:01:08,320
we hope that uh these talks will be

36
00:01:13,510 --> 00:01:10,799
interesting to all of you

37
00:01:15,749 --> 00:01:13,520
i think that's all i have

38
00:01:18,390 --> 00:01:15,759

yep so i'm gonna go ahead and hand it

39
00:01:23,670 --> 00:01:18,400
over to uh christina and we'll go ahead

40
00:01:30,230 --> 00:01:27,190
awesome can everybody hear me

41
00:01:32,950 --> 00:01:30,240
cool so our first talk of the morning

42
00:01:36,230 --> 00:01:32,960
there our first section is kind of a

43
00:01:37,270 --> 00:01:36,240
mixture of different uh research topics

44
00:01:39,429 --> 00:01:37,280
from

45
00:01:41,670 --> 00:01:39,439
a bunch of different

46
00:01:44,469 --> 00:01:41,680
fields so we're going to be having a

47
00:01:45,910 --> 00:01:44,479
short session on clathrates cubesats and

48
00:01:48,069 --> 00:01:45,920
characterization

49
00:01:49,910 --> 00:01:48,079
and the first presenter of the morning

50
00:01:51,830 --> 00:01:49,920
is abigail johnson

51
00:01:54,469 --> 00:01:51,840
with her talk bacterial clathrate

52
00:01:57,510 --> 00:01:54,479
binding proteins in the deep subsurface

53
00:01:59,510 --> 00:01:57,520
biosphere implications for gas clathrate

54
00:02:02,069 --> 00:01:59,520
stability and habitability

55
00:02:03,990 --> 00:02:02,079
and we'll be uh doing some questions at

56
00:02:07,510 --> 00:02:04,000
the end of this

57
00:02:09,990 --> 00:02:07,520
talk so if you are an in-person person

58
00:02:11,910 --> 00:02:10,000
uh just raise your hand at the end if

59
00:02:13,110 --> 00:02:11,920
you're attending through blue jeans or

60
00:02:15,190 --> 00:02:13,120
through youtube

61
00:02:17,910 --> 00:02:15,200
please just leave a comment there and

62
00:02:37,910 --> 00:02:17,920
we'll get to questions as time allows

63
00:02:37,920 --> 00:02:42,150

hello can you hear and see me

64
00:02:49,430 --> 00:02:45,030
um one second let me

65
00:02:49,440 --> 00:03:06,710
and

66
00:03:06,720 --> 00:03:19,350
hello hello

67
00:03:25,509 --> 00:03:23,670
hmm it looks like we have uh one

68
00:03:27,670 --> 00:03:25,519
some screens are displaying your

69
00:03:30,630 --> 00:03:27,680
presentation but some are not so one

70
00:03:30,640 --> 00:03:35,350
no problem can you hear me

71
00:04:07,190 --> 00:03:38,309
yes indeed we can okay that's that's

72
00:04:12,390 --> 00:04:09,830
all right looks like everybody online

73
00:04:15,429 --> 00:04:12,400
can see your presentation just fine

74
00:04:17,189 --> 00:04:15,439
so i will just pull it up here and

75
00:04:19,030 --> 00:04:17,199
the in-person people will just cycle

76
00:04:21,430 --> 00:04:19,040
through manually

77
00:04:24,390 --> 00:04:21,440
beautiful

78
00:04:28,390 --> 00:04:24,400
ah perfect go ahead

79
00:04:29,749 --> 00:04:28,400
all right uh well again my name is abby

80
00:04:30,790 --> 00:04:29,759
johnson

81
00:04:33,590 --> 00:04:30,800
my

82
00:04:36,310 --> 00:04:33,600
advisor is jennifer glass and i am in

83
00:04:38,870 --> 00:04:36,320
the ocean science and engineering phd

84
00:04:40,710 --> 00:04:38,880
program i'm actually the first cohort of

85
00:04:45,430 --> 00:04:40,720
that program and i'm now in my fifth

86
00:04:48,230 --> 00:04:45,440
year so i am actually defending in april

87
00:04:49,670 --> 00:04:48,240
so this is my last explorations i've had

88
00:04:51,350 --> 00:04:49,680

a great time

89
00:04:55,030 --> 00:04:51,360
and i look forward to seeing where this

90
00:05:01,670 --> 00:04:58,150
so first gas clathrates are also known

91
00:05:04,310 --> 00:05:01,680
as uh gas hydrates and these are pages

92
00:05:06,870 --> 00:05:04,320
of water molecules that trap guest gas

93
00:05:09,029 --> 00:05:06,880
molecules so methane clathrates or

94
00:05:11,029 --> 00:05:09,039
methane hydrates are cages of water

95
00:05:12,230 --> 00:05:11,039
molecules that trap guests methane

96
00:05:14,950 --> 00:05:12,240
molecules

97
00:05:17,430 --> 00:05:14,960
and and so these structures form under

98
00:05:20,230 --> 00:05:17,440
high pressure and low temperature and

99
00:05:22,230 --> 00:05:20,240
where there's plenty of gas and on the

100
00:05:25,110 --> 00:05:22,240
left you can see the structure of

101
00:05:26,469 --> 00:05:25,120
methane clathrate it kind of looks like

102
00:05:29,590 --> 00:05:26,479
water ice

103
00:05:32,230 --> 00:05:29,600
it has similar physical properties as

104
00:05:35,029 --> 00:05:32,240
water ice it probably tastes like water

105
00:05:38,710 --> 00:05:35,039
ice except it's flammable and only is

106
00:05:40,550 --> 00:05:38,720
stable at high pressures

107
00:05:42,390 --> 00:05:40,560
methane clathrates are found along

108
00:05:45,510 --> 00:05:42,400
continental margins in and under the

109
00:05:47,830 --> 00:05:45,520
perm in and under permafrost excuse me

110
00:05:49,590 --> 00:05:47,840
and that's represented by this darker

111
00:05:50,629 --> 00:05:49,600
blue color right along the continental

112
00:05:52,790 --> 00:05:50,639
margins

113
00:05:54,230 --> 00:05:52,800

and in this little bar graph you can see

114
00:05:57,510 --> 00:05:54,240
that there are

115
00:06:00,390 --> 00:05:57,520
gigatons more uh gas

116
00:06:02,390 --> 00:06:00,400
coming from the gas clathrates than our

117
00:06:03,270 --> 00:06:02,400
current fossil fuel reserves so they're

118
00:06:05,350 --> 00:06:03,280
um

119
00:06:07,350 --> 00:06:05,360
hi abigail sorry to interrupt uh

120
00:06:09,990 --> 00:06:07,360
unfortunately it looks like online your

121
00:06:11,510 --> 00:06:10,000
slides aren't cycling would you mind

122
00:06:12,309 --> 00:06:11,520
stopping sharing and then sharing it

123
00:06:20,309 --> 00:06:12,319
again

124
00:06:20,319 --> 00:06:23,029
uh

125
00:06:23,039 --> 00:06:28,710
here let's go with that

126
00:06:37,430 --> 00:06:31,110
i tried a different share mode

127
00:06:42,230 --> 00:06:39,909
do you just double check going to the

128
00:06:48,710 --> 00:06:42,240
next slide and then coming back yeah

129
00:06:51,270 --> 00:06:49,990
um

130
00:06:53,749 --> 00:06:51,280
let's see

131
00:06:54,150 --> 00:06:53,759
okay it looks like

132
00:06:56,550 --> 00:06:54,160
on

133
00:06:58,629 --> 00:06:56,560
[Music]

134
00:07:01,189 --> 00:06:58,639
blue jeans it might be working

135
00:07:03,029 --> 00:07:01,199
and let me just double check i don't

136
00:07:03,909 --> 00:07:03,039
know if that's working on youtube just

137
00:07:08,950 --> 00:07:03,919
yet

138
00:07:13,350 --> 00:07:11,270

ah perfect now that's working thanks so

139
00:07:18,070 --> 00:07:13,360
much for your patience yeah of course

140
00:07:21,909 --> 00:07:20,710
all right can i go

141
00:07:23,189 --> 00:07:21,919
you're good to go

142
00:07:25,270 --> 00:07:23,199
awesome

143
00:07:28,550 --> 00:07:25,280
all right

144
00:07:30,790 --> 00:07:28,560
um and so i'll just briefly repeat

145
00:07:33,909 --> 00:07:30,800
myself that the

146
00:07:36,710 --> 00:07:33,919
figure on the right is a map of where

147
00:07:38,469 --> 00:07:36,720
methane clathrates are found um and

148
00:07:39,510 --> 00:07:38,479
there's that bar graph and the bottom

149
00:07:40,710 --> 00:07:39,520
left

150
00:07:42,070 --> 00:07:40,720
showing that

151
00:07:45,510 --> 00:07:42,080
gas from

152
00:07:48,150 --> 00:07:45,520
gas clathrate store gigatons more um

153
00:07:49,350 --> 00:07:48,160
carbon than our other uh fossil fuel

154
00:07:52,070 --> 00:07:49,360
reserves

155
00:07:55,830 --> 00:07:52,080
which um means that gas cloth rates are

156
00:07:57,589 --> 00:07:55,840
point of interest for energy utilization

157
00:08:00,390 --> 00:07:57,599
and on the left is just a pretty picture

158
00:08:02,309 --> 00:08:00,400
of methane clathrate

159
00:08:04,710 --> 00:08:02,319
and what y'all are probably most

160
00:08:06,790 --> 00:08:04,720
interested in is that methane clathrates

161
00:08:07,990 --> 00:08:06,800
are predicted to be on other planetary

162
00:08:10,629 --> 00:08:08,000
bodies

163
00:08:14,070 --> 00:08:10,639

and on the left you can see the possible

164
00:08:15,110 --> 00:08:14,080
methane sources and sinks on mars

165
00:08:17,189 --> 00:08:15,120
and

166
00:08:19,749 --> 00:08:17,199
there's this nice

167
00:08:21,430 --> 00:08:19,759
methane clathrate storage predicted to

168
00:08:23,830 --> 00:08:21,440
be in the subsurface

169
00:08:26,790 --> 00:08:23,840
and the methane coming

170
00:08:29,990 --> 00:08:26,800
to that is perhaps sourced from

171
00:08:31,350 --> 00:08:30,000
some sort of methanogenesis or perhaps a

172
00:08:33,430 --> 00:08:31,360
water rock reaction called

173
00:08:36,149 --> 00:08:33,440
serpentinization

174
00:08:38,550 --> 00:08:36,159
um they're they're also predicted to be

175
00:08:40,630 --> 00:08:38,560
on uh pluto and you can see the

176
00:08:42,790 --> 00:08:40,640
schematic of the cross section where

177
00:08:43,990 --> 00:08:42,800
there's a clathrate hydrate

178
00:08:47,110 --> 00:08:44,000
uh

179
00:08:51,110 --> 00:08:47,120
layer that caps and actually stabilizes

180
00:08:57,269 --> 00:08:54,150
uh so back here on earth we have this um

181
00:09:00,150 --> 00:08:57,279
pretty bit big issue where natural gas

182
00:09:01,590 --> 00:09:00,160
clathrates actually cog clog natural gas

183
00:09:03,910 --> 00:09:01,600
pipelines

184
00:09:05,269 --> 00:09:03,920
and this is pretty can be pretty tragic

185
00:09:07,190 --> 00:09:05,279
it was the cause of the deep water

186
00:09:09,350 --> 00:09:07,200
horizon oil spill

187
00:09:12,070 --> 00:09:09,360
and so some of the solutions that we use

188
00:09:14,550 --> 00:09:12,080

now is using gas clathrate inhibitors so

189
00:09:17,670 --> 00:09:14,560
that could be a thermodynamic inhibitor

190
00:09:20,230 --> 00:09:17,680
like methanol or even a kinetic

191
00:09:23,910 --> 00:09:20,240
clathrate inhibitor like pvp that stands

192
00:09:25,590 --> 00:09:23,920
for polyvinyl pyrolidone

193
00:09:28,150 --> 00:09:25,600
and there has since

194
00:09:30,630 --> 00:09:28,160
recently been a shift towards more

195
00:09:32,630 --> 00:09:30,640
environmentally friendly inhibitors

196
00:09:35,910 --> 00:09:32,640
and that's where anti-freeze proteins

197
00:09:37,910 --> 00:09:35,920
come in so afps anti-freeze proteins

198
00:09:40,310 --> 00:09:37,920
have actually been tested as pretty

199
00:09:43,030 --> 00:09:40,320
effective gas clathrate inhibitors to

200
00:09:45,350 --> 00:09:43,040
prevent that pipeline clogging

201
00:09:46,949 --> 00:09:45,360
and so these could be called the green

202
00:09:49,670 --> 00:09:46,959
clathrate inhibitor

203
00:09:51,110 --> 00:09:49,680
and afps come in all shapes and sizes

204
00:09:53,910 --> 00:09:51,120
and

205
00:09:56,070 --> 00:09:53,920
the type 1 afp is most interesting for

206
00:09:57,190 --> 00:09:56,080
my research it's this alpha helical very

207
00:09:58,630 --> 00:09:57,200
small

208
00:09:59,990 --> 00:09:58,640
protein that's found in the winter

209
00:10:02,870 --> 00:10:00,000
flounder fish

210
00:10:04,389 --> 00:10:02,880
there's this type 3 afp

211
00:10:06,230 --> 00:10:04,399
that's a little bit different

212
00:10:08,710 --> 00:10:06,240
uh of a structure and it's found in the

213
00:10:11,750 --> 00:10:08,720

eel pouch and there's this

214
00:10:13,750 --> 00:10:11,760
uh mealworm beetle tm afp that's a beta

215
00:10:17,110 --> 00:10:13,760
solenoid shape

216
00:10:17,829 --> 00:10:17,120
and the purpose of all of these afps

217
00:10:25,350 --> 00:10:17,839
in

218
00:10:27,509 --> 00:10:25,360
ice crystals to allow these organisms to

219
00:10:32,630 --> 00:10:27,519
survive at sub-zero temperatures so it

220
00:10:37,430 --> 00:10:35,430
as you saw afps are structurally diverse

221
00:10:40,389 --> 00:10:37,440
um they're also very evolutionarily

222
00:10:42,550 --> 00:10:40,399
diverse so here's a tree of life and all

223
00:10:44,550 --> 00:10:42,560
of these symbols represent excuse me

224
00:10:47,110 --> 00:10:44,560
represent different structures so

225
00:10:49,750 --> 00:10:47,120
they're found in fish insects

226
00:10:51,990 --> 00:10:49,760
plants bacteria etc

227
00:10:54,630 --> 00:10:52,000
pretty impressive

228
00:10:57,350 --> 00:10:54,640
and the way these things work is that

229
00:10:59,110 --> 00:10:57,360
the proton proteins represented as

230
00:11:01,829 --> 00:10:59,120
little red dots

231
00:11:03,590 --> 00:11:01,839
lowers the freezing point and slightly

232
00:11:05,750 --> 00:11:03,600
elevates the melting point and that's

233
00:11:07,110 --> 00:11:05,760
because when the proteins bind near each

234
00:11:10,150 --> 00:11:07,120
other on one

235
00:11:12,310 --> 00:11:10,160
plane of the ice crystal

236
00:11:14,310 --> 00:11:12,320
a localized curvature

237
00:11:15,710 --> 00:11:14,320
will occur

238
00:11:18,230 --> 00:11:15,720

uh and that makes it less

239
00:11:19,750 --> 00:11:18,240
thermodynamically favorable to add more

240
00:11:23,030 --> 00:11:19,760
ice onto

241
00:11:25,110 --> 00:11:23,040
so that lowers the freezing point

242
00:11:27,750 --> 00:11:25,120
and it was that alpha helical protein

243
00:11:30,150 --> 00:11:27,760
the type 1 afps that were found to

244
00:11:31,910 --> 00:11:30,160
inhibit gas clathrates most effectively

245
00:11:34,310 --> 00:11:31,920
out of all the afps

246
00:11:35,509 --> 00:11:34,320
and this image is of a molecular

247
00:11:37,030 --> 00:11:35,519
dynamics

248
00:11:39,670 --> 00:11:37,040
study

249
00:11:41,590 --> 00:11:39,680
simulation showing that it's the pendant

250
00:11:44,470 --> 00:11:41,600
methyl groups of this

251
00:11:47,190 --> 00:11:44,480
threonine alanine alanine motif that

252
00:11:51,990 --> 00:11:47,200
actually gets inserted into the empty

253
00:11:57,269 --> 00:11:54,629
so we know that there are

254
00:11:58,870 --> 00:11:57,279
ice dwelling organisms that have evolved

255
00:12:00,069 --> 00:11:58,880
ice binding

256
00:12:03,030 --> 00:12:00,079
proteins

257
00:12:05,990 --> 00:12:03,040
and there are microbes living in gas

258
00:12:07,750 --> 00:12:06,000
clathrates so our question is do these

259
00:12:11,430 --> 00:12:07,760
microbes produce

260
00:12:13,750 --> 00:12:11,440
gas cloth rate binding protein

261
00:12:15,670 --> 00:12:13,760
our hypothesis is that bacterial

262
00:12:18,710 --> 00:12:15,680
proteins from methane clathrate-bearing

263
00:12:20,949 --> 00:12:18,720

sediment metagenomes are optimized for

264
00:12:25,430 --> 00:12:20,959
binding to gas clathrates and we would

265
00:12:28,069 --> 00:12:25,440
call these clothing binding proteins

266
00:12:30,389 --> 00:12:28,079
so we have sequenced microbial dna from

267
00:12:32,389 --> 00:12:30,399
clathrate-bearing sediment cores off the

268
00:12:33,990 --> 00:12:32,399
coast of oregon here in hydrate ridge

269
00:12:36,389 --> 00:12:34,000
and off the coast of japan in the

270
00:12:40,389 --> 00:12:36,399
shimokita peninsula

271
00:12:42,230 --> 00:12:40,399
and we have uh metagenomic data which is

272
00:12:44,150 --> 00:12:42,240
if you don't know dna from the entire

273
00:12:46,710 --> 00:12:44,160
microbial community

274
00:12:49,190 --> 00:12:46,720
and we found that those type 1 afps

275
00:12:51,750 --> 00:12:49,200
those short alpha helical proteins were

276
00:12:54,870 --> 00:12:51,760
top hits to a few of our

277
00:12:57,269 --> 00:12:54,880
these bacterial proteins

278
00:12:59,430 --> 00:12:57,279
so we chose a few of those proteins to

279
00:13:05,190 --> 00:12:59,440
express recombinantly

280
00:13:10,629 --> 00:13:07,910
and we

281
00:13:12,870 --> 00:13:10,639
formed a type of clathrate not methane

282
00:13:15,910 --> 00:13:12,880
clathrate yet but a structure ii

283
00:13:18,310 --> 00:13:15,920
clathrate um tetrahydrofuran or thf

284
00:13:21,030 --> 00:13:18,320
clathrate in the presence of our

285
00:13:23,750 --> 00:13:21,040
putative clathrate binding proteins and

286
00:13:27,030 --> 00:13:23,760
we did this by machining this drainage

287
00:13:31,190 --> 00:13:27,040
capable beaker and we formed thf

288
00:13:33,750 --> 00:13:31,200

clathrate crystals in the presence of

289
00:13:35,750 --> 00:13:33,760
different protein treatments and then we

290
00:13:37,750 --> 00:13:35,760
extracted the remaining solution after

291
00:13:40,230 --> 00:13:37,760
the clathrin crystal had formed and

292
00:13:43,030 --> 00:13:40,240
we're left with a beautiful crystal

293
00:13:45,990 --> 00:13:43,040
so we tested a salt solution that all

294
00:13:48,870 --> 00:13:46,000
the other proteins were suspended in

295
00:13:51,350 --> 00:13:48,880
and then we tested negative controls

296
00:13:53,670 --> 00:13:51,360
including cytochrome c

297
00:13:55,590 --> 00:13:53,680
and the egfp the green fluorescent

298
00:13:57,509 --> 00:13:55,600
protein by itself because all of the

299
00:13:59,590 --> 00:13:57,519
cbps were

300
00:14:01,350 --> 00:13:59,600
expressed with a green fluorescent

301
00:14:03,269 --> 00:14:01,360
protein

302
00:14:05,189 --> 00:14:03,279
and then our positive control is the

303
00:14:07,350 --> 00:14:05,199
type 1 afp

304
00:14:08,629 --> 00:14:07,360
and of course our our

305
00:14:10,949 --> 00:14:08,639
dbps

306
00:14:13,350 --> 00:14:10,959
classroom binding proteins

307
00:14:15,750 --> 00:14:13,360
and what we found is that with the green

308
00:14:17,750 --> 00:14:15,760
fluorescent protein just by itself

309
00:14:19,750 --> 00:14:17,760
we got a thf clathrate crystal that

310
00:14:23,189 --> 00:14:19,760
looks like it grew with nothing else

311
00:14:25,030 --> 00:14:23,199
it's beautiful it's a cubic octahedron

312
00:14:27,189 --> 00:14:25,040
and then when we shine blue light on it

313
00:14:29,350 --> 00:14:27,199

it did not fluoresce indicating that the

314
00:14:32,870 --> 00:14:29,360
egfp did not bind because that's the

315
00:14:36,550 --> 00:14:32,880
wavelength at which efp fluoresces

316
00:14:39,189 --> 00:14:36,560
whereas the type one afp had a

317
00:14:40,629 --> 00:14:39,199
uh wildly different morphology it's more

318
00:14:42,069 --> 00:14:40,639
plate-like

319
00:14:43,829 --> 00:14:42,079
it's going in different directions and

320
00:14:45,590 --> 00:14:43,839
we think that's because the afp is

321
00:14:46,389 --> 00:14:45,600
binding to like one or two of the

322
00:14:48,550 --> 00:14:46,399
different

323
00:14:50,360 --> 00:14:48,560
planes of the cloth rate forcing growth

324
00:14:52,470 --> 00:14:50,370
in one or two directions

325
00:14:54,949 --> 00:14:52,480
[Music]

