
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:16,960 --> 00:00:14,250
[Music]

3
00:00:19,750 --> 00:00:16,970
well thank you all for making it back

4
00:00:22,030 --> 00:00:19,760
from lunch it would appear that our

5
00:00:24,249 --> 00:00:22,040
session chair Haley sabers may not have

6
00:00:26,589 --> 00:00:24,259
made it so I will go ahead and introduce

7
00:00:29,290 --> 00:00:26,599
myself I'm Maggie Osborne from

8
00:00:31,029 --> 00:00:29,300
Northwestern University and today I'm

9
00:00:33,610 --> 00:00:31,039
excited to tell you about some recent

10
00:00:35,799 --> 00:00:33,620
work the life underground astrobiology

11
00:00:38,250 --> 00:00:35,809
team has been doing to look at the

12
00:00:42,750 --> 00:00:38,260
subsurface biosphere particularly that

13
00:00:46,600 --> 00:00:44,610

huh

14
00:00:48,610 --> 00:00:46,610
excellent so the deep subsurface

15
00:00:51,549 --> 00:00:48,620
biosphere consists of those organisms

16
00:00:53,979 --> 00:00:51,559
living in poor fluids within deep

17
00:00:58,000 --> 00:00:53,989
crystalline fracture networks and within

18
00:01:00,670 --> 00:00:58,010
the rocks themselves of the Continental

19
00:01:02,470 --> 00:01:00,680
and marine crust this talk is going to

20
00:01:04,119 --> 00:01:02,480
be focused primarily on the Continental

21
00:01:07,180 --> 00:01:04,129
deep subsurface biosphere because that's

22
00:01:09,160 --> 00:01:07,190
where our site is we know a fair amount

23
00:01:11,170 --> 00:01:09,170
about the subsurface biosphere in

24
00:01:13,210 --> 00:01:11,180
general and we know that it is large

25
00:01:16,660 --> 00:01:13,220
containing a large volume of organic

26
00:01:18,429 --> 00:01:16,670
carbons equaling biospheres equal to

27
00:01:20,350 --> 00:01:18,439
that of various phases of the surficial

28
00:01:22,600 --> 00:01:20,360
environment in stages of Earth's history

29
00:01:24,960 --> 00:01:22,610
we know that that biosphere is

30
00:01:27,429 --> 00:01:24,970
physically and taxonomically diverse

31
00:01:28,899 --> 00:01:27,439
there's a large number of processes

32
00:01:31,179 --> 00:01:28,909
happening and that does seem to vary

33
00:01:33,219 --> 00:01:31,189
depending on where you're at we know

34
00:01:35,140 --> 00:01:33,229
that those processes are metabolically

35
00:01:36,730 --> 00:01:35,150
dependent on the chemistry and the

36
00:01:39,340 --> 00:01:36,740
geology of the environments in which

37
00:01:41,760 --> 00:01:39,350
they're found and this feature in

38
00:01:44,109 --> 00:01:41,770

particular makes these sites key

39
00:01:46,330 --> 00:01:44,119
extraterrestrial targets and key extra

40
00:01:48,160 --> 00:01:46,340
extra-terrestrial analogues particularly

41
00:01:53,289 --> 00:01:48,170
when we're looking at rocky planetary

42
00:01:55,389 --> 00:01:53,299
bodies such as the subsurface of Mars we

43
00:01:57,520 --> 00:01:55,399
access the deep subsurface in a number

44
00:01:59,520 --> 00:01:57,530
of ways in particular we look at it in

45
00:02:02,170 --> 00:01:59,530
the form of Springs where we have

46
00:02:04,330 --> 00:02:02,180
upwelling of these diffraction fracture

47
00:02:06,190 --> 00:02:04,340
networks onto the surface springs are

48
00:02:08,169 --> 00:02:06,200
great because you can go to the edge of

49
00:02:10,840 --> 00:02:08,179
said Springs perform your experiments

50
00:02:12,970 --> 00:02:10,850
and you can have ready and continuous