326
00:14:57,990 --> 00:14:54,959
and then cbp-3

327
00:15:00,870 --> 00:14:58,000
with the egfp and without the egfp

328
00:15:03,590 --> 00:15:00,880
resulted in a very similar morphology

329
00:15:04,629 --> 00:15:03,600
and when we shined light on the egfp

330
00:15:07,030 --> 00:15:04,639
version

331
00:15:10,949 --> 00:15:07,040
it did fluoresce indicating that the

332
00:15:14,389 --> 00:15:12,470
so now we can call them clathrate

333
00:15:15,509 --> 00:15:14,399
binding proteins for sure no longer

334
00:15:18,870 --> 00:15:15,519
putative

335
00:15:21,509 --> 00:15:18,880
and next we grew meth methane clathrate

336
00:15:24,870 --> 00:15:21,519
in the presence of those cbps but to do

337
00:15:28,949 --> 00:15:24,880
this we had to machine a high pressure

338
00:15:30,710 --> 00:15:28,959

cell and it is it looks like this um it

339
00:15:33,509 --> 00:15:30,720
is made of stainless steel it has a

340
00:15:35,670 --> 00:15:33,519
sapphire window so that we can observe a

341
00:15:38,230 --> 00:15:35,680
methane clathrate shell growing on a

342
00:15:41,269 --> 00:15:38,240
treatment droplet we have some valves to

343
00:15:43,189 --> 00:15:41,279
control pressure some transducers to

344
00:15:44,629 --> 00:15:43,199
monitor pressure and temperature

345
00:15:45,910 --> 00:15:44,639
throughout the entire duration of the

346
00:15:48,949 --> 00:15:45,920
experiment

347
00:15:50,069 --> 00:15:48,959
and to nucleate the hydrate the methane

348
00:15:52,829 --> 00:15:50,079
clathrate

349
00:15:55,189 --> 00:15:52,839
i increased the pressure to five

350
00:15:57,990 --> 00:15:55,199
megapascals and left that for a couple

351
00:16:00,069 --> 00:15:58,000
hours and then i decreased using uh dry

352
00:16:02,389 --> 00:16:00,079
ice the temperature down to

353
00:16:05,350 --> 00:16:02,399
about negative 10 degrees celsius or

354
00:16:06,870 --> 00:16:05,360
whenever the cloth radium created

355
00:16:09,829 --> 00:16:06,880
and we tested

356
00:16:10,710 --> 00:16:09,839
the pbs salt solution and cytochrome c

357
00:16:12,470 --> 00:16:10,720
as

358
00:16:15,670 --> 00:16:12,480
negative controls

359
00:16:17,670 --> 00:16:15,680
the type 1 afp and actually the pvp

360
00:16:19,189 --> 00:16:17,680
which is the commercial inhibitor as our

361
00:16:22,790 --> 00:16:19,199
positive controls

362
00:16:24,949 --> 00:16:22,800
and of course our cvp

363
00:16:27,749 --> 00:16:24,959

so we actually calculated gas

364
00:16:30,310 --> 00:16:27,759
consumption during depressurization and

365
00:16:33,189 --> 00:16:30,320
all this means is that

366
00:16:34,949 --> 00:16:33,199
it's basically indicative of how much

367
00:16:36,790 --> 00:16:34,959
cloth rate was formed

368
00:16:38,949 --> 00:16:36,800
and to calculate this

369
00:16:41,749 --> 00:16:38,959
we plotted pressure

370
00:16:45,590 --> 00:16:41,759
on the y-axis against temperature

371
00:16:48,389 --> 00:16:45,600
and it is an endothermic process when um

372
00:16:51,990 --> 00:16:48,399
clathrate melts and so the thermocouple

373
00:16:54,949 --> 00:16:52,000
will read a decrease in temperature so

374
00:16:57,749 --> 00:16:54,959
we basically note when melting visually

375
00:17:00,230 --> 00:16:57,759
began by this blue arrow and then as

376
00:17:01,430 --> 00:17:00,240
we're depressurizing

377
00:17:04,069 --> 00:17:01,440
the temperature

378
00:17:06,309 --> 00:17:04,079
decreases and then we have a melting

379
00:17:08,230 --> 00:17:06,319
peak or whenever visual melting ends and

380
00:17:10,069 --> 00:17:08,240
so that's our second point and from

381
00:17:13,270 --> 00:17:10,079
there we can calculate based on these

382
00:17:16,230 --> 00:17:13,280
two points gas consumption

383
00:17:18,390 --> 00:17:16,240
we also looked at morphology

384
00:17:21,029 --> 00:17:18,400
and so this is a droplet before

385
00:17:21,909 --> 00:17:21,039
clathrate forms you can see it's

386
00:17:24,870 --> 00:17:21,919
pretty

387
00:17:28,230 --> 00:17:24,880
clear uh transparent and a little bit

388
00:17:30,870 --> 00:17:28,240

reflective whereas after clathrate forms

389
00:17:34,390 --> 00:17:30,880
it's no longer uh reflective and it's

390
00:17:37,029 --> 00:17:35,510
and so

391
00:17:40,230 --> 00:17:37,039
here i'm going to share with you the gas

392
00:17:42,310 --> 00:17:40,240
consumption data so gas consumed is on

393
00:17:46,310 --> 00:17:42,320
the x-axis and all the different

394
00:17:50,789 --> 00:17:46,320
treatments are on the y-axis um

395
00:17:53,750 --> 00:17:50,799
and so this is all uh each individual

396
00:17:56,390 --> 00:17:53,760
dot represents a trial

397
00:17:58,830 --> 00:17:56,400
and that gray oval just

398
00:18:01,590 --> 00:17:58,840
is showing the spread of the data per

399
00:18:03,029 --> 00:18:01,600
treatment and so what we found here was

400
00:18:05,750 --> 00:18:03,039
that pbs

401
00:18:06,789 --> 00:18:05,760
cytochrome and type 1 afp

402
00:18:08,390 --> 00:18:06,799
pretty much

403
00:18:11,669 --> 00:18:08,400
um

404
00:18:15,190 --> 00:18:11,679
lied in this laid in like the same

405
00:18:17,750 --> 00:18:15,200
region of gas consumed and so we would

406
00:18:20,710 --> 00:18:17,760
say that type 1 afp did not inhibit

407
00:18:22,390 --> 00:18:20,720
methane clathrate at least at the

408
00:18:24,630 --> 00:18:22,400
conditions we used which was 5

409
00:18:27,270 --> 00:18:24,640
megapascals and negative 10 degrees

410
00:18:31,909 --> 00:18:29,430
whereas pvp which is the commercial

411
00:18:35,830 --> 00:18:31,919
inhibitor did inhibit methane cloth rate

412
00:18:38,549 --> 00:18:35,840
there was way less gas consumed here

413
00:18:41,430 --> 00:18:38,559

and then the cbps

414
00:18:44,310 --> 00:18:41,440
also inhibited methane clathrate quite a

415
00:18:46,870 --> 00:18:44,320
bit better than the type 1 afp and so we

416
00:18:47,750 --> 00:18:46,880
tested cbp number 2

417
00:18:49,750 --> 00:18:47,760
3

418
00:18:51,669 --> 00:18:49,760
5 and 6

419
00:18:54,830 --> 00:18:51,679
and they pretty much

420
00:18:58,390 --> 00:18:54,840
were in the same area as pvp

421
00:19:00,230 --> 00:18:58,400
and we would say that cbp3 worked

422
00:19:02,390 --> 00:19:00,240
probably the best

423
00:19:05,110 --> 00:19:02,400
um this is actually a lower

424
00:19:07,350 --> 00:19:05,120
concentration of that protein and it's

425
00:19:08,470 --> 00:19:07,360
lying exactly where we would expect it

426
00:19:11,110 --> 00:19:08,480
to be

427
00:19:14,310 --> 00:19:11,120
between the full concentration

428
00:19:17,029 --> 00:19:14,320
and our negative controls

429
00:19:20,470 --> 00:19:17,039
and in terms of morphology

430
00:19:22,470 --> 00:19:20,480
uh pbs cytochrome and the type 1 afp

431
00:19:25,110 --> 00:19:22,480
treatments resulted in this

432
00:19:27,110 --> 00:19:25,120
more cratered morphology it had a dip in

433
00:19:31,029 --> 00:19:27,120
the center of the droplet

434
00:19:33,190 --> 00:19:31,039
whereas pvp and the cbps

435
00:19:36,230 --> 00:19:33,200
a lot of acronyms sorry about that

436
00:19:38,230 --> 00:19:36,240
uh have this dome shape

437
00:19:40,150 --> 00:19:38,240
and i have a little schematic for why we

438
00:19:42,230 --> 00:19:40,160

think this is happening

439
00:19:43,510 --> 00:19:42,240
so here's the droplet before cloth rates

440
00:19:45,350 --> 00:19:43,520
formed

441
00:19:46,710 --> 00:19:45,360
zero hours

442
00:19:48,549 --> 00:19:46,720
and

443
00:19:50,310 --> 00:19:48,559
here's the start of clathrate growth

444
00:19:52,470 --> 00:19:50,320
where it becomes opaque

445
00:19:56,310 --> 00:19:52,480
and then at the three hour mark

446
00:19:59,270 --> 00:19:56,320
here we have pvp and cbps and we think a

447
00:20:01,350 --> 00:19:59,280
very thin clathrate shell forms in the

448
00:20:03,750 --> 00:20:01,360
presence of those inhibitors

449
00:20:07,029 --> 00:20:03,760
whereas with the pbs cytochrome and type

450
00:20:08,950 --> 00:20:07,039
one afp there's more clathrate growth

451
00:20:11,510 --> 00:20:08,960
that actually craters

452
00:20:13,830 --> 00:20:11,520
this structure as the internal water is

453
00:20:17,669 --> 00:20:13,840
getting converted to cloth rate and

454
00:20:23,830 --> 00:20:20,470
so in conclusion our

455
00:20:25,510 --> 00:20:23,840
clathrate binding proteins do alter thf

456
00:20:28,630 --> 00:20:25,520
clathrate morphology which is a

457
00:20:31,430 --> 00:20:28,640
structure two clathrate as well as

458
00:20:33,590 --> 00:20:31,440
methane clathrate uh stability and

459
00:20:35,830 --> 00:20:33,600
morphology and that is a structure one

460
00:20:38,230 --> 00:20:35,840
class rate

461
00:20:40,390 --> 00:20:38,240
so the implications of these cbps is

462
00:20:42,950 --> 00:20:40,400
that one um

463
00:20:44,390 --> 00:20:42,960

these are pretty extreme environments

464
00:20:46,390 --> 00:20:44,400
that are predicted to be on other

465
00:20:48,789 --> 00:20:46,400
planetary bodies and we could

466
00:20:50,470 --> 00:20:48,799
potentially use these proteins to search

467
00:20:52,950 --> 00:20:50,480
for life elsewhere

468
00:20:55,430 --> 00:20:52,960
um also it has implications for gas

469
00:20:58,390 --> 00:20:55,440
hydrate stability um and that means

470
00:21:01,029 --> 00:20:58,400
climate change because gas cloth rates

471
00:21:04,870 --> 00:21:01,039
do store gigatons of carbon in the form

472
00:21:07,190 --> 00:21:04,880
of the greenhouse gas methane as well as

473
00:21:10,630 --> 00:21:07,200
using these proteins for

474
00:21:12,870 --> 00:21:10,640
these natural gas pipelines

475
00:21:15,190 --> 00:21:12,880
i'd like to acknowledge the nasa

476
00:21:18,149 --> 00:21:15,200
exobiology grant team

477
00:21:19,830 --> 00:21:18,159
and are my funding sources including the

478
00:21:22,390 --> 00:21:19,840
ocean science and engineering phd

479
00:21:24,230 --> 00:21:22,400
fellowship as well as the glass lab for

480
00:21:26,789 --> 00:21:24,240
giving me copious amounts of support

481
00:21:32,290 --> 00:21:26,799
during my phd

482
00:21:36,310 --> 00:21:33,990
[Applause]