51
00:02:14,650 --> 00:02:12,980
access the downside of course is that

52
00:02:16,720 --> 00:02:14,660
there's a surficial biosphere that's

53
00:02:18,610 --> 00:02:16,730
interacting and Deek involving the end

54
00:02:21,580 --> 00:02:18,620
members between the surface and the deep

55
00:02:24,009 --> 00:02:21,590
subsurface biospheres can be challenging

56
00:02:27,020 --> 00:02:24,019
getting that subsurface end member

57
00:02:28,759 --> 00:02:27,030
we also access the deep subsurface in

58
00:02:30,140 --> 00:02:28,769
bore holes and then the next three talks

59
00:02:32,750 --> 00:02:30,150
of the session you'll be hearing about

60
00:02:35,149 --> 00:02:32,760
chroma which is in a borehole of

61
00:02:37,550 --> 00:02:35,159
microbial Observatory these are great

62
00:02:38,899 --> 00:02:37,560
because they can go very deep actually

63
00:02:41,479 --> 00:02:38,909

our deepest end member of the deep

64
00:02:43,369 --> 00:02:41,489
subsurface biosphere they are easily

65
00:02:45,140 --> 00:02:43,379
accessible at the surf surface but the

66
00:02:47,660 --> 00:02:45,150
challenge can be in the mixing as you go

67
00:02:49,849 --> 00:02:47,670
down and with casing materials and with

68
00:02:52,190 --> 00:02:49,859
influx of material or fluids from the

69
00:02:54,369 --> 00:02:52,200
sides there's also a diameter limit says

70
00:02:56,599 --> 00:02:54,379
everything has to go down a little hole

71
00:02:58,250 --> 00:02:56,609
the last and the one I'll be talking

72
00:02:59,959 --> 00:02:58,260
about mostly today is the deep

73
00:03:03,259 --> 00:02:59,969
subsurface biosphere access through

74
00:03:07,610 --> 00:03:03,269
mines mines are great because humans

75
00:03:09,860 --> 00:03:07,620
sorry humans actually go down and can

76
00:03:11,990 --> 00:03:09,870
access the deep subsurface biosphere as

77
00:03:14,089 --> 00:03:12,000
it intersects on those levels in

78
00:03:15,740 --> 00:03:14,099
particular miners are great at taking

79
00:03:17,360 --> 00:03:15,750
material from the surface and bringing

80
00:03:19,220 --> 00:03:17,370
it down and vice versa and therefore

81
00:03:23,539 --> 00:03:19,230
bringing experimental apparatus is not a

82
00:03:25,280 --> 00:03:23,549
problem they are dynamic system so many

83
00:03:28,249 --> 00:03:25,290
mines are continually being excavated

84
00:03:29,899 --> 00:03:28,259
and therefore intersection of new

85
00:03:31,369 --> 00:03:29,909
fractures and waters that have been

86
00:03:33,649 --> 00:03:31,379
sequestered for millions or even

87
00:03:35,869 --> 00:03:33,659
billions I see Barbara Sherwood Lawler

88
00:03:38,119 --> 00:03:35,879

in the background there billions of

89
00:03:42,229 --> 00:03:38,129
years so we have some very deep fluids

90
00:03:44,499 --> 00:03:42,239
being accessed there of course cons so

91
00:03:46,490 --> 00:03:44,509
mines influence the local hydrology

92
00:03:49,009 --> 00:03:46,500
mines produce a fair amount of

93
00:03:51,020 --> 00:03:49,019
contamination and mines do tend to back

94
00:03:54,080 --> 00:03:51,030
fill themselves with or so things can be

95
00:03:55,640 --> 00:03:54,090
transient which can be a problem so

96
00:03:58,369 --> 00:03:55,650
today I'm going to tell you about the

97
00:03:59,809 --> 00:03:58,379
deepmind microbial Observatory which is

98
00:04:02,240 --> 00:03:59,819
a microbial Observatory that I've

99
00:04:06,589 --> 00:04:02,250