483
00:21:38,950 --> 00:21:36,320
wonderful thank you so much uh do we

484
00:21:45,510 --> 00:21:38,960
have any questions for abigail

485
00:21:51,510 --> 00:21:47,590
hey so

486
00:21:53,350 --> 00:21:51,520
my question is uh are these proteins in

487
00:21:55,590 --> 00:21:53,360
these microbes that they're found in are

488
00:21:58,470 --> 00:21:55,600

they being secreted out into sort of the

489
00:22:00,070 --> 00:21:58,480
bulk material or are they um inside the

490
00:22:03,029 --> 00:22:00,080
cell trying to make sure that they don't

491
00:22:05,990 --> 00:22:03,039
like crystallize themselves or something

492
00:22:09,190 --> 00:22:06,000
um we don't have evidence for

493
00:22:11,270 --> 00:22:09,200
secretion um that's what we believe

494
00:22:14,950 --> 00:22:11,280
there is evidence for other

495
00:22:18,950 --> 00:22:14,960
bacteria and algae doing that in ice um

496
00:22:20,549 --> 00:22:18,960
habitats but we don't have any um

497
00:22:22,470 --> 00:22:20,559
genomic

498
00:22:25,270 --> 00:22:22,480
evidence for

499
00:22:27,750 --> 00:22:25,280
either one but we we would think that

500
00:22:30,149 --> 00:22:27,760
these proteins would be secreted

501
00:22:31,830 --> 00:22:30,159
um and so basically

502
00:22:34,310 --> 00:22:31,840
they would secrete

503
00:22:36,870 --> 00:22:34,320
into their surrounding environments and

504
00:22:39,669 --> 00:22:36,880
they would bind to the surrounding cloth

505
00:22:50,149 --> 00:22:39,679
rates and that would maintain sort of a

506
00:23:00,950 --> 00:22:51,190
awesome

507
00:23:08,310 --> 00:23:03,510
all right well thank you so much

508
00:23:50,310 --> 00:23:10,789
and now we'll turn this over to william

509
00:23:53,990 --> 00:23:51,830
all right take it away

510
00:23:56,390 --> 00:23:54,000
please okay perfect

511
00:23:58,149 --> 00:23:56,400
awesome thank you

512
00:23:59,990 --> 00:23:58,159
so i'm william rossen i'm a graduate

513
00:24:03,350 --> 00:24:00,000

research assistant in the space systems

514
00:24:05,430 --> 00:24:03,360
design lab advised by dr leitzy and i am

515
00:24:06,470 --> 00:24:05,440
the systems engineering lead for the

516
00:24:08,070 --> 00:24:06,480
visors

517
00:24:09,669 --> 00:24:08,080
mission which is a two-cube set

518
00:24:11,590 --> 00:24:09,679
distributed telescope for coronal

519
00:24:13,029 --> 00:24:11,600
observation uh today we're going to talk

520
00:24:15,510 --> 00:24:13,039
a little bit about the science and

521
00:24:17,269 --> 00:24:15,520
engineering goals of this mission so

522
00:24:19,669 --> 00:24:17,279
um first we'll do a little bit of a

523
00:24:21,430 --> 00:24:19,679
detour talk about ssdl

524
00:24:23,510 --> 00:24:21,440
and cubesats for those of you that are

525
00:24:25,110 --> 00:24:23,520
not familiar and then we'll talk about

526
00:24:26,789 --> 00:24:25,120
some of the science goals and how that

527
00:24:28,070 --> 00:24:26,799
motivates the engineering demonstrations

528
00:24:28,950 --> 00:24:28,080
that we're trying to do

529
00:24:30,789 --> 00:24:28,960
and then

530
00:24:33,590 --> 00:24:30,799
hopefully we can conclude with maybe

531
00:24:36,070 --> 00:24:33,600
some takeaways and where we go from here

532
00:24:38,390 --> 00:24:36,080
so what is ssdl the space systems design

533
00:24:40,710 --> 00:24:38,400
lab here at georgia tech we do all kinds

534
00:24:43,590 --> 00:24:40,720
of research small set technologies like

535
00:24:45,909 --> 00:24:43,600
this also spacecraft navigation

536
00:24:47,909 --> 00:24:45,919
life detection with dr carr if you guys

537
00:24:49,750 --> 00:24:47,919
are familiar with his work um and some

538
00:24:51,750 --> 00:24:49,760

examples of recent work you may have

539
00:24:53,029 --> 00:24:51,760
heard about the two cubesats we just

540
00:24:55,510 --> 00:24:53,039
deployed from the international space

541
00:24:58,230 --> 00:24:55,520
station there's gt1 right there i worked

542
00:25:00,230 --> 00:24:58,240
on that in undergrad um and then as an

543
00:25:01,430 --> 00:25:00,240
example of kind of the like end-to-end

544
00:25:03,590 --> 00:25:01,440
capabilities that we're trying to

545
00:25:05,430 --> 00:25:03,600
develop this nasa lunar flashlight

546
00:25:06,950 --> 00:25:05,440
mission we've been heavily involved we

547
00:25:09,350 --> 00:25:06,960
provided a propulsion system that you

548
00:25:10,950 --> 00:25:09,360
see here we also integrated and did the

549
00:25:12,149 --> 00:25:10,960
testing campaign for the satellite and

550
00:25:13,350 --> 00:25:12,159
we're going to be operating that

551
00:25:14,950 --> 00:25:13,360
satellite

552
00:25:17,190 --> 00:25:14,960
as it orbits the moon searching for

553
00:25:19,909 --> 00:25:17,200
water ice

554
00:25:20,950 --> 00:25:19,919
so what is a cubesat exactly well it

555
00:25:23,430 --> 00:25:20,960
started out

556
00:25:25,990 --> 00:25:23,440
as a purely educational endeavor by this

557
00:25:27,510 --> 00:25:26,000
design standard maintained by cal poly

558
00:25:29,430 --> 00:25:27,520
but it's really exploded since then

559
00:25:31,750 --> 00:25:29,440
because it was adopted not just by

560
00:25:33,750 --> 00:25:31,760
educational institutions but also by

561
00:25:35,350 --> 00:25:33,760
government and commercial entities so

562
00:25:37,269 --> 00:25:35,360
that's really great for us educational

563
00:25:39,830 --> 00:25:37,279

institutions because it means we have

564
00:25:41,430 --> 00:25:39,840
all of these ride share opportunities um

565
00:25:43,350 --> 00:25:41,440
all kinds of high performance

566
00:25:45,269 --> 00:25:43,360
commercially available parts that make

567
00:25:47,750 --> 00:25:45,279
missions fast and cheap

568
00:25:50,870 --> 00:25:47,760
as well as lots of published research

569
00:25:52,390 --> 00:25:50,880
for resources starting off in design and

570
00:25:54,870 --> 00:25:52,400
kind of the result of this is that we

571
00:25:56,789 --> 00:25:54,880
have a very compact affordable form

572
00:25:59,190 --> 00:25:56,799
factor for space exploration so that's

573
00:26:00,149 --> 00:25:59,200
kind of why cubesats in general

574
00:26:02,470 --> 00:26:00,159
um

575
00:26:04,149 --> 00:26:02,480
so now specifically talking about visors

576
00:26:06,549 --> 00:26:04,159
which is an acronym for

577
00:26:08,390 --> 00:26:06,559
virtual super resolution optics uh with

578
00:26:10,149 --> 00:26:08,400
reconfigurable swarms

579
00:26:12,470 --> 00:26:10,159
so the science score we'll start off

580
00:26:14,470 --> 00:26:12,480
with a bit of an overview um is funded

581
00:26:17,190 --> 00:26:14,480
by the national science foundation from

582
00:26:18,470 --> 00:26:17,200
their cubesat ideas lab in 2019 they

583
00:26:20,390 --> 00:26:18,480
brought together a bunch of industry

584
00:26:22,390 --> 00:26:20,400
professionals and had them kind of come

585
00:26:24,310 --> 00:26:22,400
up with these crazy ideas to really push

586
00:26:26,390 --> 00:26:24,320
the boundaries of what was possible this

587
00:26:28,230 --> 00:26:26,400
is one of those missions trying to

588
00:26:31,269 --> 00:26:28,240

further knowledge of the solar corona

589
00:26:32,549 --> 00:26:31,279
via this distributed telescope concept

590
00:26:35,029 --> 00:26:32,559
and so in addition to kind of the

591
00:26:36,710 --> 00:26:35,039
science goals the demonstration of this

592
00:26:39,190 --> 00:26:36,720
kind of precise formation flying is a

593
00:26:41,269 --> 00:26:39,200
very exciting engineering goal for us

594
00:26:42,870 --> 00:26:41,279
and as far as the status we've passed

595
00:26:44,870 --> 00:26:42,880
critical design review so we're

596
00:26:46,630 --> 00:26:44,880
currently fabricating hardware getting

597
00:26:49,190 --> 00:26:46,640
ready to integrate and test

598
00:26:50,830 --> 00:26:49,200
hopefully launching early 2024 around

599
00:26:53,029 --> 00:26:50,840
solar

600
00:26:54,950 --> 00:26:53,039
maximum so this is like the formal

601
00:26:56,470 --> 00:26:54,960
statement of our minimum mission success

602
00:26:59,269 --> 00:26:56,480
science goal we're going to try to build

603
00:27:01,029 --> 00:26:59,279
this up a little bit more um but in

604
00:27:03,430 --> 00:27:01,039
observing the corona using this

605
00:27:05,430 --> 00:27:03,440
distributed telescope not only will we

606
00:27:07,110 --> 00:27:05,440
hopefully be able to observe

607
00:27:09,269 --> 00:27:07,120
some different phenomenon in the corona

608
00:27:10,789 --> 00:27:09,279
but we will also demonstrate key

609
00:27:11,750 --> 00:27:10,799
formation flying technologies so we're

610
00:27:13,269 --> 00:27:11,760
going to talk a little bit more about

611
00:27:14,710 --> 00:27:13,279
these

612
00:27:16,549 --> 00:27:14,720
in turn

613
00:27:18,630 --> 00:27:16,559

and then the other goal in addition to

614
00:27:20,630 --> 00:27:18,640
all this engineering and science

615
00:27:22,789 --> 00:27:20,640
is education and that's a big priority

616
00:27:24,310 --> 00:27:22,799
of nsf so this could also be seen as

617
00:27:26,710 --> 00:27:24,320
kind of an acknowledgement slide i am a

618
00:27:27,909 --> 00:27:26,720
very small part of this huge mission

619
00:27:30,310 --> 00:27:27,919
there are partners at all these

620
00:27:32,149 --> 00:27:30,320
educational institutions and part of the

621
00:27:34,230 --> 00:27:32,159
purpose of that is to

622
00:27:36,310 --> 00:27:34,240
educate and train the next generation of

623
00:27:38,070 --> 00:27:36,320
engineers and scientists by interacting

624
00:27:40,230 --> 00:27:38,080
with colleagues and also with

625
00:27:42,470 --> 00:27:40,240
professional engineers and scientists at

626
00:27:44,310 --> 00:27:42,480
places like nasa goddard and the

627
00:27:47,110 --> 00:27:44,320
laboratory for atmospheric and space

628
00:27:49,190 --> 00:27:47,120
physics in colorado

629
00:27:50,630 --> 00:27:49,200
so starting with the science goal which

630
00:27:52,389 --> 00:27:50,640
you could state as to achieve

631
00:27:54,470 --> 00:27:52,399
unprecedented resolution in coronal

632
00:27:56,149 --> 00:27:54,480
imagery but why do we care about this

633
00:27:57,990 --> 00:27:56,159
why do we want to do this so

634
00:28:00,470 --> 00:27:58,000
we're trying to answer the question of

635
00:28:02,549 --> 00:28:00,480
how is the corona heated so the the

636
00:28:04,310 --> 00:28:02,559
surface of the sun is very hot then the

637
00:28:06,789 --> 00:28:04,320
temperature drops off

638
00:28:08,950 --> 00:28:06,799

relatively low it's still very hot um

639
00:28:10,230 --> 00:28:08,960
but the corona is way hotter and that's

640
00:28:11,669 --> 00:28:10,240
where you get all the space weather

641
00:28:14,230 --> 00:28:11,679
coronal mass ejections and stuff like

642
00:28:15,990 --> 00:28:14,240
that so if we can understand how all

643
00:28:17,190 --> 00:28:16,000
this really rapid heating happens right

644
00:28:18,950 --> 00:28:17,200
here you might have a better

645
00:28:20,630 --> 00:28:18,960
understanding of space weather

646
00:28:22,870 --> 00:28:20,640
but the problem is that the current

647
00:28:25,029 --> 00:28:22,880
hypothesis is that these this heating

648
00:28:26,470 --> 00:28:25,039
happens in localized regions on

649
00:28:28,630 --> 00:28:26,480
incredibly small scales you know 100

650
00:28:30,630 --> 00:28:28,640
kilometers not very small but when you

651
00:28:32,149 --> 00:28:30,640
observe 100 kilometers on the sun from

652
00:28:34,789 --> 00:28:32,159
earth you're looking at something that

653
00:28:36,870 --> 00:28:34,799
is 124 000 of a degree

654
00:28:38,310 --> 00:28:36,880
so the problem with that as shown in

655
00:28:40,950 --> 00:28:38,320
this image is that it's beyond our

656
00:28:42,630 --> 00:28:40,960
current capabilities so this is a image

657
00:28:44,789 --> 00:28:42,640
of the solar corona

658
00:28:47,190 --> 00:28:44,799
0.6 arc seconds so you have to increase

659
00:28:48,950 --> 00:28:47,200
that by like a factor of four in order

660
00:28:51,190 --> 00:28:48,960
to observe these structures and then you

661
00:28:53,269 --> 00:28:51,200
can kind of see what might happen when

662
00:28:55,029 --> 00:28:53,279
you do that is uh kind of these images

663
00:28:56,950 --> 00:28:55,039

here so we're trying to get somewhere in

664
00:28:59,350 --> 00:28:56,960
here

665
00:29:01,430 --> 00:28:59,360
um so how do we achieve this resolution

666
00:29:02,789 --> 00:29:01,440
uh the first thing to know is that we

667
00:29:04,389 --> 00:29:02,799
want to observe in the extreme

668
00:29:07,190 --> 00:29:04,399
ultraviolet wavelength because that's

669
00:29:09,110 --> 00:29:07,200
where ionized helium emits the best uh

670
00:29:10,710 --> 00:29:09,120
but the problem is that these are very

671
00:29:12,389 --> 00:29:10,720
small wavelengths compared to like the

672
00:29:15,029 --> 00:29:12,399
infrared wavelengths that james webb

673
00:29:17,190 --> 00:29:15,039
uses so we can't use at least it's not

674
00:29:19,669 --> 00:29:17,200
practical to use mirror-based optics we

675
00:29:21,029 --> 00:29:19,679
just can't manufacture them to the high

676
00:29:22,230 --> 00:29:21,039
enough tolerances in these small

677
00:29:24,789 --> 00:29:22,240
wavelengths

678
00:29:27,590 --> 00:29:24,799
and so what do we do instead we can use

679
00:29:29,750 --> 00:29:27,600
what's called a diffractive optic so

680
00:29:31,750 --> 00:29:29,760
it's the one we're using is a photon

681
00:29:34,149 --> 00:29:31,760
sieve developed at nasa goddard

682
00:29:36,630 --> 00:29:34,159
it's based on the fresnel zone plate

683
00:29:38,630 --> 00:29:36,640
and this creates a interference pattern

684
00:29:40,950 --> 00:29:38,640
that is then post-processed to create an

685
00:29:43,110 --> 00:29:40,960
image and the result is that we get this

686
00:29:44,870 --> 00:29:43,120
diffraction limited resolution which we

687
00:29:47,269 --> 00:29:44,880
need to observe these structures in the

688
00:29:48,950 --> 00:29:47,279

corona so this is all great

689
00:29:51,510 --> 00:29:48,960
we have the technology but the problem

690
00:29:53,590 --> 00:29:51,520
is the focal length of this sieve is 40

691
00:29:56,070 --> 00:29:53,600
meters which is which is huge it's the

692
00:29:58,149 --> 00:29:56,080
size of the space shuttle so rather than

693
00:29:59,750 --> 00:29:58,159
spending hundreds of millions of dollars

694
00:30:01,029 --> 00:29:59,760
to build one satellite to hold this

695
00:30:01,830 --> 00:30:01,039
photon sieve

696
00:30:03,350 --> 00:30:01,840
um

697
00:30:05,510 --> 00:30:03,360
there's other solutions so how do we

698
00:30:08,230 --> 00:30:05,520
create this 40 meter telescope we can

699
00:30:10,389 --> 00:30:08,240
use formation flying with cubesats um

700
00:30:12,789 --> 00:30:10,399
specifically a two cubesat formation so

701
00:30:14,870 --> 00:30:12,799
the the optic spacecraft up here this is

702
00:30:17,110 --> 00:30:14,880
not quite to scale these are like uh

703
00:30:18,549 --> 00:30:17,120
briefcase size and then again like space

704
00:30:20,710 --> 00:30:18,559
shuttle distance

705
00:30:22,950 --> 00:30:20,720
um so the optic spacecraft holds the

706
00:30:25,430 --> 00:30:22,960
photon sieve and also the solar panels

707
00:30:26,950 --> 00:30:25,440
block kind of stray uv light and then

708
00:30:29,350 --> 00:30:26,960
the detector spacecraft has what's

709
00:30:30,950 --> 00:30:29,360
basically our camera

710
00:30:32,470 --> 00:30:30,960
but the problem again now that you've

711
00:30:33,990 --> 00:30:32,480
put these on two separate spacecraft

712
00:30:36,230 --> 00:30:34,000
that's great but now you have to

713
00:30:37,750 --> 00:30:36,240

actually form the telescope and there's

714
00:30:38,789 --> 00:30:37,760
a lot of kind of different requirements

715
00:30:40,070 --> 00:30:38,799
that go in here but the thing that i

716
00:30:41,669 --> 00:30:40,080
want to emphasize is that we're looking

717
00:30:43,350 --> 00:30:41,679
at millimeter level

718
00:30:44,789 --> 00:30:43,360
tolerances in in pretty much every

719
00:30:47,430 --> 00:30:44,799
direction and in the velocity so

720
00:30:48,710 --> 00:30:47,440
millimeter level control of these two

721
00:30:51,190 --> 00:30:48,720
systems that are orbiting around the

722
00:30:53,909 --> 00:30:51,200
earth so the question of formation

723
00:30:56,310 --> 00:30:53,919
flying is kind of how how do we do that

724
00:30:57,830 --> 00:30:56,320
so first to align them

725
00:30:59,830 --> 00:30:57,840
you can't just necessarily rely on your