established in the former home state

100
00:04:09,530 --> 00:04:06,599
goldmine these this is six a set of six

101
00:04:11,899 --> 00:04:09,540
bore holes ranging from 800 to 4050 feet

102
00:04:14,589 --> 00:04:11,909
or a little less than a kilometer and a

103
00:04:17,569 --> 00:04:14,599
half they were drilled between 1910 and

104
00:04:20,870 --> 00:04:17,579
2005 and mostly caps subsequently after

105
00:04:22,939 --> 00:04:20,880
their drilling and we have now adapted

106
00:04:25,640 --> 00:04:22,949
these sites for continuous sampling and

107
00:04:28,219 --> 00:04:25,650
installation of long-term monitoring and

108
00:04:32,390 --> 00:04:28,229
cultivation apparatus so the rest of

109
00:04:36,839 --> 00:04:34,529
the Sanford underground research

110
00:04:39,120 --> 00:04:36,849
laboratory is in the former home state

111
00:04:42,089 --> 00:04:39,130
goldmine so it's now a science facility

112
00:04:44,279 --> 00:04:42,099
aimed at understanding mostly particle

113
00:04:47,610 --> 00:04:44,289

physics applications but the facility

114
00:04:50,249 --> 00:04:47,620
does foster and encourage all types of

115
00:04:53,939 --> 00:04:50,259
scientific research there so it's a

116
00:04:55,860 --> 00:04:53,949
science facility this is a view of the

117
00:05:00,330 --> 00:04:55,870
open cut of the former Homestake mine

118
00:05:00,930 --> 00:05:00,340
you can see a variety of geology moving

119
00:05:04,230 --> 00:05:00,940
forward

120
00:05:06,990 --> 00:05:04,240
these rocks are paleoproterozoic in age

121
00:05:08,370 --> 00:05:07,000
primarily meta sediments ranging in the

122
00:05:10,140 --> 00:05:08,380
oldest from the gates which is a

123
00:05:13,320 --> 00:05:10,150
basaltic unit through the Poorman

124
00:05:15,779 --> 00:05:13,330
Homestake and Ellison formations and

125
00:05:18,870 --> 00:05:15,789
then crosscut by these visually striking

126
00:05:21,390 --> 00:05:18,880
tertiary intrusive rocks so we have a

127
00:05:23,010 --> 00:05:21,400
variety of geology then metamorphic

128
00:05:25,620 --> 00:05:23,020
grades range from green shifts to

129
00:05:27,270 --> 00:05:25,630
amphibolite in a variety of windows

130
00:05:30,420 --> 00:05:27,280
which contributes to the mineralogical

131
00:05:31,950 --> 00:05:30,430
diversity we have water ages that are

132
00:05:34,860 --> 00:05:31,960
significantly younger ranging from

133
00:05:37,680 --> 00:05:34,870
something like a year to extending to 10

134
00:05:42,029 --> 00:05:37,690
to maybe tens of thousands of years at

135
00:05:44,430 --> 00:05:42,039
the oldest so the life underground team

136
00:05:47,070 --> 00:05:44,440
has been sampling these sites since 2013

137
00:05:48,390 --> 00:05:47,080
and we've taken many samples mostly of

138
00:05:48,870 --> 00:05:48,400

opportunity that looks something like

139
00:05:51,360 --> 00:05:48,880
this

140
00:05:53,279 --> 00:05:51,370
so we have fluid coming out of the wall

141
00:05:56,459 --> 00:05:53,289
and creating these luxuriant slimy

142
00:05:58,230 --> 00:05:56,469
biofilms on the surface and sometimes

143
00:06:00,439 --> 00:05:58,240
you have water actually shooting out of

144
00:06:02,700 --> 00:06:00,449
the wall at relatively high pressure

145
00:06:04,950 --> 00:06:02,710
these sites were great but as you can

146
00:06:07,219 --> 00:06:04,960
imagine getting a controlled sample of

147
00:06:10,620 --> 00:06:07,229
something like this can be a challenge