726
00:31:01,110 --> 00:30:59,840
orbital plane pointing towards the sun

727
00:31:02,549 --> 00:31:01,120
and then they just kind of follow each

728
00:31:04,549 --> 00:31:02,559
other around you know it's not very

729
00:31:05,990 --> 00:31:04,559
flexible so in order to obtain the

730
00:31:07,430 --> 00:31:06,000
targeting that we want

731
00:31:09,909 --> 00:31:07,440
we have to use what's called a relative

732
00:31:11,750 --> 00:31:09,919
orbit so this is kind of an example here

733
00:31:14,149 --> 00:31:11,760
where the one spacecraft is at this

734
00:31:16,950 --> 00:31:14,159
little dot the other one in a relative

735
00:31:18,870 --> 00:31:16,960
sense orbits around so you can produce

736
00:31:21,669 --> 00:31:18,880
alignment towards the sun and you can

737
00:31:23,830 --> 00:31:21,679
recalculate this trajectory to obtain

738
00:31:24,870 --> 00:31:23,840

any alignment you need towards the sun

739
00:31:26,710 --> 00:31:24,880
but

740
00:31:28,870 --> 00:31:26,720
what what is a relative orbit exactly

741
00:31:30,310 --> 00:31:28,880
it's not quite the spacecraft orbiting

742
00:31:32,870 --> 00:31:30,320
each other they're still orbiting the

743
00:31:35,029 --> 00:31:32,880
earth but they're doing so in very

744
00:31:37,029 --> 00:31:35,039
slightly different orbits so that if you

745
00:31:39,269 --> 00:31:37,039
say okay forget about the fact they're

746
00:31:41,190 --> 00:31:39,279
orbiting the earth

747
00:31:43,110 --> 00:31:41,200
and just say that this one spacecraft is

748
00:31:44,950 --> 00:31:43,120
the origin here it's not moving and you

749
00:31:47,190 --> 00:31:44,960
just look at the relative motion it can

750
00:31:48,710 --> 00:31:47,200
kind of appear to orbit around another

751
00:31:50,230 --> 00:31:48,720
and the nice thing about this is that

752
00:31:53,029 --> 00:31:50,240
you can linearize these equations of

753
00:31:56,230 --> 00:31:53,039
motion um which has great implications

754
00:31:58,389 --> 00:31:56,240
and control as we're going to get into

755
00:31:59,909 --> 00:31:58,399
so this is an example of kind of the

756
00:32:01,909 --> 00:31:59,919
different trajectories we can accomplish

757
00:32:03,269 --> 00:32:01,919
with this relative orbit so we can

758
00:32:05,590 --> 00:32:03,279
design trajectories to have different

759
00:32:07,269 --> 00:32:05,600
purposes this kind of standby relax

760
00:32:09,430 --> 00:32:07,279
trajectory and then we want to do

761
00:32:11,350 --> 00:32:09,440
science we go into this tighter orbit

762
00:32:12,789 --> 00:32:11,360
but how do we actually get there how do

763
00:32:14,950 --> 00:32:12,799

we make sure we stay on track because

764
00:32:16,789 --> 00:32:14,960
there's other disturbances there's solar

765
00:32:18,710 --> 00:32:16,799
radiation pressure and atmospheric drag

766
00:32:20,149 --> 00:32:18,720
so how do we actually maintain that

767
00:32:22,149 --> 00:32:20,159
orbit

768
00:32:24,070 --> 00:32:22,159
and that is the question of guidance

769
00:32:25,269 --> 00:32:24,080
navigation and control so we're going to

770
00:32:26,950 --> 00:32:25,279
talk about these

771
00:32:29,110 --> 00:32:26,960
one at a time but this is maybe the

772
00:32:30,710 --> 00:32:29,120
better order is navigation guidance and

773
00:32:32,389 --> 00:32:30,720
control but that's not how people ever

774
00:32:34,310 --> 00:32:32,399
say it um

775
00:32:36,470 --> 00:32:34,320
so starting with navigation so how do i

776
00:32:37,830 --> 00:32:36,480
determine my position and velocity the

777
00:32:39,750 --> 00:32:37,840
nice thing about being in low earth

778
00:32:42,310 --> 00:32:39,760
orbit is that you're still below the gps

779
00:32:45,269 --> 00:32:42,320
constellation so you can use gps which

780
00:32:47,190 --> 00:32:45,279
is great but gps quote unquote only

781
00:32:49,430 --> 00:32:47,200
provides meter level accuracy which is

782
00:32:51,830 --> 00:32:49,440
really good but again it's not good

783
00:32:53,990 --> 00:32:51,840
enough we need millimeter level accuracy

784
00:32:55,830 --> 00:32:54,000
and it turns out that the key here is

785
00:32:57,350 --> 00:32:55,840
that we need millimeter level accuracy

786
00:32:59,509 --> 00:32:57,360
in the relative position and the

787
00:33:01,669 --> 00:32:59,519
relative is really key because we don't

788
00:33:03,590 --> 00:33:01,679

care necessarily as much where we are

789
00:33:05,110 --> 00:33:03,600
relative to the center of the earth so

790
00:33:07,029 --> 00:33:05,120
we can use a technique called

791
00:33:08,789 --> 00:33:07,039
differential gps

792
00:33:10,630 --> 00:33:08,799
which has been applied on earth for

793
00:33:13,590 --> 00:33:10,640
things like aircraft like you can see

794
00:33:16,630 --> 00:33:13,600
here and the basic concept is the errors

795
00:33:18,870 --> 00:33:16,640
in gps vary spatially so if you know

796
00:33:21,029 --> 00:33:18,880
your your your correct position you can

797
00:33:23,029 --> 00:33:21,039
kind of correct your gps measurement and

798
00:33:25,430 --> 00:33:23,039
then broadcast those corrections and

799
00:33:27,190 --> 00:33:25,440
other users can get better accuracy so

800
00:33:29,029 --> 00:33:27,200
we're kind of abstracting that concept

801
00:33:30,789 --> 00:33:29,039
and say well we don't exactly know our

802
00:33:32,470 --> 00:33:30,799
exact position but we know these two

803
00:33:34,470 --> 00:33:32,480
things are close together so we know the

804
00:33:36,070 --> 00:33:34,480
errors have to be similar and so you can

805
00:33:38,470 --> 00:33:36,080
kind of use the subtraction of the two

806
00:33:39,590 --> 00:33:38,480
measurements to provide millimeter level

807
00:33:40,389 --> 00:33:39,600
accuracy

808
00:33:41,909 --> 00:33:40,399
and

809
00:33:43,269 --> 00:33:41,919
specifically we use this algorithm

810
00:33:45,350 --> 00:33:43,279
developed at stanford they're one of the

811
00:33:46,470 --> 00:33:45,360
partners on this project called digital

812
00:33:48,149 --> 00:33:46,480
um

813
00:33:50,070 --> 00:33:48,159

but again the challenge here this has to

814
00:33:51,269 --> 00:33:50,080
happen autonomously we can't be sending

815
00:33:52,870 --> 00:33:51,279
information back and forth to the

816
00:33:54,630 --> 00:33:52,880
spacecraft they have to talk to each

817
00:33:56,389 --> 00:33:54,640
other so how do we enable them to talk

818
00:33:58,149 --> 00:33:56,399
to each other well we have what's called

819
00:33:59,669 --> 00:33:58,159
an inner satellite link

820
00:34:02,470 --> 00:33:59,679
and this has to be omnidirectional we

821
00:34:03,669 --> 00:34:02,480
can't rely on exactly how they're being

822
00:34:05,509 --> 00:34:03,679
pointed because again they're orbiting

823
00:34:07,830 --> 00:34:05,519
around each other so we have these patch

824
00:34:10,230 --> 00:34:07,840
antennas on every face of the spacecraft

825
00:34:12,149 --> 00:34:10,240
we have a second dedicated radio not for

826
00:34:13,430 --> 00:34:12,159
space to ground communication but for

827
00:34:15,510 --> 00:34:13,440
you could call it space to space

828
00:34:17,750 --> 00:34:15,520
communication and that enables them to

829
00:34:19,030 --> 00:34:17,760
share the navigation data that they need

830
00:34:20,790 --> 00:34:19,040
in order to

831
00:34:22,550 --> 00:34:20,800
provide this millimeter level accuracy

832
00:34:24,310 --> 00:34:22,560
so that's the first kind of key enabling

833
00:34:26,310 --> 00:34:24,320
technology or you could think about as a

834
00:34:28,069 --> 00:34:26,320
pair is the navigation algorithm and

835
00:34:29,750 --> 00:34:28,079
this inner satellite link

836
00:34:31,109 --> 00:34:29,760
so we know where we are but what if

837
00:34:32,710 --> 00:34:31,119
we're not where we want to be or what if

838
00:34:35,270 --> 00:34:32,720

we need to change where we are so we're

839
00:34:36,950 --> 00:34:35,280
in this standby orbit which is great for

840
00:34:39,430 --> 00:34:36,960
downlinking data but we need to go do

841
00:34:41,430 --> 00:34:39,440
science so how do we do that we have to

842
00:34:42,950 --> 00:34:41,440
calculate a trajectory which would

843
00:34:45,270 --> 00:34:42,960
involve a maneuver plan so this is the

844
00:34:47,349 --> 00:34:45,280
problem of guidance and we can actually

845
00:34:49,190 --> 00:34:47,359
use the fact that we can linearize the

846
00:34:50,470 --> 00:34:49,200
relative equations of motion to do this

847
00:34:51,669 --> 00:34:50,480
very easily

848
00:34:53,109 --> 00:34:51,679
and you can actually pose it as an

849
00:34:55,829 --> 00:34:53,119
optimization problem which is what we do

850
00:34:57,829 --> 00:34:55,839
on visors so there's an onboard

851
00:35:00,150 --> 00:34:57,839
convex optimization solver that is

852
00:35:02,390 --> 00:35:00,160
solving these constrained problems to

853
00:35:04,790 --> 00:35:02,400
minimize our propellant consumption

854
00:35:06,470 --> 00:35:04,800
and also subject it to the constraints

855
00:35:08,310 --> 00:35:06,480
of our propulsion system because it

856
00:35:10,470 --> 00:35:08,320
can't do everything so we know what it

857
00:35:12,550 --> 00:35:10,480
can do and we're able to minimize how

858
00:35:13,670 --> 00:35:12,560
much propellant we have to expend

859
00:35:15,750 --> 00:35:13,680
and you get this trigger so you have

860
00:35:17,990 --> 00:35:15,760
this blue trajectory and it calculates

861
00:35:19,670 --> 00:35:18,000
all your little maneuvers to get there

862
00:35:21,670 --> 00:35:19,680
you can also use this for control so if

863
00:35:22,950 --> 00:35:21,680

you're in this red orbit you can use it

864
00:35:25,030 --> 00:35:22,960
to stabilize and make sure that you

865
00:35:26,630 --> 00:35:25,040
don't leave the orbit for example so

866
00:35:29,270 --> 00:35:26,640
this is another enabling technology as

867
00:35:30,630 --> 00:35:29,280
these optimal guidance algorithms

868
00:35:32,550 --> 00:35:30,640
so this is great we have all these

869
00:35:35,270 --> 00:35:32,560
maneuvers we know we need to do but how

870
00:35:36,870 --> 00:35:35,280
do we actually do it so obviously use

871
00:35:38,630 --> 00:35:36,880
thrusters been done on spacecraft

872
00:35:41,589 --> 00:35:38,640
forever but they're very complicated

873
00:35:43,670 --> 00:35:41,599
they require pressure tanks and valves

874
00:35:45,910 --> 00:35:43,680
and explosive propellants that are

875
00:35:48,069 --> 00:35:45,920
highly toxic right which is not great

876
00:35:49,349 --> 00:35:48,079
for cubesats especially if you're on

877
00:35:50,470 --> 00:35:49,359
part of a larger launch vehicle they

878
00:35:53,430 --> 00:35:50,480
don't like that

879
00:35:55,109 --> 00:35:53,440
so what we do is we 3d print propulsion

880
00:35:56,950 --> 00:35:55,119
systems and this is something that we've

881
00:35:59,270 --> 00:35:56,960
done several times at georgia tech and

882
00:36:01,349 --> 00:35:59,280
we use what's called cold gas so in this

883
00:36:04,069 --> 00:36:01,359
case it's actually a refrigerant that's

884
00:36:05,510 --> 00:36:04,079
relatively non-toxic

885
00:36:07,109 --> 00:36:05,520
and the great thing about this is we can

886
00:36:08,230 --> 00:36:07,119
fit it into these small irregular

887
00:36:11,190 --> 00:36:08,240
volumes we've got all these other

888
00:36:12,550 --> 00:36:11,200

important science and mission payloads

889
00:36:14,710 --> 00:36:12,560
and we can kind of cram it into the

890
00:36:17,109 --> 00:36:14,720
bottom here because we're 3d printing it

891
00:36:18,310 --> 00:36:17,119
um and it really gives us a lot of

892
00:36:20,069 --> 00:36:18,320
performance things that wouldn't have

893
00:36:22,550 --> 00:36:20,079
been possible in a cubesat form factor

894
00:36:23,990 --> 00:36:22,560
before so this miniaturized propulsion

895
00:36:26,230 --> 00:36:24,000
is another enabling technology that

896
00:36:27,589 --> 00:36:26,240
we're demonstrating here

897
00:36:29,109 --> 00:36:27,599
so now we can put it all together we

898
00:36:31,430 --> 00:36:29,119
have relative navigation with meter

899
00:36:33,190 --> 00:36:31,440
level accuracy we have guidance

900
00:36:34,550 --> 00:36:33,200
algorithms to figure out how to get

901
00:36:36,790 --> 00:36:34,560
where we need to go we have this

902
00:36:39,190 --> 00:36:36,800
miniaturized propulsion system to get us

903
00:36:41,349 --> 00:36:39,200
there and so these form kind of the key

904
00:36:43,430 --> 00:36:41,359
formation flying enabling technologies

905
00:36:45,910 --> 00:36:43,440
that will allow us to expand what we can

906
00:36:47,670 --> 00:36:45,920
do in a cubesat form factor

907
00:36:49,109 --> 00:36:47,680
and where do we go with this so you know

908
00:36:50,230 --> 00:36:49,119
maybe in the context of kind of

909
00:36:52,390 --> 00:36:50,240
exploring

910
00:36:54,550 --> 00:36:52,400
the universe around us one potential

911
00:36:56,069 --> 00:36:54,560
application is observing exoplanets so

912
00:36:57,589 --> 00:36:56,079
they're very hard to observe because

913
00:36:59,670 --> 00:36:57,599

they're very dim compared to the stars

914
00:37:01,109 --> 00:36:59,680
that they orbit around so one concept

915
00:37:02,870 --> 00:37:01,119
that's being explored is this kind of

916
00:37:05,190 --> 00:37:02,880
star uh star shade

917
00:37:06,630 --> 00:37:05,200
telescope combination so you would fly

918
00:37:08,550 --> 00:37:06,640
in formation it would work a little bit

919
00:37:10,310 --> 00:37:08,560
differently you'd be a lot further away

920
00:37:12,150 --> 00:37:10,320
but this giant star shade would block

921
00:37:13,910 --> 00:37:12,160
out the light of the star allowing the

922
00:37:16,230 --> 00:37:13,920
telescope to observe exoplanets kind of

923
00:37:17,430 --> 00:37:16,240
along the fringe so that's one potential

924
00:37:19,349 --> 00:37:17,440
application

925
00:37:21,510 --> 00:37:19,359
there's others and kind of these swarm

926
00:37:22,790 --> 00:37:21,520
concepts where instead of getting like

927
00:37:24,870 --> 00:37:22,800
one

928
00:37:26,630 --> 00:37:24,880
measurement from your instrument per 90

929
00:37:28,069 --> 00:37:26,640
minutes as you orbit around you have a

930
00:37:30,230 --> 00:37:28,079
string of them and you can maybe get

931
00:37:33,190 --> 00:37:30,240
like one every minute for like a 10

932
00:37:34,230 --> 00:37:33,200
minute period or something like that

933
00:37:36,069 --> 00:37:34,240
so

934
00:37:37,750 --> 00:37:36,079
takeaways we're trying to enable

935
00:37:40,310 --> 00:37:37,760
groundbreaking resolution in coronal

936
00:37:42,069 --> 00:37:40,320
imagery to analyze heat release regions

937
00:37:44,069 --> 00:37:42,079
in the sun and if we succeed in this

938
00:37:45,510 --> 00:37:44,079

goal we will also be demonstrating

939
00:37:46,790 --> 00:37:45,520
several key formation flying

940
00:37:48,550 --> 00:37:46,800
technologies

941
00:37:50,630 --> 00:37:48,560
and in terms of the bigger picture this

942
00:37:52,310 --> 00:37:50,640
is really exciting because if we can

943
00:37:54,230 --> 00:37:52,320
meet these really ambitious goals if we

944
00:37:56,470 --> 00:37:54,240
can do better than these 100 million

945
00:37:58,550 --> 00:37:56,480
dollar solar observatories in a like

946
00:38:00,150 --> 00:37:58,560
singles of millions of dollars budget

947
00:38:02,390 --> 00:38:00,160
it's a really interesting paradigm that

948
00:38:04,310 --> 00:38:02,400
will enable nasa and nsf and other

949
00:38:05,910 --> 00:38:04,320
partners to really strive for some more

950
00:38:07,349 --> 00:38:05,920
ambitious goals which is already

951
00:38:09,270 --> 00:38:07,359
happening you know there's a lot of nasa

952
00:38:10,950 --> 00:38:09,280
cubesats they're doing really exciting

953
00:38:13,109 --> 00:38:10,960
science and that's kind of the really

954
00:38:14,550 --> 00:38:13,119
interesting uh paradigm here

955
00:38:16,390 --> 00:38:14,560
um and again i just want to emphasize

956
00:38:18,069 --> 00:38:16,400
you know i stayed pretty high level here

957
00:38:19,670 --> 00:38:18,079
to kind of introduce you to the mission

958
00:38:22,310 --> 00:38:19,680
but we are we've we've designed all the

959
00:38:23,910 --> 00:38:22,320
hardware and we're working to uh build

960
00:38:26,710 --> 00:38:23,920
and test components right now which is

961
00:38:31,270 --> 00:38:28,390
uh yeah that's all i have so i'd be

962
00:38:34,470 --> 00:38:31,280
happy to answer any questions

963
00:38:36,230 --> 00:38:34,480

[Applause]