148
00:06:13,529 --> 00:06:10,630
what is actually happening in this photo

149
00:06:15,149 --> 00:06:13,539
this one we have a bore hole that was

150
00:06:18,749 --> 00:06:15,159
drilled and then capped with concrete

151
00:06:21,089 --> 00:06:18,759
and so the sites that we were sampling

152
00:06:23,010 --> 00:06:21,099
are places where this concrete cap was

153
00:06:25,350 --> 00:06:23,020
leaking allowing some of this to come

154
00:06:28,249 --> 00:06:25,360
out so the goal of the establishment of

155
00:06:30,659 --> 00:06:28,259
demo was to clean this out and in

156
00:06:32,879 --> 00:06:30,669
interface between the subsurface

157
00:06:34,350 --> 00:06:32,889
environment and the mine environment in

158
00:06:36,689 --> 00:06:34,360
a way that we could go back and take the

159
00:06:38,399 --> 00:06:36,699
same samples over and over again and

160
00:06:40,500 --> 00:06:38,409
really start to perform controlled

161
00:06:42,110 --> 00:06:40,510
experiments within this subsurface

162
00:06:45,180 --> 00:06:42,120
environment

163
00:06:47,279 --> 00:06:45,190

so we did just that and so conveniently

164
00:06:49,140 --> 00:06:47,289
many of the surf staff are old miners

165
00:06:53,219 --> 00:06:49,150
that are well versed at drilling holes

166
00:06:54,089 --> 00:06:53,229
and crystal and bedrock and thus we this

167
00:06:56,430 --> 00:06:54,099
is guy named fritz

168
00:06:58,409 --> 00:06:56,440
and he drilled out a couple of holes for

169
00:07:00,749 --> 00:06:58,419
us these were sites that were had been

170
00:07:04,710 --> 00:07:00,759
sampled previously and thus we were able

171
00:07:10,710 --> 00:07:04,720
to sort of focus our efforts on the

172
00:07:14,520 --> 00:07:10,720
sites that were most interesting aha

173
00:07:16,580 --> 00:07:14,530
so in our newly cleaned out holes we've

174
00:07:19,980 --> 00:07:16,590
placed custom designed and fabricated

175
00:07:22,890 --> 00:07:19,990
high-density plastic Packers metal is

176
00:07:24,360 --> 00:07:22,900
the common thing to make a packer out of

177
00:07:26,520 --> 00:07:24,370
but in the subsurface environment it

178
00:07:28,050 --> 00:07:26,530
corrodes extremely rapidly and that's

179
00:07:30,330 --> 00:07:28,060
what that was not a good choice for us

180
00:07:32,339 --> 00:07:30,340
the packer is composed of a threaded

181
00:07:35,550 --> 00:07:32,349
core and then outer components that when

182
00:07:39,480 --> 00:07:35,560
compressed seal against the wall of that

183
00:07:42,659 --> 00:07:39,490
borehole and is not advancing very well

184
00:07:44,969 --> 00:07:42,669
but okay this is the final product here

185
00:07:46,950 --> 00:07:44,979
so this in this way we can actually feel

186
00:07:49,140 --> 00:07:46,960
that subsurface environment from the

187
00:07:56,510 --> 00:07:49,150
mined environment and can take real

188
00:08:09,020 --> 00:07:58,370

I mean I assure you I'm pushing the

189
00:08:10,339 --> 00:08:09,030
button all right all right so here is a

190
00:08:12,110 --> 00:08:10,349
cross sectional view of the Mayan

191
00:08:14,210 --> 00:08:12,120
ranging from surface topography at the

192
00:08:16,999 --> 00:08:14,220
top with horizontal layers representing

193
00:08:18,980 --> 00:08:17,009
the mining levels in gray are mined out

194
00:08:21,170 --> 00:08:18,990
or bodies of various stages of the

195
00:08:23,600 --> 00:08:21,180
mining and the arcuate colored curves