964
00:38:40,790 --> 00:38:36,240
i think we've got time for one question

965
00:38:44,630 --> 00:38:42,390
so uh

966
00:38:46,230 --> 00:38:44,640
why is formation flying an easier

967
00:38:48,230 --> 00:38:46,240
solution than using something like

968
00:38:49,190 --> 00:38:48,240
cables

969
00:38:50,150 --> 00:38:49,200
so

970
00:38:53,750 --> 00:38:50,160
um

971
00:38:58,230 --> 00:38:53,760
tethers are an option

972
00:39:00,390 --> 00:38:58,240
kind of less flexible

973
00:39:02,230 --> 00:39:00,400
in the sense that like once you're kind

974
00:39:05,109 --> 00:39:02,240
of orbiting each other around the tether

975
00:39:06,870 --> 00:39:05,119
it's a little more difficult to change

976
00:39:08,790 --> 00:39:06,880
the way in which you're orbiting to a

977
00:39:11,190 --> 00:39:08,800
line in a different way so you would

978
00:39:13,109 --> 00:39:11,200
still need to be able to

979
00:39:14,710 --> 00:39:13,119
for example control your position to

980
00:39:16,790 --> 00:39:14,720
like millimeter level accuracy because

981
00:39:18,230 --> 00:39:16,800
the tethers are i said they're not

982
00:39:19,910 --> 00:39:18,240
flexible but they are flexible is the

983
00:39:22,230 --> 00:39:19,920
problem too right so you're gonna get

984
00:39:23,349 --> 00:39:22,240
bending and warping so that is an option

985
00:39:26,310 --> 00:39:23,359
and it's something that people have

986
00:39:28,310 --> 00:39:26,320
explored um but it kind of hasn't gained

987
00:39:29,589 --> 00:39:28,320
as much traction because you still run

988
00:39:31,270 --> 00:39:29,599

into the same problems with having to

989
00:39:33,510 --> 00:39:31,280
figure out where you are and needing to

990
00:39:35,430 --> 00:39:33,520
be able to actuate yourself to change

991
00:39:37,270 --> 00:39:35,440
where you're pointing um and stuff like

992
00:39:38,310 --> 00:39:37,280
that but that definitely is an option

993
00:39:40,630 --> 00:39:38,320
and there are people that are looking

994
00:39:44,630 --> 00:39:40,640
into doing cubesat swarms with tethers

995
00:39:50,150 --> 00:39:47,670
awesome thank you so much

996
00:40:06,069 --> 00:39:50,160
all right and now we'll turn this over

997
00:40:06,079 --> 00:40:10,950
which one's yours

998
00:40:34,309 --> 00:40:30,150
right

999
00:40:36,710 --> 00:40:34,319
this is going to be awesome

1000
00:40:44,710 --> 00:40:36,720
thank you very much

1001
00:40:49,750 --> 00:40:47,750
hi uh good morning i am excited to be at

1002
00:40:51,510 --> 00:40:49,760
my very first explorations colloquium

1003
00:40:53,190 --> 00:40:51,520
i'm coming to you guys from kennesaw

1004
00:40:54,550 --> 00:40:53,200
state university

1005
00:40:57,190 --> 00:40:54,560
where i work with dr heather abbott

1006
00:40:58,870 --> 00:40:57,200
lyons some of you may already know her

1007
00:41:01,349 --> 00:40:58,880
and i'm currently finishing up my

1008
00:41:02,950 --> 00:41:01,359
master's thesis there where i am focused

1009
00:41:05,109 --> 00:41:02,960
on the characterization and thermal

1010
00:41:06,710 --> 00:41:05,119
studies of metal phosphites

1011
00:41:08,150 --> 00:41:06,720
um and their potential role in

1012
00:41:09,910 --> 00:41:08,160
astrobiology

1013
00:41:11,829 --> 00:41:09,920

so if you're not already familiar with

1014
00:41:14,630 --> 00:41:11,839
the origin of life and the phosphorus

1015
00:41:16,150 --> 00:41:14,640
problem uh we know that the bio that

1016
00:41:18,470 --> 00:41:16,160
most of the biogenic elements were

1017
00:41:20,390 --> 00:41:18,480
present at least in part in a volatile

1018
00:41:22,950 --> 00:41:20,400
phase on the early earth

1019
00:41:24,870 --> 00:41:22,960
except for phosphorus

1020
00:41:26,309 --> 00:41:24,880
um it is believed that the conditions of

1021
00:41:29,349 --> 00:41:26,319
the early earth would have been too

1022
00:41:31,750 --> 00:41:29,359
oxidizing due to the presence of water

1023
00:41:34,150 --> 00:41:31,760
uh for phosphorus to exist in a volatile

1024
00:41:35,349 --> 00:41:34,160
phase such as phosphine

1025
00:41:37,829 --> 00:41:35,359
additionally

1026
00:41:39,910 --> 00:41:37,839
the majority of phosphorus found on

1027
00:41:42,309 --> 00:41:39,920
planet earth is found in the form of

1028
00:41:44,950 --> 00:41:42,319
phosphate which contains phosphorus in

1029
00:41:46,710 --> 00:41:44,960
its most oxidized uh form

1030
00:41:48,390 --> 00:41:46,720
the issue with phosphates on planet

1031
00:41:50,550 --> 00:41:48,400
earth is that they are very

1032
00:41:52,790 --> 00:41:50,560
unreactive with organics as well as in

1033
00:41:54,309 --> 00:41:52,800
soluble and aqueous environments so that

1034
00:41:56,710 --> 00:41:54,319
leads us to the question of how did

1035
00:42:00,150 --> 00:41:56,720
phosphorus become incorporated into so

1036
00:42:02,390 --> 00:42:00,160
many biological molecules and processes

1037
00:42:04,390 --> 00:42:02,400
our hypothesis is that metal phosphites

1038
00:42:06,470 --> 00:42:04,400

could have contributed a source of

1039
00:42:07,910 --> 00:42:06,480
reactive phosphorus that would have been

1040
00:42:10,069 --> 00:42:07,920
necessary to facilitate the

1041
00:42:11,990 --> 00:42:10,079
incorporation of phosphorus into these

1042
00:42:14,150 --> 00:42:12,000
prebiotic molecules

1043
00:42:16,710 --> 00:42:14,160
there are many natural sources of

1044
00:42:18,630 --> 00:42:16,720
phosphite that we have

1045
00:42:21,510 --> 00:42:18,640
literature

1046
00:42:23,589 --> 00:42:21,520
evidence for one of which is meteoritic

1047
00:42:26,710 --> 00:42:23,599
meteoritic corrosion products one of

1048
00:42:28,550 --> 00:42:26,720
those meteoritic

1049
00:42:31,030 --> 00:42:28,560
minerals is known as shriversite which

1050
00:42:33,430 --> 00:42:31,040
has been shown to corrode in

1051
00:42:35,670 --> 00:42:33,440
aqueous solution to various different

1052
00:42:38,230 --> 00:42:35,680
phosphorus species one of those being

1053
00:42:39,829 --> 00:42:38,240
the reduced form of phosphite

1054
00:42:42,230 --> 00:42:39,839
other natural sources of phosphite

1055
00:42:43,910 --> 00:42:42,240
include geothermal pools as well as the

1056
00:42:46,790 --> 00:42:43,920
iron redox geochemistry that would have

1057
00:42:48,870 --> 00:42:46,800
occurred in early archaean oceans

1058
00:42:50,790 --> 00:42:48,880
as well as lightning-induced reduction

1059
00:42:53,190 --> 00:42:50,800
of phosphorus minerals

1060
00:42:56,069 --> 00:42:53,200
to further support the availability of

1061
00:42:59,430 --> 00:42:56,079
phosphites we also know that various

1062
00:43:02,470 --> 00:42:59,440
bacteria are capable of using phosphite

1063
00:43:03,349 --> 00:43:02,480

in metabolic processes

1064
00:43:05,430 --> 00:43:03,359
oh

1065
00:43:08,710 --> 00:43:05,440
also mental phosphates are significantly

1066
00:43:10,630 --> 00:43:08,720
more soluble in aqueous environments

1067
00:43:13,030 --> 00:43:10,640
as compared to their phosphate

1068
00:43:14,870 --> 00:43:13,040
counterparts so for example calcium

1069
00:43:17,910 --> 00:43:14,880
phosphate has a solubility constant on

1070
00:43:19,589 --> 00:43:17,920
the order of 10 to the minus 8 whereas

1071
00:43:21,190 --> 00:43:19,599
calcium phosphate found as

1072
00:43:22,790 --> 00:43:21,200
hydroxyapatite

1073
00:43:25,270 --> 00:43:22,800
has a solubility constant of 10 to the

1074
00:43:27,750 --> 00:43:25,280
minus 58. so metal phosphites would have

1075
00:43:31,750 --> 00:43:27,760
been significantly more available in

1076
00:43:33,270 --> 00:43:31,760
neutral waters found on the early earth

1077
00:43:35,030 --> 00:43:33,280
since metal phosphites are not

1078
00:43:36,950 --> 00:43:35,040
commercially available we synthesize

1079
00:43:39,589 --> 00:43:36,960
them ourselves following a very simple

1080
00:43:41,910 --> 00:43:39,599
two-step reaction uh this perform both

1081
00:43:43,109 --> 00:43:41,920
steps performed in aqueous solution at

1082
00:43:45,510 --> 00:43:43,119
room temperature

1083
00:43:48,390 --> 00:43:45,520
uh first we react sodium hydroxide with

1084
00:43:50,470 --> 00:43:48,400
phosphorus acid to create sodium

1085
00:43:53,030 --> 00:43:50,480
phosphite and then we react the sodium

1086
00:43:56,710 --> 00:43:53,040
phosphite with a metal chloride to yield

1087
00:44:00,150 --> 00:43:58,150
these metal phosphites were also

1088
00:44:02,470 --> 00:44:00,160

characterized and studied using x-ray

1089
00:44:04,630 --> 00:44:02,480
diffraction thermogravimetric analysis

1090
00:44:07,270 --> 00:44:04,640
infrared spectroscopy as well as

1091
00:44:09,349 --> 00:44:07,280
phosphorus nmr

1092
00:44:11,990 --> 00:44:09,359
additionally these metal phosphites were

1093
00:44:14,550 --> 00:44:12,000
subjected to heating at

1094
00:44:17,190 --> 00:44:14,560
uh excuse me heating in a nitrogen

1095
00:44:19,349 --> 00:44:17,200
atmosphere in a tube furnace up to 600

1096
00:44:21,349 --> 00:44:19,359
degrees in increments of 100 degrees

1097
00:44:23,430 --> 00:44:21,359
celsius after each target temperature

1098
00:44:25,829 --> 00:44:23,440
was reached we would pull the sample and

1099
00:44:27,030 --> 00:44:25,839
analyze um using all of these methods

1100
00:44:29,109 --> 00:44:27,040
once again

1101
00:44:30,950 --> 00:44:29,119
for time's sake we do have data on all

1102
00:44:32,309 --> 00:44:30,960
four of these metal phosphites but um it

1103
00:44:36,790 --> 00:44:32,319
is a lot of data so we're only going to

1104
00:44:41,349 --> 00:44:39,670
um following the synthesis methods that

1105
00:44:42,950 --> 00:44:41,359
we following the synthesis of each of

1106
00:44:43,910 --> 00:44:42,960
the metal phosphates we characterize

1107
00:44:45,910 --> 00:44:43,920
them

1108
00:44:47,109 --> 00:44:45,920
with x-ray diffraction which provides us

1109
00:44:49,190 --> 00:44:47,119
information about the chemical

1110
00:44:50,950 --> 00:44:49,200
composition of our sample

1111
00:44:53,750 --> 00:44:50,960
and here i'm showing you the

1112
00:44:56,230 --> 00:44:53,760
experimental trace shown in black for

1113
00:44:58,630 --> 00:44:56,240

our synthesized metal phosphite which

1114
00:45:00,630 --> 00:44:58,640
appears to agree best with

1115
00:45:03,109 --> 00:45:00,640
the calcium phosphite standard that's

1116
00:45:05,270 --> 00:45:03,119
found in the xrd database

1117
00:45:07,349 --> 00:45:05,280
shown here to you as the blue drop the

1118
00:45:09,270 --> 00:45:07,359
light blue drop lines

1119
00:45:11,190 --> 00:45:09,280
and plotted against two impurities

1120
00:45:12,550 --> 00:45:11,200
calcium phosphate as well as calcium

1121
00:45:16,710 --> 00:45:12,560
hydroxide

1122
00:45:18,710 --> 00:45:16,720
so we were confident that our sample was

1123
00:45:21,510 --> 00:45:18,720
mostly calcium phosphite and if any

1124
00:45:23,430 --> 00:45:21,520
impurities did exist they did not

1125
00:45:28,790 --> 00:45:23,440
they were not present in large enough

1126
00:45:32,710 --> 00:45:30,710
following that we use thermogravimetric

1127
00:45:33,910 --> 00:45:32,720
analysis in order to gather some

1128
00:45:36,390 --> 00:45:33,920
information about the waters of

1129
00:45:37,589 --> 00:45:36,400
hydration and any oxidation events that

1130
00:45:40,470 --> 00:45:37,599
would have been occurring in these

1131
00:45:42,309 --> 00:45:40,480
calcium in calcium phosphite

1132
00:45:44,870 --> 00:45:42,319
and thermogravimetric analysis measures

1133
00:45:46,710 --> 00:45:44,880
changes in the mass of

1134
00:45:47,829 --> 00:45:46,720
a sample is a function of its

1135
00:45:49,589 --> 00:45:47,839
temperature

1136
00:45:51,750 --> 00:45:49,599
and here i'm showing you

1137
00:45:52,950 --> 00:45:51,760
um a temperature scan of calcium

1138
00:45:55,750 --> 00:45:52,960

phosphite

1139
00:45:58,230 --> 00:45:55,760
from 30 to 900 degrees celsius performed

1140
00:46:01,510 --> 00:45:58,240
in both air shown as the blue trace as

1141
00:46:02,790 --> 00:46:01,520
well as argon shown as a black trace a

1142
00:46:05,430 --> 00:46:02,800
couple of things that i wanted to point

1143
00:46:07,109 --> 00:46:05,440
out here are that we see relatively the

1144
00:46:08,069 --> 00:46:07,119
same characteristics

1145
00:46:11,430 --> 00:46:08,079
um

1146
00:46:14,790 --> 00:46:11,440
in the tga data in both air and argon

1147
00:46:16,870 --> 00:46:14,800
the first of which being this

1148
00:46:19,829 --> 00:46:16,880
the first of which being the significant

1149
00:46:22,230 --> 00:46:19,839
and rapid mass loss uh between 200 and

1150
00:46:24,630 --> 00:46:22,240
300 degrees celsius which is attributed

1151
00:46:27,510 --> 00:46:24,640
to the loss of waters of hydration of

1152
00:46:29,750 --> 00:46:27,520
the calcium phosphite and from this we

1153
00:46:30,870 --> 00:46:29,760
can also calculate the number of

1154
00:46:32,309 --> 00:46:30,880
hydration

1155
00:46:34,470 --> 00:46:32,319
waters that are in the sample which were

1156
00:46:36,950 --> 00:46:34,480
calculated to be one in both air and

1157
00:46:42,230 --> 00:46:39,109
the probably more interesting piece of

1158
00:46:43,430 --> 00:46:42,240
data here is that in both scans we see

1159
00:46:46,069 --> 00:46:43,440
this

1160
00:46:48,150 --> 00:46:46,079
significant increase in mass

1161
00:46:50,710 --> 00:46:48,160
in the higher temperature region which

1162
00:46:52,470 --> 00:46:50,720
is attributed to oxidation events that

1163
00:46:54,710 --> 00:46:52,480

are happening and what was the most

1164
00:46:57,109 --> 00:46:54,720
interesting to us is that we see

1165
00:46:58,230 --> 00:46:57,119
relatively the same amount of oxidation

1166
00:47:01,430 --> 00:46:58,240
in both

1167
00:47:03,829 --> 00:47:01,440
the argon purge as well as the air purge

1168
00:47:06,069 --> 00:47:03,839
so to us this indicated that whatever

1169
00:47:08,790 --> 00:47:06,079
oxidation was occurring

1170
00:47:11,190 --> 00:47:08,800
was not a direct result of oxidation by

1171
00:47:14,470 --> 00:47:11,200
the o2 molecules that were found in air

1172
00:47:16,069 --> 00:47:14,480
but rather from something else

1173
00:47:18,950 --> 00:47:16,079
so in order to further investigate the

1174
00:47:21,670 --> 00:47:18,960
oxidation species the oxidized species

1175
00:47:23,589 --> 00:47:21,680
that were being formed we performed

1176
00:47:25,109 --> 00:47:23,599
proton-coupled phosphorus nmr on these

1177
00:47:26,870 --> 00:47:25,119
samples

1178
00:47:28,549 --> 00:47:26,880
after they had been dried to each target

1179
00:47:30,390 --> 00:47:28,559
temperature all of the samples were

1180
00:47:32,950 --> 00:47:30,400
prepped at 100 millimolar and ph

1181
00:47:34,309 --> 00:47:32,960
adjusted to a ph4 for consistency in

1182
00:47:35,829 --> 00:47:34,319
comparison

1183
00:47:37,829 --> 00:47:35,839
and the key things that i wanted to

1184
00:47:40,630 --> 00:47:37,839
point out here are that there's no

1185
00:47:41,910 --> 00:47:40,640
variability between the samples that are

1186
00:47:45,670 --> 00:47:41,920
um

1187
00:47:48,309 --> 00:47:45,680
unheated

1188
00:47:50,630 --> 00:47:48,319

um versus after it had been heated to

1189
00:47:53,109 --> 00:47:50,640
200 degrees celsius we don't see any new

1190
00:47:56,069 --> 00:47:53,119
species forming in the phosphorus nmr

1191
00:47:58,230 --> 00:47:56,079
there however at about three at 300

1192
00:48:00,470 --> 00:47:58,240
degrees celsius we see the presence of

1193
00:48:02,069 --> 00:48:00,480
an oxidized species form

1194
00:48:03,430 --> 00:48:02,079
phosphate

1195
00:48:05,990 --> 00:48:03,440
and that peak

1196
00:48:07,430 --> 00:48:06,000
at zero ppm continues to increase in

1197
00:48:09,270 --> 00:48:07,440
intensity as we

1198
00:48:10,790 --> 00:48:09,280
get

1199
00:48:12,710 --> 00:48:10,800
higher in temperature which also

1200
00:48:14,549 --> 00:48:12,720
indicates that not only do we have the

1201
00:48:16,390 --> 00:48:14,559
presence of the oxidized species but it

1202
00:48:18,870 --> 00:48:16,400
continues to the sample continues to

1203
00:48:20,790 --> 00:48:18,880
oxidize as we heat it

1204
00:48:23,829 --> 00:48:20,800
at higher temperatures for

1205
00:48:27,670 --> 00:48:23,839
so 500 and 600 degrees celsius we see

1206
00:48:30,309 --> 00:48:27,680
uh the appearance of um phosphate dimers

1207
00:48:32,549 --> 00:48:30,319
and trimers so pyrophosphate and

1208
00:48:34,549 --> 00:48:32,559
triphosphate which indicates us that the

1209
00:48:38,870 --> 00:48:34,559
oxidized species was starting to

1210
00:48:42,790 --> 00:48:41,030
after running some longer

1211
00:48:45,670 --> 00:48:42,800
phosphorus nmr experiments we were able

1212
00:48:48,710 --> 00:48:45,680
to resolve a few more peaks between -3

1213
00:48:50,390 --> 00:48:48,720

and -8 ppm which have been assigned to

1214
00:48:55,349 --> 00:48:50,400
pyrophosphite

1215
00:48:57,670 --> 00:48:55,359
the

1216
00:48:58,870 --> 00:48:57,680
reduced form of phosphorus that is

1217
00:49:01,270 --> 00:48:58,880
phosphite

1218
00:49:03,190 --> 00:49:01,280
so our major takeaways from the nmr data

1219
00:49:04,790 --> 00:49:03,200
are that we not only have oxidation

1220
00:49:06,549 --> 00:49:04,800
occurring but we also have

1221
00:49:07,829 --> 00:49:06,559
polymerization occurring at the exact

1222
00:49:09,109 --> 00:49:07,839
same temperature so we have two

1223
00:49:11,270 --> 00:49:09,119
different processes happening at the

1224
00:49:13,510 --> 00:49:11,280
same time

1225
00:49:15,750 --> 00:49:13,520
and if we look at the infrared region

1226
00:49:18,150 --> 00:49:15,760
that's associated with the

1227
00:49:19,990 --> 00:49:18,160
stretching modes for the po3 for the

1228
00:49:23,589 --> 00:49:20,000
phosphite ion

1229
00:49:26,069 --> 00:49:23,599
we can see that at 300 400 and 500

1230
00:49:27,829 --> 00:49:26,079
degrees we see some significant changes

1231
00:49:29,109 --> 00:49:27,839
in the features that are associated with

1232
00:49:31,589 --> 00:49:29,119
the po3

1233
00:49:33,910 --> 00:49:31,599
stretching modes this further

1234
00:49:35,030 --> 00:49:33,920
corroborates with the temperatures that

1235
00:49:36,790 --> 00:49:35,040
we saw

1236
00:49:41,910 --> 00:49:36,800
oxidized and polymerized species

1237
00:49:45,990 --> 00:49:44,230
so we ran a series of isothermal

1238
00:49:47,349 --> 00:49:46,000

experiments i've only shown you a

1239
00:49:49,030 --> 00:49:47,359
selection here because we do have quite

1240
00:49:50,549 --> 00:49:49,040
a bit of data on this

1241
00:49:52,549 --> 00:49:50,559
and i know that there's a lot going on

1242
00:49:54,390 --> 00:49:52,559
in this slide so i just want to draw

1243
00:49:57,109 --> 00:49:54,400
your attention to a few things

1244
00:49:59,829 --> 00:49:57,119
one we know that we have quite a bit of

1245
00:50:01,190 --> 00:49:59,839
variability in the amount of oxidation

1246
00:50:04,549 --> 00:50:01,200
seen

1247
00:50:06,790 --> 00:50:04,559
even at the same isothermal temperature

1248
00:50:07,910 --> 00:50:06,800
however when we pre-dry one of our

1249
00:50:10,870 --> 00:50:07,920
samples

1250
00:50:13,109 --> 00:50:10,880
to 300 degrees in a tube furnace before

1251
00:50:15,510 --> 00:50:13,119
performing an isothermal experiment we

1252
00:50:17,270 --> 00:50:15,520
see little to no oxidation occurring

1253
00:50:19,270 --> 00:50:17,280
after the waters of hydration have been

1254
00:50:20,950 --> 00:50:19,280
driven off this was really interesting

1255
00:50:23,190 --> 00:50:20,960
to us um

1256
00:50:24,870 --> 00:50:23,200
and it then suggested that it's actually

1257
00:50:26,630 --> 00:50:24,880
interstitial waters that are found in

1258
00:50:28,870 --> 00:50:26,640
the calcium phosphite sample that are

1259
00:50:32,309 --> 00:50:28,880
causing the oxidation rather than the

1260
00:50:33,910 --> 00:50:32,319
oxygen found in the air purge

1261
00:50:35,670 --> 00:50:33,920
another thing that i wanted to point out

1262
00:50:37,870 --> 00:50:35,680
is that at some temperatures we see

1263
00:50:40,950 --> 00:50:37,880

these oscillatory patterns in the

1264
00:50:43,349 --> 00:50:40,960
isotherm um which at first we were

1265
00:50:44,630 --> 00:50:43,359
really taken aback by but after thinking

1266
00:50:47,109 --> 00:50:44,640
about it for a little while we

1267
00:50:49,030 --> 00:50:47,119
remembered that based on the nmr studies

1268
00:50:51,030 --> 00:50:49,040
that we performed we had two different

1269
00:50:52,390 --> 00:50:51,040
species we had two different processes

1270
00:50:54,710 --> 00:50:52,400
that were occurring remember we had the

1271
00:50:57,589 --> 00:50:54,720
polymerization happening as well as the

1272
00:50:59,430 --> 00:50:57,599
oxidation and so uh this indicated to us

1273
00:51:01,430 --> 00:50:59,440
that these two processes might be

1274
00:51:04,470 --> 00:51:01,440
competing with each other which would be

1275
00:51:06,549 --> 00:51:04,480
forming this oscillatory pattern um also

1276
00:51:09,430 --> 00:51:06,559
upon a literature review

1277
00:51:12,309 --> 00:51:09,440
we then realized we also learned that

1278
00:51:14,549 --> 00:51:12,319
the oscillations in tga data could also

1279
00:51:17,190 --> 00:51:14,559
be indicative of diffusion controlled

1280
00:51:19,750 --> 00:51:17,200
kinetics so we wanted to test for this

1281
00:51:22,470 --> 00:51:19,760
of course so we took one of our samples

1282
00:51:24,230 --> 00:51:22,480
um and saved it to a relatively uniform

1283
00:51:26,470 --> 00:51:24,240
particle size before performing the

1284
00:51:29,030 --> 00:51:26,480
isotherm and we see that those

1285
00:51:29,829 --> 00:51:29,040
oscillations have now been diminished

1286
00:51:31,349 --> 00:51:29,839
so

1287
00:51:32,630 --> 00:51:31,359
a couple of conclusions that we can take

1288
00:51:36,549 --> 00:51:32,640

away from this

1289
00:51:38,470 --> 00:51:36,559
uh we do believe that particle size has

1290
00:51:39,829 --> 00:51:38,480
a significant role in the reactivity

1291
00:51:41,829 --> 00:51:39,839
that we see

1292
00:51:43,430 --> 00:51:41,839
because it may affect the amount of

1293
00:51:45,349 --> 00:51:43,440
interstitial water that's present in the

1294
00:51:48,230 --> 00:51:45,359
sample

1295
00:51:50,309 --> 00:51:48,240
and we also know that the interstitial

1296
00:51:53,589 --> 00:51:50,319
water is causing the oxidation that we

1297
00:51:54,630 --> 00:51:53,599
see in the isotherms of the sample

1298
00:51:57,190 --> 00:51:54,640
and that

1299
00:51:59,910 --> 00:51:57,200
as the system is polymerized it releases

1300
00:52:01,670 --> 00:51:59,920
more water which further oxidizes the

1301
00:52:03,910 --> 00:52:01,680
sample

1302
00:52:05,589 --> 00:52:03,920
this can be further corroborated by what

1303
00:52:07,829 --> 00:52:05,599
i think is probably the most interesting

1304
00:52:09,589 --> 00:52:07,839
part of this data

1305
00:52:12,470 --> 00:52:09,599
if we look at the infrared region that's

1306
00:52:14,549 --> 00:52:12,480
associated with the phosphorus hydrogen

1307
00:52:16,470 --> 00:52:14,559
stretching mode of the molecule we can

1308
00:52:19,190 --> 00:52:16,480
see a couple of things that kind of

1309
00:52:21,670 --> 00:52:19,200
align with what we're trying to say so

1310
00:52:25,670 --> 00:52:21,680
initially we thought that the peak that

1311
00:52:28,710 --> 00:52:25,680
uh shows up 24 36 wave numbers

1312
00:52:31,349 --> 00:52:28,720
was the um ph stretching mode of calcium

1313
00:52:34,309 --> 00:52:31,359

phosphite however we now believe that

1314
00:52:35,750 --> 00:52:34,319
that mode is associated with a ph bond

1315
00:52:38,630 --> 00:52:35,760
where the hydrogen is actually

1316
00:52:39,910 --> 00:52:38,640
interacting somehow with a neighboring

1317
00:52:41,910 --> 00:52:39,920
oxygen

1318
00:52:44,069 --> 00:52:41,920
atom that could have that could be on

1319
00:52:46,790 --> 00:52:44,079
either a full water molecule or on a

1320
00:52:47,910 --> 00:52:46,800
hydroxyl

1321
00:52:50,549 --> 00:52:47,920
as we

1322
00:52:53,589 --> 00:52:50,559
drive off the waters we see this new

1323
00:52:55,750 --> 00:52:53,599
feature grow in around 2500 wave numbers

1324
00:52:58,710 --> 00:52:55,760
which we believe to be the

1325
00:53:01,750 --> 00:52:58,720
ph the true ph stretch and we believe

1326
00:53:05,750 --> 00:53:01,760
that it's growing in at 300 degrees as

1327
00:53:07,990 --> 00:53:05,760
the ph bond itself is strengthened um as

1328
00:53:09,910 --> 00:53:08,000
the waters you know go away from the

1329
00:53:12,309 --> 00:53:09,920
sample and the oxygen is no longer

1330
00:53:14,390 --> 00:53:12,319
pulling the electron density away from

1331
00:53:17,510 --> 00:53:14,400
the hydrogen molecule which allows this

1332
00:53:18,710 --> 00:53:17,520
peak to be blue shifted

1333
00:53:20,790 --> 00:53:18,720
um

1334
00:53:23,510 --> 00:53:20,800
however one thing that we do find is

1335
00:53:25,990 --> 00:53:23,520
interesting which kind of aligns with um

1336
00:53:28,630 --> 00:53:26,000
the data that we gathered on the tga is

1337
00:53:30,950 --> 00:53:28,640
that that initial peak that we

1338
00:53:33,670 --> 00:53:30,960

attributed to being the ph stretch is

1339
00:53:36,230 --> 00:53:33,680
retained in the sample which tells us

1340
00:53:38,549 --> 00:53:36,240
that um there is still some form of

1341
00:53:40,630 --> 00:53:38,559
water being retained in the sample up to

1342
00:53:42,710 --> 00:53:40,640
500 degrees celsius whether it be a full

1343
00:53:44,870 --> 00:53:42,720
water molecule or in the form of a

1344
00:53:46,549 --> 00:53:44,880
hydroxyl

1345
00:53:48,710 --> 00:53:46,559
so the conclusions that we can take away

1346
00:53:51,910 --> 00:53:48,720
from these data are that we do in fact

1347
00:53:53,430 --> 00:53:51,920
have simultaneous processes happening

1348
00:53:55,589 --> 00:53:53,440
one of which being the oxidation of

1349
00:53:57,349 --> 00:53:55,599
phosphite as well as the polymerization

1350
00:53:58,790 --> 00:53:57,359
of both the reduced and the oxidized

1351
00:54:00,470 --> 00:53:58,800
species

1352
00:54:01,910 --> 00:54:00,480
and we do think that we have diffusion

1353
00:54:03,910 --> 00:54:01,920
controlled kinetics that are playing a

1354
00:54:05,510 --> 00:54:03,920
role at higher temperatures this

1355
00:54:07,349 --> 00:54:05,520
combined with these two competing

1356
00:54:09,349 --> 00:54:07,359
processes make it really difficult for

1357
00:54:11,109 --> 00:54:09,359
us to pull any thermodynamic

1358
00:54:13,030 --> 00:54:11,119
information from these systems though we

1359
00:54:14,710 --> 00:54:13,040
have tried

1360
00:54:16,230 --> 00:54:14,720
as they don't appear to follow first

1361
00:54:17,910 --> 00:54:16,240
order kinetics so it is difficult to

1362
00:54:20,790 --> 00:54:17,920
gather that information

1363
00:54:23,270 --> 00:54:20,800

um and these results on a broader scale

1364
00:54:24,870 --> 00:54:23,280
suggest that calcium phosphites

1365
00:54:27,270 --> 00:54:24,880
are unlikely to be preserved in the

1366
00:54:28,950 --> 00:54:27,280
geological rock records in their reduced

1367
00:54:32,309 --> 00:54:28,960
form so you would instead see them in

1368
00:54:36,150 --> 00:54:34,150
and with that i would like to thank my

1369
00:54:37,990 --> 00:54:36,160
pi dr heather abbott lion as well as the

1370
00:54:40,230 --> 00:54:38,000
undergraduates in the lab that have

1371
00:54:42,069 --> 00:54:40,240
helped me collect some of this data

1372
00:54:43,589 --> 00:54:42,079
and we are in collaboration with dr

1373
00:54:45,750 --> 00:54:43,599
matthew pasek

1374
00:54:47,589 --> 00:54:45,760
who is our phosphorous nmr expert at the

1375
00:54:49,030 --> 00:54:47,599
university of south florida

1376
00:54:50,180 --> 00:54:49,040
and with that i'm happy to take any

1377
00:54:55,990 --> 00:54:50,190
questions

1378
00:55:08,470 --> 00:54:57,270
fantastic

1379
00:55:13,349 --> 00:55:10,710
hey so i

1380
00:55:14,549 --> 00:55:13,359
uh is it i'm just wondering how

1381
00:55:16,950 --> 00:55:14,559
interesting

1382
00:55:19,190 --> 00:55:16,960
is it for for just from just from the

1383
00:55:21,270 --> 00:55:19,200
perspective of interesting things that

1384
00:55:22,710 --> 00:55:21,280
the phosphites can do

1385
00:55:24,069 --> 00:55:22,720
that just

1386
00:55:25,829 --> 00:55:24,079
accidentally doing an experiment you

1387
00:55:27,990 --> 00:55:25,839
started getting a you started getting

1388
00:55:31,270 --> 00:55:28,000

oscillatory dynamics does that does that

1389
00:55:34,789 --> 00:55:31,280
suggest that these things can uh

1390
00:55:37,109 --> 00:55:34,799
do interesting uh chemistry that there's

1391
00:55:40,470 --> 00:55:37,119
um that there's uh

1392
00:55:42,950 --> 00:55:40,480
because i i'm not familiar with uh with

1393
00:55:44,390 --> 00:55:42,960
this um with this

1394
00:55:46,390 --> 00:55:44,400
with this chemistry is that is it

1395
00:55:52,100 --> 00:55:46,400
interesting that just accidentally you

1396
00:55:55,190 --> 00:55:53,589
[Music]

1397
00:55:57,270 --> 00:55:55,200
that's a good question and i appreciate

1398
00:55:58,630 --> 00:55:57,280
that question very much so at first

1399
00:56:00,309 --> 00:55:58,640
initially no i didn't think it was

1400
00:56:02,789 --> 00:56:00,319
interesting at all

1401
00:56:04,150 --> 00:56:02,799
until we started to realize that

1402
00:56:06,309 --> 00:56:04,160
some of those temperatures where we were

1403
00:56:07,750 --> 00:56:06,319
seeing those oscillations were also

1404
00:56:10,150 --> 00:56:07,760
occurring at the same temperatures that

1405
00:56:12,069 --> 00:56:10,160
we started seeing two processes

1406
00:56:14,069 --> 00:56:12,079
occurring from the nmr

1407
00:56:16,309 --> 00:56:14,079
so the two different processes of

1408
00:56:19,990 --> 00:56:16,319
oxidation and polymerization we believe

1409
00:56:22,630 --> 00:56:20,000
are what's causing those oscillations in

1410
00:56:24,309 --> 00:56:22,640
the tga data that we saw

1411
00:56:26,470 --> 00:56:24,319
as far as the chemistry goes we are

1412
00:56:28,230 --> 00:56:26,480
still actually trying to think about and

1413
00:56:29,990 --> 00:56:28,240

work out some of those mechanisms by

1414
00:56:36,710 --> 00:56:30,000
which things are happening and things

1415
00:56:43,430 --> 00:56:40,790
awesome well thank you so much kimberly

1416
00:56:46,470 --> 00:56:43,440
[Applause]

1417
00:56:49,829 --> 00:56:46,480
and we'll be taking a break now and

1418
00:57:10,790 --> 00:56:49,839
we'll see you all at 1105.

1419
00:57:10,800 --> 00:58:03,170
[Music]

1420
00:58:12,069 --> 00:58:03,430
[Applause]

1421
00:58:18,549 --> 00:58:15,360
i can keep on knocking doors

1422
00:59:12,930 --> 00:58:18,559
[Music]

1423
00:59:26,610 --> 00:59:12,940
so

1424
01:00:05,750 --> 00:59:57,200
[Music]

1425
01:00:05,760 --> 01:00:09,020
so

1426
01:04:23,109 --> 01:00:14,830
[Music]