196
00:08:26,089 --> 00:08:23,610
are the trajectories of the diamond bore

197
00:08:31,000 --> 00:08:26,099
holes that we have capped color-coded by

198
00:08:33,769 --> 00:08:31,010
geology so our shallowest site demo1

199
00:08:35,839 --> 00:08:33,779
starts out here and it's four whole

200
00:08:37,670 --> 00:08:35,849
trajectory well not on this map almost

201
00:08:40,519 --> 00:08:37,680
outcrops at the surface so this is our

202
00:08:42,589 --> 00:08:40,529
by far our shallow a sample sort of

203
00:08:45,980 --> 00:08:42,599
closer to a terrestrial end member or

204
00:08:47,870 --> 00:08:45,990
surficial end member demo2 is also on

205
00:08:50,150 --> 00:08:47,880
the 800-foot level but access is more

206
00:08:54,260 --> 00:08:50,160
diverse ethology x' and somewhat older

207
00:08:56,300 --> 00:08:54,270
water demo 3 is on the 2,000 foot level

208
00:09:01,870 --> 00:08:56,310
and you can see is heading off kind of

209
00:09:05,590 --> 00:09:01,880
in its own direction here demo 4 is on a

210
00:09:08,990 --> 00:09:05,600
4100 foot level this green line here and

211
00:09:10,699 --> 00:09:09,000
it's sort of pared whole is demo 5 on

212
00:09:12,410 --> 00:09:10,709
the 48 foot level and you can see that

213
00:09:14,690 --> 00:09:12,420

these two borehole trajectories are

214
00:09:16,490 --> 00:09:14,700
coming in to a similar package of rocks

215
00:09:19,280 --> 00:09:16,500
and so these two boreholes are

216
00:09:22,760 --> 00:09:19,290
encountering sort of similar water with

217
00:09:24,829 --> 00:09:22,770
depth the final hole is demos demo 6

218
00:09:27,139 --> 00:09:24,839
which we've not switched out and still

219
00:09:29,269 --> 00:09:27,149
has a stainless steel manifold but this

220
00:09:30,800 --> 00:09:29,279
is accessing some interesting geology

221
00:09:36,380 --> 00:09:30,810
and chemistry and thus we have kept it

222
00:09:39,260 --> 00:09:36,390
in this week before during and after

223
00:09:41,960 --> 00:09:39,270
drilling we've embarked on the campaign

224
00:09:45,110 --> 00:09:41,970
of constant monitoring of these sites so

225
00:09:46,940 --> 00:09:45,120
we're currently engaged in every other

226
00:09:51,139 --> 00:09:46,950
month we go and take a full suite of

227
00:09:53,690 --> 00:09:51,149
samples this includes geochemistry major

228
00:09:55,639 --> 00:09:53,700
anions cations gas geochemistry redact

229
00:09:58,389 --> 00:09:55,649
sensitive geochemistry your physical

230
00:10:00,470 --> 00:09:58,399
measurements like flow rate and also

231
00:10:04,430 --> 00:10:00,480
microbiology so things like cell counts

232
00:10:06,760 --> 00:10:04,440
and sequencing this is my field go back

233
00:10:08,900 --> 00:10:06,770
this is my field lead Brittany Kruger

234
00:10:10,070 --> 00:10:08,910
without which none of this would be

235
00:10:12,230 --> 00:10:10,080
possible

236
00:10:17,600 --> 00:10:12,240
my grad student Katelyn kazar who will

237
00:10:19,700 --> 00:10:17,610
be speaking more on this on Friday just

238
00:10:23,260 --> 00:10:19,710

to show you a little bit of data from

239
00:10:26,630 --> 00:10:23,270
our suite this is a schematic of the

240
00:10:28,730 --> 00:10:26,640
bore of the demo Network and I'll show

241
00:10:30,470 --> 00:10:28,740
you a couple data graphs like this we

242
00:10:33,260 --> 00:10:30,480
have flow rates ranging from mostly a

243
00:10:35,780 --> 00:10:33,270
couple hundred mils per minute up to

244
00:10:37,640 --> 00:10:35,790
greater than 10 liters per minute we

245
00:10:39,590 --> 00:10:37,650
have temperature that broadly increases

246
00:10:43,190 --> 00:10:39,600
as you go downward ranging from 10 to

247
00:10:46,250 --> 00:10:43,200
about 35 pH also increases as you go

248
00:10:48,560 --> 00:10:46,260
downward oxidation reduction potential

249
00:10:50,660 --> 00:10:48,570
we're getting more reducing with depth

250
00:10:53,960 --> 00:10:50,670
and we're also getting somewhat saltier

251
00:10:56,840 --> 00:10:53,970
maxing out at something like brackish in

252
00:11:01,310 --> 00:10:56,850
terms of the number of cells in these

253
00:11:04,220 --> 00:11:01,320
waters we are at low 10 to the third up

254
00:11:07,070 --> 00:11:04,230
to mid 10 to the fifth cells per mil so

255
00:11:09,230 --> 00:11:07,080
quite low at the top we have very simple

256
00:11:12,320 --> 00:11:09,240
morphologies mostly just woods

257
00:11:16,160 --> 00:11:12,330
cells they're slightly more diverse in

258
00:11:19,990 --> 00:11:16,170
demo to increased types of morphologies

259
00:11:23,950 --> 00:11:20,000
in demo 3 & 4 although still very low

260
00:11:25,820 --> 00:11:23,960
cell density z' we get quite a lot more

261
00:11:28,430 --> 00:11:25,830
morphological diversity when you get

262
00:11:30,440 --> 00:11:28,440
into demo 5 and demo 6 you can see these

263
00:11:33,560 --> 00:11:30,450

filaments and rods in addition to the

264
00:11:36,320 --> 00:11:33,570
coxy hinting at a potentially more

265
00:11:38,270 --> 00:11:36,330
diverse ecosystem in do see we have a

266
00:11:41,120 --> 00:11:38,280
decrease in gradient from the surface to

267
00:11:45,260 --> 00:11:41,130
deep potentially thinking about long

268
00:11:47,540 --> 00:11:45,270
term carbon usage within the crust di c

269
00:11:49,280 --> 00:11:47,550
is a little interesting so this probably

270
00:11:51,560 --> 00:11:49,290
is varying based on the interactions

271
00:11:54,170 --> 00:11:51,570
with rocks and then the isotopes of di c

272
00:11:55,880 --> 00:11:54,180
are showing potentially some closed

273
00:11:57,410 --> 00:11:55,890
system carbon cycling behavior these

274
00:12:01,250 --> 00:11:57,420
numbers are much lower than you might

275
00:12:06,020 --> 00:12:01,260
expect just a little bit of microbiology

276
00:12:08,060 --> 00:12:06,030
before I run out of time so each box is

277
00:12:12,260 --> 00:12:08,070
a site and then this is data with time

278
00:12:14,750 --> 00:12:12,270
so demo one youngest oldest you can see

279
00:12:17,090 --> 00:12:14,760
oh and the arrows represent where we

280
00:12:18,980 --> 00:12:17,100
drilled so this is before drilling and

281
00:12:21,440 --> 00:12:18,990
after drilling before drilling and after

282
00:12:23,240 --> 00:12:21,450
drilling the first sort of like sort of

283
00:12:24,770 --> 00:12:23,250
broad scale observation is that the

284
00:12:26,270 --> 00:12:24,780
we didn't completely disrupt these

285
00:12:29,090 --> 00:12:26,280
ecosystems in the way you might have

286
00:12:30,620 --> 00:12:29,100
expected these number these bars are not

287
00:12:32,240 --> 00:12:30,630
radically different colors from this

288
00:12:35,270 --> 00:12:32,250

time step to this time step we just have

289
00:12:37,070 --> 00:12:35,280
a minor change in population we have

290
00:12:38,630 --> 00:12:37,080
lots of unknowns we have lots of