1427
01:04:24,630 --> 01:04:23,119
all right for our second session this is

1428
01:04:26,309 --> 01:04:24,640
gonna be all about mars i know

1429
01:04:30,390 --> 01:04:26,319
everybody's so excited i'm really

1430
01:04:32,069 --> 01:04:30,400
excited um so we've got

1431
01:04:34,470 --> 01:04:32,079
we've got um

1432
01:04:37,589 --> 01:04:34,480
three talks in this session um so we

1433
01:04:40,390 --> 01:04:37,599
have uh dr james ray's group and then dr

1434
01:04:42,789 --> 01:04:40,400
francis hernandez's group

1435
01:04:44,309 --> 01:04:42,799
and so the first talk is going to be

1436
01:04:45,990 --> 01:04:44,319
emmy hughes

1437
01:04:47,750 --> 01:04:46,000
and all

1438
01:04:50,309 --> 01:04:47,760

if you have questions online or in

1439
01:04:51,670 --> 01:04:50,319
person we'll do that after her talk

1440
01:04:53,109 --> 01:04:51,680
and then after this whole session will

1441
01:04:54,710 --> 01:04:53,119
be lunch

1442
01:04:57,349 --> 01:04:54,720
so just to get it started emmy if you

1443
01:04:59,589 --> 01:04:57,359
want to come up here

1444
01:05:01,270 --> 01:04:59,599
and have you take it away did i ever put

1445
01:05:06,069 --> 01:05:01,280
your thinking

1446
01:05:11,270 --> 01:05:08,549
i think this is yours yeah yeah oh nice

1447
01:05:11,280 --> 01:05:17,589
all right

1448
01:05:22,230 --> 01:05:20,069
okay uh hello everyone my name is emmy

1449
01:05:24,470 --> 01:05:22,240
hughes i'm a first year phd student here

1450
01:05:25,270 --> 01:05:24,480
at georgia tech working with dr james

1451
01:05:26,630 --> 01:05:25,280
ray

1452
01:05:28,789 --> 01:05:26,640
and today i'll be talking about

1453
01:05:30,870 --> 01:05:28,799
geochemical and mineralogical evidence

1454
01:05:33,430 --> 01:05:30,880
against hydrothermal conditions in

1455
01:05:35,430 --> 01:05:33,440
aerodania basin on mars so i'll take you

1456
01:05:38,470 --> 01:05:35,440
through the title a little bit

1457
01:05:41,270 --> 01:05:38,480
i'm using geochemistry and mineralogy on

1458
01:05:44,230 --> 01:05:41,280
sort of regional scale so sort of course

1459
01:05:45,750 --> 01:05:44,240
uh resolution but broad coverage to sort

1460
01:05:48,069 --> 01:05:45,760
of investigate the extent of

1461
01:05:49,910 --> 01:05:48,079
hydrothermal conditions in area dania

1462
01:05:52,309 --> 01:05:49,920
basin it's a sort of ancient basin

1463
01:05:54,069 --> 01:05:52,319

system on mars dated to sort of early

1464
01:05:55,109 --> 01:05:54,079
martian potentially habitable time

1465
01:05:56,789 --> 01:05:55,119
periods

1466
01:05:58,390 --> 01:05:56,799
that may have had and hosted a

1467
01:05:59,910 --> 01:05:58,400
hydrothermal system and so i'm

1468
01:06:01,990 --> 01:05:59,920
investigating whether the regional

1469
01:06:04,390 --> 01:06:02,000
geochemistry and the mineralogy sort of

1470
01:06:06,470 --> 01:06:04,400
corroborate the existence of that system

1471
01:06:08,390 --> 01:06:06,480
and as you can see by the word against

1472
01:06:09,829 --> 01:06:08,400
here maybe we're seeing that it might

1473
01:06:11,510 --> 01:06:09,839
not

1474
01:06:13,270 --> 01:06:11,520
um so just to

1475
01:06:15,190 --> 01:06:13,280
sort of back up a little bit and think

1476
01:06:17,430 --> 01:06:15,200
about the martian regolith on broad

1477
01:06:20,309 --> 01:06:17,440
scales we know that mars is mostly

1478
01:06:22,470 --> 01:06:20,319
basaltic um so sort of uh relatively

1479
01:06:24,549 --> 01:06:22,480
primitive igneous rocks uh and we know

1480
01:06:26,470 --> 01:06:24,559
that the regolith is composed of that

1481
01:06:28,390 --> 01:06:26,480
primary basaltic material so you have

1482
01:06:30,549 --> 01:06:28,400
mostly pyroxenes plagioclases and

1483
01:06:31,750 --> 01:06:30,559
olivine minerals but we also know that

1484
01:06:33,430 --> 01:06:31,760
you know there's been some water

1485
01:06:36,150 --> 01:06:33,440
alteration processes that have happened

1486
01:06:38,309 --> 01:06:36,160
on mars and the production of secondary

1487
01:06:40,630 --> 01:06:38,319
minerals uh from the sort of alteration

1488
01:06:42,549 --> 01:06:40,640

of that primary basaltic mineralogy so

1489
01:06:44,789 --> 01:06:42,559
you get things like sulfates chlorides

1490
01:06:47,190 --> 01:06:44,799
carbonates clays and hematite um here

1491
01:06:49,349 --> 01:06:47,200
are some lovely uh hematite sort of

1492
01:06:51,109 --> 01:06:49,359
nodules uh that are called blueberries

1493
01:06:52,789 --> 01:06:51,119
that were identified and are really nice

1494
01:06:54,710 --> 01:06:52,799
evidence of secondary alteration

1495
01:06:56,549 --> 01:06:54,720
processes we also have some iron

1496
01:06:58,230 --> 01:06:56,559
sulfates up here uh that you can see

1497
01:07:00,390 --> 01:06:58,240
from the rover tracks from the spirit

1498
01:07:02,309 --> 01:07:00,400
rover so when that rover was sort of

1499
01:07:03,750 --> 01:07:02,319
doing its daily business it unearthed

1500
01:07:05,510 --> 01:07:03,760
some interesting geology that there's

1501
01:07:07,029 --> 01:07:05,520
this sort of layer of iron sulfate in

1502
01:07:09,430 --> 01:07:07,039
the martian regolith

1503
01:07:10,789 --> 01:07:09,440
um so as you can see we have a few

1504
01:07:13,029 --> 01:07:10,799
different ways of constraining that

1505
01:07:15,670 --> 01:07:13,039
mineralogy we have in-situ data from

1506
01:07:17,990 --> 01:07:15,680
ridiani gusev and gale and now of course

1507
01:07:19,670 --> 01:07:18,000
jezera with our perseverance rover we

1508
01:07:21,510 --> 01:07:19,680
also have these iron sulfates and then

1509
01:07:23,589 --> 01:07:21,520
we also know that there's some soil

1510
01:07:25,430 --> 01:07:23,599
variation potentially across the martian

1511
01:07:27,190 --> 01:07:25,440
topographic dichotomy

1512
01:07:29,029 --> 01:07:27,200
but there are also some unknowns and

1513
01:07:32,069 --> 01:07:29,039

some of these unknowns include whether

1514
01:07:34,789 --> 01:07:32,079
or not the soil is relatively homogeneic

1515
01:07:37,029 --> 01:07:34,799
or sort of the same as a global unit

1516
01:07:38,950 --> 01:07:37,039
across mars or whether it's more locally

1517
01:07:40,390 --> 01:07:38,960
derived whether you have sort of erosion

1518
01:07:42,470 --> 01:07:40,400
of local bedrock

1519
01:07:43,349 --> 01:07:42,480
and it might be more heterogeneic across

1520
01:07:45,349 --> 01:07:43,359
mars

1521
01:07:47,190 --> 01:07:45,359
we also uh don't necessarily know the

1522
01:07:48,950 --> 01:07:47,200
mechanical and the chemical pathways of

1523
01:07:51,510 --> 01:07:48,960
alteration and whether we're getting

1524
01:07:53,430 --> 01:07:51,520
sort of in-situ alteration ongoing now

1525
01:07:55,750 --> 01:07:53,440
if maybe we're even forming low ph

1526
01:07:57,029 --> 01:07:55,760
brines on mars on the modern surface and

1527
01:07:59,109 --> 01:07:57,039
finally we don't really know if there's

1528
01:08:01,109 --> 01:07:59,119
sort of soil horizons or stratification

1529
01:08:03,910 --> 01:08:01,119
or if it's relatively homogeneous on a

1530
01:08:05,829 --> 01:08:03,920
sort of lateral dimension or

1531
01:08:07,430 --> 01:08:05,839
looking up and down

1532
01:08:08,789 --> 01:08:07,440
so we have some data sets that we can

1533
01:08:10,630 --> 01:08:08,799
use to investigate these kinds of

1534
01:08:12,470 --> 01:08:10,640
questions one of the main ones i'm

1535
01:08:14,150 --> 01:08:12,480
working with is gamma ray spectroscopy

1536
01:08:15,750 --> 01:08:14,160
data so this is

1537
01:08:17,829 --> 01:08:15,760
sort of gamma data it gives you

1538
01:08:20,470 --> 01:08:17,839

elemental abundances for mars and you

1539
01:08:22,789 --> 01:08:20,480
can see that it's about five degrees by

1540
01:08:24,550 --> 01:08:22,799
five degree pixel scale so relatively

1541
01:08:26,630 --> 01:08:24,560
coarse coarse-grained you can use this

1542
01:08:29,349 --> 01:08:26,640
to reconstruct the sort of

1543
01:08:30,709 --> 01:08:29,359
regional uh differences in geology and

1544
01:08:33,110 --> 01:08:30,719
sort of understand the kind of

1545
01:08:35,030 --> 01:08:33,120
large-scale geologic history of mars so

1546
01:08:36,630 --> 01:08:35,040
we have a variety of mineral-forming

1547
01:08:38,470 --> 01:08:36,640
elements that we can constrain with

1548
01:08:39,590 --> 01:08:38,480
gamma-ray spectroscopy data but there

1549
01:08:41,990 --> 01:08:39,600
are some that we don't have and this

1550
01:08:43,749 --> 01:08:42,000
includes magnesium phosphorus sodium and

1551
01:08:45,590 --> 01:08:43,759
manganese all of which are important

1552
01:08:47,510 --> 01:08:45,600
mineral forming elements

1553
01:08:49,189 --> 01:08:47,520
so it's important to figure out a way to

1554
01:08:52,709 --> 01:08:49,199
constrain these abundances if we want to

1555
01:08:53,990 --> 01:08:52,719
get at the total mineralogy of mars

1556
01:08:55,990 --> 01:08:54,000
we also have thermal emission

1557
01:08:58,149 --> 01:08:56,000
spectroscopy data so this is relying on

1558
01:09:00,070 --> 01:08:58,159
the emissivity of the surface minerals

1559
01:09:01,910 --> 01:09:00,080
uh because of that we can't get coverage

1560
01:09:04,149 --> 01:09:01,920
for all of mars so there's relatively

1561
01:09:06,550 --> 01:09:04,159
dusty areas for which we don't have sort

1562
01:09:08,309 --> 01:09:06,560
of surface mineralogical data but we can

1563
01:09:10,630 --> 01:09:08,319

use it to derive a series of sort of

1564
01:09:13,110 --> 01:09:10,640
classes that can tell you about sort of

1565
01:09:14,390 --> 01:09:13,120
uh global variations in mineralogy and

1566
01:09:15,749 --> 01:09:14,400
so that's the map that you're seeing

1567
01:09:17,349 --> 01:09:15,759
here

1568
01:09:19,189 --> 01:09:17,359
so these two data sets combined we can

1569
01:09:20,950 --> 01:09:19,199
sort of integrate them to understand the

1570
01:09:22,789 --> 01:09:20,960
overall mineralogy of the martian

1571
01:09:24,149 --> 01:09:22,799
surface

1572
01:09:25,990 --> 01:09:24,159
i'll just take a pause and catch my

1573
01:09:28,789 --> 01:09:26,000
breath a little bit my mask is uh making

1574
01:09:31,669 --> 01:09:28,799
it troublesome to breathe

1575
01:09:34,950 --> 01:09:33,030
okay so

1576
01:09:37,189 --> 01:09:34,960
our overall process is integrating these

1577
01:09:39,430 --> 01:09:37,199
two data sets um and so there's been

1578
01:09:41,590 --> 01:09:39,440
some previous work that's done this uh

1579
01:09:44,309 --> 01:09:41,600
this is using in-situ data for mars for

1580
01:09:46,550 --> 01:09:44,319
spirit and opportunity rovers um so for

1581
01:09:48,789 --> 01:09:46,560
these data sets we have rover uh

1582
01:09:51,189 --> 01:09:48,799
capabilities to do geochemical data

1583
01:09:53,030 --> 01:09:51,199
using ap excess data we also have what's

1584
01:09:55,030 --> 01:09:53,040
called mini tests so that's sort of a

1585
01:09:56,790 --> 01:09:55,040
small thermal emission spectrometer and

1586
01:09:58,550 --> 01:09:56,800
we can use those data sets to integrate

1587
01:10:01,189 --> 01:09:58,560
them to get at the total mineralogy of

1588
01:10:03,350 --> 01:10:01,199

both primary and secondary minerals so

1589
01:10:05,910 --> 01:10:03,360
for our work we're substituting gamma

1590
01:10:08,070 --> 01:10:05,920
ray spectroscopy data for ap excess data

1591
01:10:10,149 --> 01:10:08,080
test data for many tests and then we

1592
01:10:12,470 --> 01:10:10,159
don't have moss bar data so that's uh

1593
01:10:15,110 --> 01:10:12,480
secondary or sorry that's iron minerals

1594
01:10:16,390 --> 01:10:15,120
um so we use test data sorry i actually

1595
01:10:17,990 --> 01:10:16,400
might take my mask off i'm having a

1596
01:10:23,270 --> 01:10:18,000
little trouble breathing

1597
01:10:25,430 --> 01:10:24,229
okay

1598
01:10:27,910 --> 01:10:25,440
so i'm gonna pop through this quickly

1599
01:10:30,229 --> 01:10:27,920
because i've already talked about that

1600
01:10:31,669 --> 01:10:30,239
okay yeah so we need to derive

1601
01:10:33,750 --> 01:10:31,679
additional elements that we don't have

1602
01:10:35,990 --> 01:10:33,760
constrained via gamma-ray spectroscopy

1603
01:10:38,229 --> 01:10:36,000
data so a lot of my work was doing that

1604
01:10:40,070 --> 01:10:38,239
um so i developed a variety of methods

1605
01:10:41,990 --> 01:10:40,080
including ratio methods regression and

1606
01:10:43,110 --> 01:10:42,000
mass balance approaches to get at some

1607
01:10:44,790 --> 01:10:43,120
secondary

1608
01:10:46,950 --> 01:10:44,800
or to get some additional elemental

1609
01:10:48,470 --> 01:10:46,960
concentrations and abundances um and i

1610
01:10:50,149 --> 01:10:48,480
can talk about that in detail if people

1611
01:10:52,070 --> 01:10:50,159
want to hear about it but generally

1612
01:10:54,229 --> 01:10:52,080
speaking i've derived a sort of robust

1613
01:10:56,149 --> 01:10:54,239

way of getting additional oxide

1614
01:10:58,229 --> 01:10:56,159
abundances that aren't constrained with

1615
01:11:00,310 --> 01:10:58,239
grs data and here are some of these sort

1616
01:11:02,149 --> 01:11:00,320
of ratios that are at play here using

1617
01:11:04,149 --> 01:11:02,159
both sort of meteoritic data in situ

1618
01:11:06,790 --> 01:11:04,159
data so on and so forth and then i've

1619
01:11:08,950 --> 01:11:06,800
reconstructed the maps of what magnesium

1620
01:11:11,590 --> 01:11:08,960
might look like across mars

1621
01:11:13,669 --> 01:11:11,600
and also the other oxide abundances so

1622
01:11:15,030 --> 01:11:13,679
this was successful um

1623
01:11:16,310 --> 01:11:15,040
and so now that you have a sense of the

1624
01:11:18,950 --> 01:11:16,320
methods that we're using and why we're

1625
01:11:20,630 --> 01:11:18,960
using them uh we can talk about eradania

1626
01:11:23,030 --> 01:11:20,640
basin in more detail so this is

1627
01:11:25,110 --> 01:11:23,040
aerodania basin here you can see that

1628
01:11:26,870 --> 01:11:25,120
there's uh this sort of maybe you can

1629
01:11:29,030 --> 01:11:26,880
see it the sort of channel system that's

1630
01:11:30,870 --> 01:11:29,040
kind of up in the north so this is

1631
01:11:32,630 --> 01:11:30,880
what's called madame valles and up here

1632
01:11:35,350 --> 01:11:32,640
is gusev crater the landing site of the

1633
01:11:37,510 --> 01:11:35,360
spirit rover an aerodania basin may have

1634
01:11:38,950 --> 01:11:37,520
been sort of a large system for uh

1635
01:11:41,350 --> 01:11:38,960
through which this channel was connected

1636
01:11:43,750 --> 01:11:41,360
to gusev crater that in the nowakian era

1637
01:11:46,310 --> 01:11:43,760
may have been for a sort of a long time

1638
01:11:48,870 --> 01:11:46,320

hundreds of millions of years of scale

1639
01:11:50,470 --> 01:11:48,880
had a paleo lake basin and this paleo

1640
01:11:54,870 --> 01:11:50,480
lake basin may have also hosted a

1641
01:11:57,350 --> 01:11:54,880
hydrothermal system so uh in 2017 uh uh

1642
01:11:58,870 --> 01:11:57,360
joel mcchelsky uh published a paper

1643
01:12:01,270 --> 01:11:58,880
about the possibility of an ancient

1644
01:12:03,350 --> 01:12:01,280
hydrothermal seafloor deposit system

1645
01:12:05,110 --> 01:12:03,360
here um so there's a lot of secondary

1646
01:12:08,149 --> 01:12:05,120
minerals that are indicative of this

1647
01:12:10,149 --> 01:12:08,159
potential system and then in 2021 uh

1648
01:12:12,149 --> 01:12:10,159
luju osha who is a graduate of georgia

1649
01:12:13,750 --> 01:12:12,159
tech's phd program published a paper

1650
01:12:16,229 --> 01:12:13,760
that maybe the system was heated

1651
01:12:17,750 --> 01:12:16,239
amigotically by the decay of radiogenic

1652
01:12:19,590 --> 01:12:17,760
heat producing elements including

1653
01:12:22,070 --> 01:12:19,600
thorium and potassium which are both

1654
01:12:24,149 --> 01:12:22,080
enriched in this region so there's some

1655
01:12:26,470 --> 01:12:24,159
evidence and some recent sort of push

1656
01:12:28,149 --> 01:12:26,480
towards an ancient hydrothermal system

1657
01:12:29,590 --> 01:12:28,159
in this area

1658
01:12:32,070 --> 01:12:29,600
and some of the evidence for this comes

1659
01:12:33,910 --> 01:12:32,080
from the mineralogy also comes from

1660
01:12:35,669 --> 01:12:33,920
magnetic anomalies that we see that may

1661
01:12:37,510 --> 01:12:35,679
be due to the presence of magnetite

1662
01:12:39,910 --> 01:12:37,520
induced by serpentinization of the

1663
01:12:41,750 --> 01:12:39,920

olivine rich crust we also see these

1664
01:12:43,430 --> 01:12:41,760
radioactive element enrichment which may

1665
01:12:44,550 --> 01:12:43,440
be decaying and leading to that thermal

1666
01:12:46,310 --> 01:12:44,560
gradient

1667
01:12:48,149 --> 01:12:46,320
and here is the sort of overall scope

1668
01:12:50,310 --> 01:12:48,159
for what eradania may have looked like

1669
01:12:51,510 --> 01:12:50,320
here are some deep basin deposits and

1670
01:12:53,830 --> 01:12:51,520
then here's how the system may have

1671
01:12:56,070 --> 01:12:53,840
worked according to the machelsky paper

1672
01:12:57,750 --> 01:12:56,080
uh and so the more recent paper suggests

1673
01:12:59,430 --> 01:12:57,760
here's our sort of region of thorium and

1674
01:13:01,750 --> 01:12:59,440
potassium enrichment here are our

1675
01:13:03,189 --> 01:13:01,760
magnetic anomalies so overall it seems

1676
01:13:04,870 --> 01:13:03,199
like there's some

1677
01:13:07,270 --> 01:13:04,880
sort of global data sets indicating the

1678
01:13:08,790 --> 01:13:07,280
presence of this system

1679
01:13:11,830 --> 01:13:08,800
but there's also been pushback against

1680
01:13:13,590 --> 01:13:11,840
that idea so in 2020 dr david levington

1681
01:13:16,630 --> 01:13:13,600
posted a paper that sort of interpreted

1682
01:13:18,390 --> 01:13:16,640
the uh the signatures that may that were

1683
01:13:19,750 --> 01:13:18,400
previously interpreted as fluvial or

1684
01:13:22,390 --> 01:13:19,760
liquestrine

1685
01:13:23,830 --> 01:13:22,400
as potentially low viscosity lava flows

1686
01:13:26,470 --> 01:13:23,840
so reinterpreting these kind of

1687
01:13:28,390 --> 01:13:26,480
geomorphic features um and also

1688
01:13:30,470 --> 01:13:28,400

suggested that the abundance of

1689
01:13:32,709 --> 01:13:30,480
secondary minerals that we're finding in

1690
01:13:34,550 --> 01:13:32,719
the eradania region are not

1691
01:13:36,229 --> 01:13:34,560
significantly more enriched within the

1692
01:13:38,870 --> 01:13:36,239
confines topographic confines of

1693
01:13:40,950 --> 01:13:38,880
varidania than they are outside of it so

1694
01:13:43,669 --> 01:13:40,960
maybe this you know wasn't necessarily a

1695
01:13:45,030 --> 01:13:43,679
putative balea lake uh after all so

1696
01:13:47,990 --> 01:13:45,040
that's sort of the impetus for our work

1697
01:13:49,750 --> 01:13:48,000
here so we derived the mineralogy for

1698
01:13:51,590 --> 01:13:49,760
the region using a couple of different

1699
01:13:53,910 --> 01:13:51,600
uh geographic constraints based on

1700
01:13:55,990 --> 01:13:53,920
t-tests of the abundance of both thorium

1701
01:13:58,470 --> 01:13:56,000
and potassium and we got at the sort of

1702
01:14:01,189 --> 01:13:58,480
bulk average mineralogy for the region

1703
01:14:04,070 --> 01:14:01,199
and as you can see we see mostly uh sort

1704
01:14:06,070 --> 01:14:04,080
of relatively unaltered mafic mineralogy

1705
01:14:07,910 --> 01:14:06,080
so we've got very high olivine abundance

1706
01:14:10,149 --> 01:14:07,920
and if you know anything about olivine

1707
01:14:12,310 --> 01:14:10,159
it weathers very quickly uh with just a

1708
01:14:13,830 --> 01:14:12,320
little bit of water so we if this lake

1709
01:14:16,070 --> 01:14:13,840
existed for hundreds of millions of

1710
01:14:18,790 --> 01:14:16,080
years we shouldn't see such high olivine

1711
01:14:20,390 --> 01:14:18,800
abundances we're at about 28 percent

1712
01:14:22,310 --> 01:14:20,400
we use two different methods of deriving

1713
01:14:24,550 --> 01:14:22,320

the magnesium you can see that they're

1714
01:14:27,110 --> 01:14:24,560
uh corroborating each other

1715
01:14:28,550 --> 01:14:27,120
quite well um so that's a pretty good

1716
01:14:30,470 --> 01:14:28,560
sort of indication that we've got high

1717
01:14:32,390 --> 01:14:30,480
olivine here we've also got about 10

1718
01:14:35,030 --> 01:14:32,400
weight percent of secondary minerals in

1719
01:14:36,950 --> 01:14:35,040
total um so that is

1720
01:14:38,550 --> 01:14:36,960
you know that's that's a lot but it's

1721
01:14:40,790 --> 01:14:38,560
not necessarily more than the martian

1722
01:14:42,390 --> 01:14:40,800
crustal averages for those uh so what

1723
01:14:45,030 --> 01:14:42,400
we're seeing here is relatively

1724
01:14:46,470 --> 01:14:45,040
unaltered mafic mineralogy which is not

1725
01:14:50,630 --> 01:14:46,480
consistent with what you would expect

1726
01:14:54,470 --> 01:14:52,310
so uh in order to look at a different

1727
01:14:56,790 --> 01:14:54,480
data set and maybe sort of investigate

1728
01:14:58,470 --> 01:14:56,800
uh you know if there are other ways to

1729
01:15:00,790 --> 01:14:58,480
to corroborate that we were looking at

1730
01:15:02,950 --> 01:15:00,800
chrism data which is uh visible to near

1731
01:15:04,950 --> 01:15:02,960
infrared spectral data of the region um

1732
01:15:06,950 --> 01:15:04,960
so these are lots of the sort of uh

1733
01:15:09,030 --> 01:15:06,960
chrism stamps that we investigated that

1734
01:15:10,390 --> 01:15:09,040
i investigated um and we were looking

1735
01:15:12,790 --> 01:15:10,400
specifically for

1736
01:15:15,430 --> 01:15:12,800
uh morphe silica which is a very useful

1737
01:15:17,590 --> 01:15:15,440
mineraloid for reconstructing a paleo

1738
01:15:19,350 --> 01:15:17,600

environment because the sort of shape

1739
01:15:21,430 --> 01:15:19,360
and the depth of the absorptions can

1740
01:15:23,110 --> 01:15:21,440
kind of tell you the extent of uh

1741
01:15:25,270 --> 01:15:23,120
interaction with water so it can be a

1742
01:15:27,430 --> 01:15:25,280
proxy for hydrothermal versus epithermal

1743
01:15:28,870 --> 01:15:27,440
conditions and so on and so forth so we

1744
01:15:30,790 --> 01:15:28,880
were looking for this mineraloid in

1745
01:15:33,110 --> 01:15:30,800
order to do that kind of reconstruction

1746
01:15:35,669 --> 01:15:33,120
um we found two chrism stamps that had

1747
01:15:38,870 --> 01:15:35,679
uh that had a more basilica they are up

1748
01:15:39,990 --> 01:15:38,880
here and over here so these were our two

1749
01:15:41,830 --> 01:15:40,000
kind of

1750
01:15:43,990 --> 01:15:41,840
main ways of being able to derive

1751
01:15:46,310 --> 01:15:44,000
insight into that question and both of

1752
01:15:47,990 --> 01:15:46,320
them seem to be in sort of paraglacial

1753
01:15:50,149 --> 01:15:48,000
or aeolian settings

1754
01:15:52,390 --> 01:15:50,159
so in this chrism stamp we see mostly

1755
01:15:54,470 --> 01:15:52,400
what looks like redistributed aeolian

1756
01:15:56,310 --> 01:15:54,480
amorphous silica and then in this chrism

1757
01:15:57,189 --> 01:15:56,320
stamp over here which i'm showing just

1758
01:15:58,950 --> 01:15:57,199
here

1759
01:16:00,390 --> 01:15:58,960
shows this sort of sawtooth pattern

1760
01:16:01,910 --> 01:16:00,400
which i'm not sure how well you can see

1761
01:16:03,510 --> 01:16:01,920
on this structure and that's more

1762
01:16:05,750 --> 01:16:03,520
indicative of relatively recent

1763
01:16:07,350 --> 01:16:05,760

paraglacial processes so neither of

1764
01:16:10,229 --> 01:16:07,360
these seem to be sort of bedrock

1765
01:16:12,390 --> 01:16:10,239
settings or consistent with sort of uh

1766
01:16:13,910 --> 01:16:12,400
kind of a hydrothermal system but maybe

1767
01:16:15,990 --> 01:16:13,920
more something like redistribution or

1768
01:16:18,390 --> 01:16:16,000
paraglacial processes and this was

1769
01:16:20,229 --> 01:16:18,400
corroborated by our spectral analysis

1770
01:16:22,149 --> 01:16:20,239
you can see some of our data plots in

1771
01:16:24,070 --> 01:16:22,159
the um the area of aeolian and

1772
01:16:25,669 --> 01:16:24,080
paraglacial or in the sort of overlapped

1773
01:16:27,350 --> 01:16:25,679
region but nothing very clearly

1774
01:16:29,110 --> 01:16:27,360
indicating bedrock

1775
01:16:30,229 --> 01:16:29,120
and we do that by looking at the sort of

1776
01:16:31,830 --> 01:16:30,239
position and the depth of the

1777
01:16:34,390 --> 01:16:31,840
absorptions that you can see here in

1778
01:16:35,669 --> 01:16:34,400
this vnir spectral plot

1779
01:16:37,030 --> 01:16:35,679
so we've come up with two different

1780
01:16:39,110 --> 01:16:37,040
models that we're sort of offering for

1781
01:16:40,790 --> 01:16:39,120
the overall region one of them is a

1782
01:16:43,510 --> 01:16:40,800
mafic volcanism model which does not

1783
01:16:45,189 --> 01:16:43,520
necessitate any hydrothermalism at all

1784
01:16:47,189 --> 01:16:45,199
and so we suggest that the secondary

1785
01:16:49,030 --> 01:16:47,199
minerals may have been formed by

1786
01:16:52,310 --> 01:16:49,040
incipient alteration of the basaltic

1787
01:16:54,149 --> 01:16:52,320
material or sort of fumorolic action so

1788
01:16:56,070 --> 01:16:54,159

if you have sort of explosive lava flows

1789
01:16:57,910 --> 01:16:56,080
where you get or explosive volcanism

1790
01:16:59,750 --> 01:16:57,920
where you get a lot of volatilization

1791
01:17:01,669 --> 01:16:59,760
these can sort of quickly alter your ash

1792
01:17:02,870 --> 01:17:01,679
and potentially lead to the formation of

1793
01:17:05,189 --> 01:17:02,880
those secondary

1794
01:17:08,070 --> 01:17:05,199
minerals that we're seeing we also offer

1795
01:17:10,310 --> 01:17:08,080
a hydrothermal and mafic model where you

1796
01:17:12,310 --> 01:17:10,320
have some hydrothermalism but you also

1797
01:17:15,270 --> 01:17:12,320
have some effusive low viscosity

1798
01:17:17,270 --> 01:17:15,280
volcanic flows that then sort of

1799
01:17:19,350 --> 01:17:17,280
create a mafic cap essentially over the

1800
01:17:21,350 --> 01:17:19,360
evidence for hydrothermal minerals so

1801
01:17:23,189 --> 01:17:21,360
these are our sort of uh two ways of

1802
01:17:25,430 --> 01:17:23,199
potentially tying everything that we're

1803
01:17:27,510 --> 01:17:25,440
seeing together the secondary minerals

1804
01:17:30,310 --> 01:17:27,520
as well as the evidence for sort of a

1805
01:17:31,910 --> 01:17:30,320
mafic mineralogy overall so our

1806
01:17:34,229 --> 01:17:31,920
conclusions are that the magnesium in

1807
01:17:35,669 --> 01:17:34,239
the aerodynamia region is on par with

1808
01:17:38,550 --> 01:17:35,679
global crustal averages which is not

1809
01:17:40,390 --> 01:17:38,560
something i went into but is about true

1810
01:17:42,550 --> 01:17:40,400
the regional mineralogy is consistent

1811
01:17:44,630 --> 01:17:42,560
with unaltered basaltic material and

1812
01:17:46,390 --> 01:17:44,640
finally that spectral analysis seems to

1813
01:17:48,229 --> 01:17:46,400

indicate that the amorphous silica is

1814
01:17:50,149 --> 01:17:48,239
more consistent with aeolian and glacial

1815
01:17:51,350 --> 01:17:50,159
activity than it is with hydrothermal

1816
01:17:54,470 --> 01:17:51,360
activity

1817
01:17:57,110 --> 01:17:54,480
um so thank you i'll also thank uh james

1818
01:17:58,630 --> 01:17:57,120
ray dr sunnity coronatillokay don hood

1819
01:18:00,750 --> 01:17:58,640
gus bates and alco for their help with

1820
01:18:07,189 --> 01:18:00,760
this but thanks very much

1821
01:18:11,030 --> 01:18:09,270
all right does anybody have questions i

1822
01:18:12,790 --> 01:18:11,040
think we have time for about one

1823
01:18:14,550 --> 01:18:12,800
question

1824
01:18:17,350 --> 01:18:14,560
anybody online either

1825
01:18:21,750 --> 01:18:17,360
is there any ques no okay

1826
01:18:25,350 --> 01:18:23,110
uh when you talk about these

1827
01:18:26,870 --> 01:18:25,360
hydrothermal systems are these proposed

1828
01:18:28,149 --> 01:18:26,880
to be low temperature or high

1829
01:18:30,550 --> 01:18:28,159
temperature

1830
01:18:33,990 --> 01:18:30,560
um i think this would be relatively high

1831
01:18:35,750 --> 01:18:34,000
temperature um i guess depending on

1832
01:18:39,189 --> 01:18:35,760
you know the concentration of these

1833
01:18:42,149 --> 01:18:39,199
radiogenic heat producing uh elements uh

1834
01:18:43,430 --> 01:18:42,159
sort of in the upper crust i guess um

1835
01:18:44,870 --> 01:18:43,440
but yeah i think it'd be relatively high

1836
01:18:46,950 --> 01:18:44,880
temperature if you wanted to look into

1837
01:18:49,030 --> 01:18:46,960
it in more detail the oja 2021 paper

1838
01:18:52,310 --> 01:18:49,040

provides the thermal gradients

1839
01:18:55,110 --> 01:18:52,320
that you'd expect so um so yeah

1840
01:18:56,790 --> 01:18:55,120
but sort of uh centrally there is

1841
01:18:58,709 --> 01:18:56,800
sufficient sort of energy gaps or

1842
01:19:00,870 --> 01:18:58,719
gradients in this kind of

1843
01:19:04,310 --> 01:19:00,880
uh in this expected hydrothermal system

1844
01:19:06,470 --> 01:19:04,320
for you know exploitability by life

1845
01:19:10,709 --> 01:19:06,480
thank you

1846
01:19:13,189 --> 01:19:10,719
that was awesome um our next speaker

1847
01:19:17,940 --> 01:19:13,199
will be abigail russ

1848
01:19:17,950 --> 01:19:55,669
[Applause]

1849
01:20:12,950 --> 01:20:08,229
thank you

1850
01:20:14,870 --> 01:20:12,960
hello uh my name is abigail russ i am an

1851
01:20:17,189 --> 01:20:14,880
undergraduate working with dr rivera

1852
01:20:18,550 --> 01:20:17,199
hernandez in the gt planetsis lab and

1853
01:20:19,669 --> 01:20:18,560
today i'm going to be talking about my

1854
01:20:21,510 --> 01:20:19,679
research what i've been doing for the

1855
01:20:23,189 --> 01:20:21,520
past few semesters which is simulating

1856
01:20:25,430 --> 01:20:23,199
mud in mars-like conditions and

1857
01:20:27,189 --> 01:20:25,440
basically looking at how mud or rather

1858
01:20:29,910 --> 01:20:27,199
mud flows behave under mars-like

1859
01:20:31,430 --> 01:20:29,920
conditions now why do we care about mud

1860
01:20:33,030 --> 01:20:31,440
on mars well

1861
01:20:33,750 --> 01:20:33,040
a little bit of background information

1862
01:20:35,669 --> 01:20:33,760
so

1863
01:20:37,590 --> 01:20:35,679

recently we've been getting a lot of

1864
01:20:39,110 --> 01:20:37,600
much higher resolution images of the

1865
01:20:41,270 --> 01:20:39,120
martian surface and we have come to

1866
01:20:43,510 --> 01:20:41,280
realize that what we thought were once

1867
01:20:45,590 --> 01:20:43,520
volcanic features may actually not be

1868
01:20:48,709 --> 01:20:45,600
volcanic features but rather mud

1869
01:20:50,950 --> 01:20:48,719
volcanism because we have thought about

1870
01:20:52,310 --> 01:20:50,960
the conditions on mars and realized mud

1871
01:20:54,229 --> 01:20:52,320
probably behaves a little bit

1872
01:20:55,990 --> 01:20:54,239
differently in such a low pressure low

1873
01:20:58,550 --> 01:20:56,000
temperature and low gravity environment

1874
01:21:00,870 --> 01:20:58,560
specifically mud behaves rather like

1875
01:21:02,550 --> 01:21:00,880
lava flows on earth do

1876
01:21:04,550 --> 01:21:02,560
and so this is kind of relevant because

1877
01:21:06,709 --> 01:21:04,560
where there is mud there is water and so

1878
01:21:08,629 --> 01:21:06,719
knowing a bit more about where the mud

1879
01:21:10,229 --> 01:21:08,639
is coming from where the mud is forming

1880
01:21:11,830 --> 01:21:10,239
and what the mud formations look like on

1881
01:21:14,229 --> 01:21:11,840
mars can kind of point to the paleo

1882
01:21:17,110 --> 01:21:14,239
climate of mars and seeing where there

1883
01:21:18,149 --> 01:21:17,120
was water at one point

1884
01:21:22,310 --> 01:21:18,159
so

1885
01:21:24,229 --> 01:21:22,320
with dr peter brosh uh in his lab at i

1886
01:21:26,950 --> 01:21:24,239
believe the university of london where

1887
01:21:29,350 --> 01:21:26,960
he actually began to do some experiments

1888
01:21:31,669 --> 01:21:29,360

on mud in these low pressure low

1889
01:21:34,310 --> 01:21:31,679
temperature conditions now obviously we

1890
01:21:36,229 --> 01:21:34,320
can't simulate the gravity of mars here

1891
01:21:38,070 --> 01:21:36,239
on earth but we got pretty close and

1892
01:21:40,390 --> 01:21:38,080
what we saw is what we expected that the

1893
01:21:43,030 --> 01:21:40,400
mud in this very low pressure condition

1894
01:21:45,350 --> 01:21:43,040
behaves a lot like lava we see lobes we

1895
01:21:47,189 --> 01:21:45,360
see cavities we see voids

1896
01:21:49,830 --> 01:21:47,199
and so this kind of motivated us to take

1897
01:21:51,430 --> 01:21:49,840
a much closer look at the mud in these

1898
01:21:53,510 --> 01:21:51,440
conditions and start to build up a

1899
01:21:54,950 --> 01:21:53,520
computer simulation so we can kind of

1900
01:21:56,550 --> 01:21:54,960
better gauge what this is going to look

1901
01:21:59,350 --> 01:21:56,560
like

1902
01:22:01,510 --> 01:21:59,360
so here's another example of a mud flow

1903
01:22:02,950 --> 01:22:01,520
on mars versus a mud flow on earth or a

1904
01:22:03,990 --> 01:22:02,960
lava flow on earth and a blood flow on

1905
01:22:05,510 --> 01:22:04,000
mars and you can kind of see the

1906
01:22:06,550 --> 01:22:05,520
similarities between the two and kind of

1907
01:22:08,149 --> 01:22:06,560
understand

1908
01:22:12,070 --> 01:22:08,159
our starting point and why we took an

1909
01:22:16,470 --> 01:22:14,629
so why are we modeling mud and rather

1910
01:22:18,149 --> 01:22:16,480
just not doing experiments and basically

1911
01:22:20,790 --> 01:22:18,159
it comes down to it's really hard to

1912
01:22:22,550 --> 01:22:20,800
make mars-like conditions here on earth

1913
01:22:24,470 --> 01:22:22,560

and in the computer simulation we can

1914
01:22:25,910 --> 01:22:24,480
actually fine-tune the parameters get

1915
01:22:27,990 --> 01:22:25,920
the gravity better get the temperature

1916
01:22:29,270 --> 01:22:28,000
better have wind speeds and really

1917
01:22:30,870 --> 01:22:29,280
better simulate

1918
01:22:33,270 --> 01:22:30,880
everything and get a much better picture

1919
01:22:34,390 --> 01:22:33,280
of the morphology of mud in these

1920
01:22:36,310 --> 01:22:34,400
conditions

1921
01:22:38,070 --> 01:22:36,320
and to do so we use this program called

1922
01:22:40,470 --> 01:22:38,080
console multiphysics on console is

1923
01:22:41,830 --> 01:22:40,480
traditionally used for engineering but

1924
01:22:43,350 --> 01:22:41,840
recently a lot more earth and

1925
01:22:44,709 --> 01:22:43,360
atmospheric scientists have started

1926
01:22:47,830 --> 01:22:44,719
using it for

1927
01:22:49,750 --> 01:22:47,840
uh fluid-like simulations

1928
01:22:51,990 --> 01:22:49,760
so here is the data that dr brosh

1929
01:22:54,709 --> 01:22:52,000
provided us with basically he took two

1930
01:22:56,149 --> 01:22:54,719
tubes of mud um turned down the pressure

1931
01:22:57,270 --> 01:22:56,159
there's a lot going on in this graph

1932
01:22:59,430 --> 01:22:57,280
we'll kind of parse through that in a

1933
01:23:01,910 --> 01:22:59,440
second um turned down the pressure and

1934
01:23:04,550 --> 01:23:01,920
watched how the mud behaves

1935
01:23:06,790 --> 01:23:04,560
and what he saw was that the top of the

1936
01:23:07,910 --> 01:23:06,800
mud tubes got a lot colder than the

1937
01:23:09,510 --> 01:23:07,920
bottom and that is because of

1938
01:23:11,270 --> 01:23:09,520

evaporative cooling in these low

1939
01:23:13,750 --> 01:23:11,280
pressure conditions evaporative cooling

1940
01:23:15,430 --> 01:23:13,760
becomes the dominant cooling force and

1941
01:23:17,669 --> 01:23:15,440
we see

1942
01:23:20,470 --> 01:23:17,679
these bubbles forming and rapid rapid

1943
01:23:22,229 --> 01:23:20,480
heat loss at the top and because of

1944
01:23:25,110 --> 01:23:22,239
rapid heat loss we get things like crust

1945
01:23:27,189 --> 01:23:25,120
formations and lobes and volcanic-like

1946
01:23:28,870 --> 01:23:27,199
behavior in mud

1947
01:23:30,470 --> 01:23:28,880
so uh this is kind of a little picture

1948
01:23:31,990 --> 01:23:30,480
of the console simulation if you're not

1949
01:23:33,510 --> 01:23:32,000
familiar with console don't worry you

1950
01:23:34,390 --> 01:23:33,520
don't really need to understand this to

1951
01:23:36,390 --> 01:23:34,400
understand

1952
01:23:38,870 --> 01:23:36,400
where i'm going in this presentation

1953
01:23:42,149 --> 01:23:38,880
basically we looked at a

1954
01:23:44,950 --> 01:23:42,159
mud-like fluid with certain initial

1955
01:23:46,709 --> 01:23:44,960
temperatures and initial conditions

1956
01:23:49,189 --> 01:23:46,719
based off of what we expect the mud to

1957
01:23:51,750 --> 01:23:49,199
behave like

1958
01:23:54,470 --> 01:23:51,760
and so this is the data that we found

1959
01:23:57,830 --> 01:23:54,480
as you can see we see a similar pattern

1960
01:23:59,830 --> 01:23:57,840
in the top of the tube being a lot

1961
01:24:02,149 --> 01:23:59,840
colder than the bottom of the tube as

1962
01:24:03,350 --> 01:24:02,159
the pressure dropped

1963
01:24:05,110 --> 01:24:03,360

here's a little animation of the

1964
01:24:07,430 --> 01:24:05,120
simulation uh

1965
01:24:08,390 --> 01:24:07,440
some fun little visuals for you uh on

1966
01:24:15,350 --> 01:24:08,400
the

1967
01:24:16,709 --> 01:24:15,360
evaporative cooling this shows evidence

1968
01:24:18,550 --> 01:24:16,719
that we are in fact observing the

1969
01:24:19,510 --> 01:24:18,560
evaporative cooling that we expected to

1970
01:24:21,350 --> 01:24:19,520
see

1971
01:24:22,709 --> 01:24:21,360
um

1972
01:24:25,110 --> 01:24:22,719
yeah

1973
01:24:27,030 --> 01:24:25,120
so looking comparing the two data sets

1974
01:24:28,709 --> 01:24:27,040
we see once again very similar behaviors

1975
01:24:30,390 --> 01:24:28,719
however it should be noted we don't see

1976
01:24:31,110 --> 01:24:30,400
them at the same degree

1977
01:24:33,030 --> 01:24:31,120
so

1978
01:24:35,350 --> 01:24:33,040
the uh brochure experiments done in the

1979
01:24:37,270 --> 01:24:35,360
lab we saw a much more rapid drop than

1980
01:24:39,189 --> 01:24:37,280
in the computer simulations and that can

1981
01:24:40,790 --> 01:24:39,199
be due to a number of reasons mostly we

1982
01:24:43,030 --> 01:24:40,800
expected that

1983
01:24:44,550 --> 01:24:43,040
in our simulation we didn't have any

1984
01:24:45,910 --> 01:24:44,560
sort of drafts didn't have any sort of

1985
01:24:48,070 --> 01:24:45,920
wins it was a very stationary

1986
01:24:49,910 --> 01:24:48,080
environment whereas in the real world

1987
01:24:52,229 --> 01:24:49,920
real world experiment

1988
01:24:55,189 --> 01:24:52,239

um they had some wind flow within the

1989
01:24:59,750 --> 01:24:57,830
moving forward we have started to try to

1990
01:25:01,669 --> 01:24:59,760
build up an actual mud volcano in

1991
01:25:03,350 --> 01:25:01,679
console now kind of using this as a

1992
01:25:05,910 --> 01:25:03,360
proof of concept test knowing that we

1993
01:25:07,910 --> 01:25:05,920
can in fact do mud-like simulations in

1994
01:25:09,910 --> 01:25:07,920
console we want to build an actual mud

1995
01:25:12,310 --> 01:25:09,920
volcano and the first step of that is

1996
01:25:15,030 --> 01:25:12,320
looking at just a single lobe of mud

1997
01:25:16,470 --> 01:25:15,040
flowing in these conditions

1998
01:25:19,350 --> 01:25:16,480
and specifically we dropped a two

1999
01:25:22,310 --> 01:25:19,360
centimeter two centimeter radius a

2000
01:25:25,510 --> 01:25:22,320
little sphere of mud pretty much and we

2001
01:25:27,270 --> 01:25:25,520
ran it over a series of conditions

2002
01:25:29,350 --> 01:25:27,280
specifically temperature pressure

2003
01:25:31,990 --> 01:25:29,360
gravity and three different viscosities

2004
01:25:33,750 --> 01:25:32,000
and this is to look at what parameters

2005
01:25:35,510 --> 01:25:33,760
actually matter when it comes to mud

2006
01:25:36,950 --> 01:25:35,520
flow is it the temperature is it the

2007
01:25:39,110 --> 01:25:36,960
pressure is it the gravity or is it the

2008
01:25:41,510 --> 01:25:39,120
viscosity and we found

2009
01:25:44,149 --> 01:25:41,520
we found a lot of data we got 16

2010
01:25:47,110 --> 01:25:44,159
specific plots but what's actually

2011
01:25:49,430 --> 01:25:47,120
relevant from these plots

2012
01:25:51,990 --> 01:25:49,440
so looking at constant viscosity this is

2013
01:25:54,870 --> 01:25:52,000

under the viscosity of i believe

2014
01:25:57,750 --> 01:25:54,880
50 pascals per second which is think

2015
01:25:59,990 --> 01:25:57,760
like halfway between water and honey uh

2016
01:26:01,990 --> 01:26:00,000
and looking at this we noticed first of

2017
01:26:03,830 --> 01:26:02,000
all that the earth like one behaved as

2018
01:26:05,669 --> 01:26:03,840
we would expect we saw it drop we kind

2019
01:26:07,750 --> 01:26:05,679
of saw it flow a little bit it formed a

2020
01:26:09,830 --> 01:26:07,760
bunch of different droplets and the mars

2021
01:26:12,950 --> 01:26:09,840
one stayed relatively together it stayed

2022
01:26:16,310 --> 01:26:12,960
relatively uniform and had this kind of

2023
01:26:17,990 --> 01:26:16,320
single lobe shape single lobe morphology

2024
01:26:20,149 --> 01:26:18,000
which is what we were wanting to see

2025
01:26:21,300 --> 01:26:20,159
because once again behaves like global

2026
01:26:23,270 --> 01:26:21,310
does

2027
01:26:25,510 --> 01:26:23,280
[Music]

2028
01:26:27,830 --> 01:26:25,520
so looking at differing viscosities this

2029
01:26:31,270 --> 01:26:27,840
is relevant because we don't entirely

2030
01:26:33,669 --> 01:26:31,280
know what type of mud formed these mud

2031
01:26:35,270 --> 01:26:33,679
volcanoes formed these formations so

2032
01:26:36,950 --> 01:26:35,280
looking at differing viscosities we can

2033
01:26:38,709 --> 01:26:36,960
kind of see

2034
01:26:41,270 --> 01:26:38,719
what actually once again what actually

2035
01:26:43,430 --> 01:26:41,280
matters and we in the from the data that

2036
01:26:44,870 --> 01:26:43,440
we gathered learned that viscosity

2037
01:26:46,950 --> 01:26:44,880
matters more than we might have thought

2038
01:26:48,470 --> 01:26:46,960

because in the lower viscosity we saw a

2039
01:26:49,669 --> 01:26:48,480
huge difference between earth-like and

2040
01:26:51,270 --> 01:26:49,679
mars-like

2041
01:26:53,510 --> 01:26:51,280
conditions whereas in the high

2042
01:26:55,350 --> 01:26:53,520
viscosities they look almost identical

2043
01:26:57,750 --> 01:26:55,360
so this is kind of illustrating the

2044
01:26:59,030 --> 01:26:57,760
points that when we're going to analyze

2045
01:27:01,110 --> 01:26:59,040
these formations we need to be taking

2046
01:27:03,750 --> 01:27:01,120
into consideration what kind of mud was

2047
01:27:05,990 --> 01:27:03,760
making these formations and

2048
01:27:07,830 --> 01:27:06,000
all of this is to say there's a lot more

2049
01:27:11,910 --> 01:27:07,840
to the volcanic features on mars than we

2050
01:27:16,470 --> 01:27:13,590
so some wider applications once again

2051
01:27:18,550 --> 01:27:16,480
why does any of this actually matter so

2052
01:27:20,229 --> 01:27:18,560
as you can see the mars rovers are

2053
01:27:22,149 --> 01:27:20,239
starting to see a lot of interesting

2054
01:27:24,149 --> 01:27:22,159
volcanic or mud-based activity and we

2055
01:27:26,390 --> 01:27:24,159
want to be able to identify we want to

2056
01:27:28,950 --> 01:27:26,400
know what is actually going on and it

2057
01:27:31,350 --> 01:27:28,960
kind of can show us some insight into

2058
01:27:33,270 --> 01:27:31,360
the past oceans past lakes past water

2059
01:27:35,189 --> 01:27:33,280
formations and also potential

2060
01:27:36,870 --> 01:27:35,199
astrobiology targets because where

2061
01:27:39,830 --> 01:27:36,880
there's water there's life

2062
01:27:41,830 --> 01:27:39,840
and overall looking at this mud we can

2063
01:27:43,669 --> 01:27:41,840

generally improve our understanding so

2064
01:27:45,110 --> 01:27:43,679
we can better identify mud flows and mud

2065
01:27:46,790 --> 01:27:45,120
volcanoes and just

2066
01:27:48,470 --> 01:27:46,800
in general what is going on on the

2067
01:27:50,709 --> 01:27:48,480
martian surface

2068
01:27:52,070 --> 01:27:50,719
um

2069
01:27:53,750 --> 01:27:52,080
these are kind of some acknowledgements

2070
01:27:56,149 --> 01:27:53,760
and sources thank you again to dr bear

2071
01:27:57,830 --> 01:27:56,159
hernandez uh for helping with this dr

2072
01:27:59,669 --> 01:27:57,840
jacob adler who's i don't think he's

2073
01:28:00,390 --> 01:27:59,679
here right now um

2074
01:28:02,750 --> 01:28:00,400
yeah

2075
01:28:08,310 --> 01:28:02,760
any any questions

2076
01:28:12,310 --> 01:28:10,629
thank you abigail is great does anybody

2077
01:28:15,750 --> 01:28:12,320
have any questions i think we have time

2078
01:28:20,149 --> 01:28:18,390
so you've investigated what uh

2079
01:28:23,110 --> 01:28:20,159
mud flows look like on mars and how they

2080
01:28:24,550 --> 01:28:23,120
look like lava on earth but have you

2081
01:28:26,870 --> 01:28:24,560
done any modeling or has any other

2082
01:28:29,030 --> 01:28:26,880
modeling been done on what lava looks

2083
01:28:30,390 --> 01:28:29,040
like on mars uh that's a great question

2084
01:28:32,149 --> 01:28:30,400
um so going back to the differing

2085
01:28:33,990 --> 01:28:32,159
viscosity slide this is why this is

2086
01:28:35,990 --> 01:28:34,000
relevant because lava has a very high

2087
01:28:37,669 --> 01:28:36,000
viscosity i believe it's like

2088
01:28:40,470 --> 01:28:37,679

200 pascals per second i don't know off

2089
01:28:41,990 --> 01:28:40,480
the top of my head um this this plot

2090
01:28:44,390 --> 01:28:42,000
right here is kind of showing how at

2091
01:28:45,910 --> 01:28:44,400
higher viscosities factors like pressure

2092
01:28:49,590 --> 01:28:45,920
and temperature don't matter nearly as

2093
01:28:50,950 --> 01:28:49,600
much as the lower viscosity flows

2094
01:28:53,430 --> 01:28:50,960
um so we haven't done any particular

2095
01:28:55,270 --> 01:28:53,440
experiments with lava but it's less

2096
01:28:58,560 --> 01:28:55,280
relevant to understanding the morphology

2097
01:29:03,430 --> 01:29:01,270
[Music]

2098
01:29:06,310 --> 01:29:03,440
do you have any current theories as to

2099
01:29:09,430 --> 01:29:06,320
what the mud composition would be and

2100
01:29:11,830 --> 01:29:09,440
what the formation mechanisms of these

2101
01:29:14,070 --> 01:29:11,840
volcanoes would be um so in terms of

2102
01:29:15,990 --> 01:29:14,080
formation mechanisms let me go back up

2103
01:29:17,750 --> 01:29:16,000
quite a few slides um

2104
01:29:20,550 --> 01:29:17,760
this is kind of the current theory where

2105
01:29:22,870 --> 01:29:20,560
we see this feeder dike evaporative

2106
01:29:25,590 --> 01:29:22,880
cooling and then general

2107
01:29:27,189 --> 01:29:25,600
flow in this way as to the composition

2108
01:29:28,870 --> 01:29:27,199
itself we haven't actually started

2109
01:29:30,550 --> 01:29:28,880
looking into this this is very new

2110
01:29:32,310 --> 01:29:30,560
research we've only really gotten into

2111
01:29:34,629 --> 01:29:32,320
this uh and

2112
01:29:37,189 --> 01:29:34,639
the past i thought gosh couple like half

2113
01:29:39,270 --> 01:29:37,199

year i want to say um so we're trying to

2114
01:29:41,350 --> 01:29:39,280
first understand the general and then go

2115
01:29:46,229 --> 01:29:41,360
into the specifics of what the mud

2116
01:29:46,239 --> 01:29:51,590
all right are there any other questions

2117
01:29:54,110 --> 01:29:53,510
if not thank you again abigail that was

2118
01:30:00,470 --> 01:29:54,120
awesome

2119
01:30:33,590 --> 01:30:03,669
and our last speaker in this session is

2120
01:31:06,229 --> 01:31:01,189
is

2121
01:31:08,870 --> 01:31:06,239
an undergraduate physics student here at

2122
01:31:11,669 --> 01:31:08,880
georgia tech and i have recently started

2123
01:31:15,110 --> 01:31:11,679
a research project on the arabia terra

2124
01:31:18,870 --> 01:31:15,120
region of mars with dr rivera hernandez

2125
01:31:22,790 --> 01:31:20,550
first i'll give you a little background

2126
01:31:24,870 --> 01:31:22,800
on the existing research and then i'll

2127
01:31:27,510 --> 01:31:24,880
tell you about my specific project

2128
01:31:30,790 --> 01:31:27,520
including my objectives

2129
01:31:33,350 --> 01:31:30,800
methodology and results so

2130
01:31:35,990 --> 01:31:33,360
70 percent of mars's surface has been

2131
01:31:39,030 --> 01:31:36,000
resurfaced by volcanic activity which

2132
01:31:41,430 --> 01:31:39,040
can't be accounted for by the existing

2133
01:31:42,870 --> 01:31:41,440
volcanoes or the volcanoes we already

2134
01:31:45,270 --> 01:31:42,880
know about

2135
01:31:49,030 --> 01:31:45,280
this has inspired a search for other

2136
01:31:49,990 --> 01:31:49,040
sources of this volcanic material

2137
01:31:52,070 --> 01:31:50,000
and

2138
01:31:54,070 --> 01:31:52,080

we are starting to consider other other

2139
01:31:56,870 --> 01:31:54,080
sources on earth we have something

2140
01:31:58,709 --> 01:31:56,880
called a collapsed volcano like crater

2141
01:32:00,229 --> 01:31:58,719
lake in oregon which you see in the top

2142
01:32:02,950 --> 01:32:00,239
picture there

2143
01:32:05,590 --> 01:32:02,960
crater lake used to be a high elevation

2144
01:32:07,669 --> 01:32:05,600
volcano and has since fallen to around

2145
01:32:08,790 --> 01:32:07,679
the same elevation as the surrounding

2146
01:32:11,590 --> 01:32:08,800
land

2147
01:32:14,070 --> 01:32:11,600
if it exists on mars it if it exists on

2148
01:32:16,149 --> 01:32:14,080
earth it could exist on mars too and

2149
01:32:18,470 --> 01:32:16,159
there have been some proposed

2150
01:32:19,750 --> 01:32:18,480
collapsed volcanoes in the arabia terra

2151
01:32:21,750 --> 01:32:19,760
region of

2152
01:32:24,870 --> 01:32:21,760
mars

2153
01:32:27,750 --> 01:32:24,880
for some context here is a topographical

2154
01:32:29,189 --> 01:32:27,760
map of mars with the arabia terra region

2155
01:32:33,030 --> 01:32:29,199
circled

2156
01:32:35,510 --> 01:32:33,040
zooming in we can see the patera which

2157
01:32:37,990 --> 01:32:35,520
is a bowl-shaped depression on a

2158
01:32:40,149 --> 01:32:38,000
planetary surface called eden patera

2159
01:32:42,149 --> 01:32:40,159
it's the number one candidate for a

2160
01:32:46,149 --> 01:32:42,159
collapsed volcano and i'll talk a little

2161
01:32:48,229 --> 01:32:46,159
bit more about this particular patera

2162
01:32:50,870 --> 01:32:48,239
it was once thought of as an impact

2163
01:32:53,030 --> 01:32:50,880

crater although it doesn't have a lot of

2164
01:32:55,350 --> 01:32:53,040
the characteristics of an impact crater

2165
01:32:57,350 --> 01:32:55,360
like near circular geometry

2166
01:32:59,189 --> 01:32:57,360
a central peak and

2167
01:33:03,110 --> 01:32:59,199
and raised rim

2168
01:33:05,750 --> 01:33:03,120
so these factors have contributed to the

2169
01:33:08,390 --> 01:33:05,760
the hypothesis that this might have been

2170
01:33:11,350 --> 01:33:08,400
a volcano in the past

2171
01:33:13,669 --> 01:33:11,360
my project is to test this hypothesis to

2172
01:33:15,350 --> 01:33:13,679
look and look into the mineralogy of the

2173
01:33:18,629 --> 01:33:15,360
surrounding area

2174
01:33:19,669 --> 01:33:18,639
there are some minerals that

2175
01:33:22,790 --> 01:33:19,679
that

2176
01:33:25,510 --> 01:33:22,800
are indicative of

2177
01:33:26,709 --> 01:33:25,520
altered volcanic material and they

2178
01:33:29,350 --> 01:33:26,719
include

2179
01:33:31,669 --> 01:33:29,360
silica glass mechtites zeolites and

2180
01:33:34,070 --> 01:33:31,679
sulfates

2181
01:33:35,910 --> 01:33:34,080
each element and mineral has its own

2182
01:33:37,350 --> 01:33:35,920
spectral signature and an instrument

2183
01:33:39,990 --> 01:33:37,360
called chrism aboard the mars

2184
01:33:42,629 --> 01:33:40,000
reconnaissance orbiter can record these

2185
01:33:47,669 --> 01:33:42,639
spectra and i can look at them to try to

2186
01:33:51,830 --> 01:33:49,990
going back to eden patera we can look at

2187
01:33:54,390 --> 01:33:51,840
this map which includes all of these

2188
01:33:55,510 --> 01:33:54,400

little bow tie shapes which are chrism

2189
01:33:57,110 --> 01:33:55,520
images

2190
01:33:59,350 --> 01:33:57,120
the first thought would be to look at

2191
01:34:01,110 --> 01:33:59,360
eden patera to determine its mineralogy

2192
01:34:03,750 --> 01:34:01,120
but unfortunately we don't have any

2193
01:34:07,030 --> 01:34:03,760
charism images on eden patera

2194
01:34:09,030 --> 01:34:07,040
however if eden patera was a volcano

2195
01:34:11,110 --> 01:34:09,040
once there may be

2196
01:34:13,990 --> 01:34:11,120
minerals in the surrounding area

2197
01:34:16,470 --> 01:34:14,000
the crater i have circled is 200

2198
01:34:19,430 --> 01:34:16,480
kilometers away from eden patera

2199
01:34:21,830 --> 01:34:19,440
this is an existing model showing the

2200
01:34:24,310 --> 01:34:21,840
thickness of the volcanic deposits as a

2201
01:34:25,430 --> 01:34:24,320
function of distance and eden patera is

2202
01:34:27,990 --> 01:34:25,440
labeled there

2203
01:34:30,470 --> 01:34:28,000
and the thickest deposits are within 500

2204
01:34:31,830 --> 01:34:30,480
kilometers from the patera so the data

2205
01:34:34,390 --> 01:34:31,840
i'm looking at should be within that

2206
01:34:36,870 --> 01:34:34,400
range and if there are volcanic

2207
01:34:41,510 --> 01:34:36,880
materials i should be able to find them

2208
01:34:44,310 --> 01:34:41,520
using the available chrism data

2209
01:34:47,030 --> 01:34:44,320
this is that image i had circled

2210
01:34:49,830 --> 01:34:47,040
in the crater nearby eden patera

2211
01:34:53,189 --> 01:34:49,840
the process is to use something called a

2212
01:34:54,790 --> 01:34:53,199
parameter which is essentially a filter

2213
01:34:55,830 --> 01:34:54,800

that takes out parts of the light

2214
01:34:57,430 --> 01:34:55,840
spectrum

2215
01:34:59,990 --> 01:34:57,440
that don't have

2216
01:35:02,229 --> 01:35:00,000
indicative spectral features of a

2217
01:35:03,910 --> 01:35:02,239
particular mineral

2218
01:35:06,390 --> 01:35:03,920
this is an example of one of those

2219
01:35:09,270 --> 01:35:06,400
parameters this shows

2220
01:35:11,430 --> 01:35:09,280
this creates a kind of heat map

2221
01:35:12,229 --> 01:35:11,440
where you can find

2222
01:35:14,070 --> 01:35:12,239
find

2223
01:35:16,149 --> 01:35:14,080
minerals and this parameter helps us

2224
01:35:18,310 --> 01:35:16,159
find silica so the bright spots should

2225
01:35:20,070 --> 01:35:18,320
show a silica now you might notice there

2226
01:35:23,430 --> 01:35:20,080
are these big stripes running north and

2227
01:35:26,070 --> 01:35:23,440
south across the image and that is a a

2228
01:35:28,149 --> 01:35:26,080
result of how chrism takes data

2229
01:35:30,550 --> 01:35:28,159
essentially it starts at a shallow angle

2230
01:35:32,470 --> 01:35:30,560
and takes a panorama of the land below

2231
01:35:33,590 --> 01:35:32,480
which is why we have kind of this bow

2232
01:35:36,709 --> 01:35:33,600
tie shape

2233
01:35:38,629 --> 01:35:36,719
and different parts of the

2234
01:35:40,470 --> 01:35:38,639
the sensor are more sensitive to

2235
01:35:41,990 --> 01:35:40,480
different kinds of light so

2236
01:35:44,310 --> 01:35:42,000
we will see some streaking down the

2237
01:35:45,990 --> 01:35:44,320
entire image it's unlikely we have

2238
01:35:48,390 --> 01:35:46,000

silica channels running north and south

2239
01:35:50,070 --> 01:35:48,400
across the crater so we have to take

2240
01:35:53,590 --> 01:35:50,080
that into consideration what's more

2241
01:35:55,590 --> 01:35:53,600
likely is if we have

2242
01:35:56,950 --> 01:35:55,600
bright spots going across multiple parts

2243
01:35:59,270 --> 01:35:56,960
of the sensor

2244
01:36:03,109 --> 01:35:59,280
and if they also correspond with the

2245
01:36:06,229 --> 01:36:03,119
geology below this part of the

2246
01:36:08,310 --> 01:36:06,239
of the the image corresponds with the

2247
01:36:10,070 --> 01:36:08,320
crater's rim

2248
01:36:12,790 --> 01:36:10,080
the next step is to recombine all of

2249
01:36:14,790 --> 01:36:12,800
this data and create a spectrum

2250
01:36:16,709 --> 01:36:14,800
and here is the spectrum from that

2251
01:36:19,189 --> 01:36:16,719
particular region of interest

2252
01:36:21,270 --> 01:36:19,199
you can see absorption lines at 1.9 and

2253
01:36:24,550 --> 01:36:21,280
2.2 microns

2254
01:36:26,310 --> 01:36:24,560
in my in in my data on the left and on

2255
01:36:29,910 --> 01:36:26,320
your right is the

2256
01:36:32,790 --> 01:36:29,920
example spectra a spectrum from

2257
01:36:35,430 --> 01:36:32,800
the chrism team of hydrated silica and

2258
01:36:37,030 --> 01:36:35,440
you can see those same 1.9 and 2.2

2259
01:36:39,510 --> 01:36:37,040
absorption lines

2260
01:36:41,510 --> 01:36:39,520
so this is a vote of confidence for

2261
01:36:43,910 --> 01:36:41,520
silica in the area

2262
01:36:44,950 --> 01:36:43,920
another way to use chrismdata is to

2263
01:36:46,709 --> 01:36:44,960

create

2264
01:36:49,430 --> 01:36:46,719
color images by assigning different

2265
01:36:50,790 --> 01:36:49,440
parameters different colors in an rgb

2266
01:36:52,950 --> 01:36:50,800
image

2267
01:36:54,790 --> 01:36:52,960
this introduces another another level of

2268
01:36:57,270 --> 01:36:54,800
nuance so you can see multiple minerals

2269
01:36:59,189 --> 01:36:57,280
in some areas and as you can see here

2270
01:37:01,990 --> 01:36:59,199
there might be aluminum smectite in the

2271
01:37:04,470 --> 01:37:02,000
yellow areas and i say mites because you

2272
01:37:05,990 --> 01:37:04,480
have to look at the spectrum otherwise

2273
01:37:07,350 --> 01:37:06,000
you don't know for sure these are

2274
01:37:09,590 --> 01:37:07,360
essentially

2275
01:37:11,350 --> 01:37:09,600
guesses based on the software

2276
01:37:13,189 --> 01:37:11,360
so i took another region of interest in

2277
01:37:15,030 --> 01:37:13,199
a very similar location you can see it's

2278
01:37:17,830 --> 01:37:15,040
right next to the first region of

2279
01:37:20,550 --> 01:37:17,840
interest and i created another spectrum

2280
01:37:24,310 --> 01:37:20,560
and this time we also have an absorption

2281
01:37:26,870 --> 01:37:24,320
at 2.3 microns and this is actually

2282
01:37:28,709 --> 01:37:26,880
consistent with magnesium or

2283
01:37:29,510 --> 01:37:28,719
iron spectite

2284
01:37:31,030 --> 01:37:29,520
the

2285
01:37:32,870 --> 01:37:31,040
software might have guessed aluminum

2286
01:37:35,189 --> 01:37:32,880
smacktype because of the 2.2 micron

2287
01:37:36,390 --> 01:37:35,199
absorption line which we know might have

2288
01:37:38,950 --> 01:37:36,400

actually been

2289
01:37:40,629 --> 01:37:38,960
silica so in this case we may have more

2290
01:37:43,750 --> 01:37:40,639
than one mineral in the area which is

2291
01:37:45,750 --> 01:37:43,760
why we have this particular spectrum

2292
01:37:48,229 --> 01:37:45,760
both of these minerals are

2293
01:37:49,189 --> 01:37:48,239
consistent with volcanic activity on

2294
01:37:50,070 --> 01:37:49,199
mars

2295
01:37:52,310 --> 01:37:50,080
there

2296
01:37:54,229 --> 01:37:52,320
is a lot more data to be analyzed and

2297
01:37:57,430 --> 01:37:54,239
i'm going to spend a lot of time looking

2298
01:37:59,430 --> 01:37:57,440
at other chrism images as well as

2299
01:38:01,510 --> 01:37:59,440
potentially doing a thermal analysis of

2300
01:38:03,510 --> 01:38:01,520
the area to determine if

2301
01:38:05,830 --> 01:38:03,520
the the thermal signatures of the area

2302
01:38:08,629 --> 01:38:05,840
are consistent with volcanic material

2303
01:38:10,070 --> 01:38:08,639
so there may be volcanoes it remains to

2304
01:38:11,910 --> 01:38:10,080
be seen and

2305
01:38:13,030 --> 01:38:11,920
more work will be done thank you very

2306
01:38:17,430 --> 01:38:13,040
much

2307
01:38:22,070 --> 01:38:19,510
oh does anyone have questions

2308
01:38:23,270 --> 01:38:22,080
all right thank you grace um we have

2309
01:38:24,470 --> 01:38:23,280
plenty of time for questions so if

2310
01:38:28,870 --> 01:38:24,480
anybody has

2311
01:38:33,189 --> 01:38:31,350
are there any hypotheses as to why those

2312
01:38:36,070 --> 01:38:33,199
minerals are on the edge of that crater

2313
01:38:37,830 --> 01:38:36,080

or if they were you know deposited from

2314
01:38:39,270 --> 01:38:37,840
volcanism nearby and then might have

2315
01:38:40,629 --> 01:38:39,280
been stored in in the edge for any

2316
01:38:43,990 --> 01:38:40,639
particular reason

2317
01:38:45,109 --> 01:38:44,000
sure so um actually related to this is

2318
01:38:47,510 --> 01:38:45,119
um

2319
01:38:48,870 --> 01:38:47,520
you know if you if you imagine there was

2320
01:38:50,870 --> 01:38:48,880
a volcano

2321
01:38:52,550 --> 01:38:50,880
there might be volcanic material

2322
01:38:54,470 --> 01:38:52,560
covering the entire surface and so you

2323
01:38:56,229 --> 01:38:54,480
might wonder why this whole image isn't

2324
01:38:58,390 --> 01:38:56,239
just bright with silica

2325
01:39:00,709 --> 01:38:58,400
and the reason is because these

2326
01:39:02,790 --> 01:39:00,719
volcanoes existed a really long time ago

2327
01:39:05,030 --> 01:39:02,800
and there's a lot of

2328
01:39:07,350 --> 01:39:05,040
martian dust covering everything and

2329
01:39:08,070 --> 01:39:07,360
that's why we only get little peaks and

2330
01:39:10,470 --> 01:39:08,080
so

2331
01:39:12,629 --> 01:39:10,480
if there is an outcropping of silica

2332
01:39:15,990 --> 01:39:12,639
especially on the rim of a crater it may

2333
01:39:18,229 --> 01:39:16,000
be because that particular part of the

2334
01:39:20,950 --> 01:39:18,239
crater doesn't have as much dust and i

2335
01:39:23,669 --> 01:39:20,960
think that's that's why i

2336
01:39:25,430 --> 01:39:23,679
am also a little new so

2337
01:39:27,510 --> 01:39:25,440
there may be other contributing reasons

2338
01:39:32,070 --> 01:39:27,520

but i think that's that's

2339
01:39:32,080 --> 01:39:38,790
any other questions

2340
01:39:42,470 --> 01:39:40,950
thank you is the chrism

2341
01:39:43,990 --> 01:39:42,480
uh instrument still working on the

2342
01:39:45,910 --> 01:39:44,000
spacecraft

2343
01:39:47,830 --> 01:39:45,920
no i don't believe it is i mean i think

2344
01:39:51,510 --> 01:39:47,840
it it is um

2345
01:39:52,950 --> 01:39:51,520
it is mostly done taking data i think

2346
01:39:55,510 --> 01:39:52,960
which explains why we can't get direct

2347
01:39:59,990 --> 01:39:55,520
data from the crater yeah okay

2348
01:40:00,000 --> 01:40:03,750
any other questions

2349
01:40:03,760 --> 01:40:08,900
okay if not thank you so much grace

2350
01:40:08,910 --> 01:40:14,629
[Applause]

2351
01:40:20,310 --> 01:40:16,950
and with that that is the end of our

2352
01:40:22,310 --> 01:40:20,320
mars session um and now it is lunchtime

2353
01:40:23,990 --> 01:40:22,320
so we will take a break and then be back

2354
01:40:33,910 --> 01:40:24,000
for