291
00:12:40,610 --> 00:12:38,640
candidate phyla and these samples are

292
00:12:44,000 --> 00:12:40,620
dominated by Proteobacteria as you might

293
00:12:47,030 --> 00:12:44,010
expect of the subsurface biosphere we

294
00:12:49,430 --> 00:12:47,040
have mostly not a lot of archaea except

295
00:12:52,340 --> 00:12:49,440
we have populations in demo four so

296
00:12:54,860 --> 00:12:52,350
there seems to be a local favorite we

297
00:12:59,210 --> 00:12:54,870
have large populations of op3

298
00:13:01,190 --> 00:12:59,220
particularly in demo one demo six is

299
00:13:07,220 --> 00:13:01,200
very different it's dominated by

300
00:13:08,090 --> 00:13:07,230
Firmicutes bacteria DDS and op1 just a

301
00:13:10,220 --> 00:13:08,100
little bit on the ongoing

302
00:13:12,220 --> 00:13:10,230
experimentation now that we have this

303
00:13:14,600 --> 00:13:12,230
network we can actually install

304
00:13:17,900 --> 00:13:14,610
cultivation reactors and experimentation

305
00:13:19,640 --> 00:13:17,910
institute and leave it for months and so

306
00:13:21,290 --> 00:13:19,650
what my lab has been doing our

307
00:13:23,090 --> 00:13:21,300
experiments that look like this we call

308
00:13:24,800 --> 00:13:23,100
these flow through cultivation reactors

309
00:13:26,360 --> 00:13:24,810
we're changing the substrates and the

310
00:13:28,250 --> 00:13:26,370
minerals that are in these allowing

311
00:13:31,760 --> 00:13:28,260
colonization to happen over the scale of

312
00:13:34,070 --> 00:13:31,770
months experiments in the orphan lab are

313
00:13:36,079 --> 00:13:34,080

testing things like mythology and flow

314
00:13:38,210 --> 00:13:36,089
rates and in the Orkut labs were doing

315
00:13:40,010 --> 00:13:38,220
controlled amendments there are also in

316
00:13:42,700 --> 00:13:40,020
situ electrode cultivation reactors

317
00:13:45,170 --> 00:13:42,710
being done by an ero in MO al-najjar lab

318
00:13:47,300 --> 00:13:45,180
just want to plug my student Caitlin's

319
00:13:49,579 --> 00:13:47,310
talked Friday at 3:00 she will tell you

320
00:13:51,110 --> 00:13:49,589
more about the cultivation happening

321
00:13:54,260 --> 00:13:51,120
from the slow through coaches and show

322
00:13:55,460 --> 00:13:54,270
some truly beautiful images and with

323
00:13:58,190 --> 00:13:55,470
that I would like to acknowledge my

324
00:14:00,590 --> 00:13:58,200
funding from NASA the surf staff that

325
00:14:02,450 --> 00:14:00,600
makes these samples possible the rest of

326
00:14:03,890 --> 00:14:02,460
the NAI team and the northwestern stable

327
00:14:06,380 --> 00:14:03,900
isotope facility for producing our

328
00:14:13,860 --> 00:14:06,390
carbon isotope numbers and I think I

329
00:14:18,040 --> 00:14:16,660
so we have time for one question and the

330
00:14:25,870 --> 00:14:18,050
next speaker can come up and get miked

331
00:14:30,070 --> 00:14:25,880
well the questions perfect then you

332
00:14:33,340 --> 00:14:30,080
understand everything okay just a

333
00:14:36,790 --> 00:14:33,350
comment or two of requesting it one or

334
00:14:40,420 --> 00:14:36,800
two on logistically how difficult was it

335
00:14:42,610 --> 00:14:40,430
to do this work how much effort did you

336
00:14:44,230 --> 00:14:42,620
acquire to get the equipment down was it

337
00:14:46,720 --> 00:14:44,240
difficult to work in the mines things

338
00:14:48,790 --> 00:14:46,730

like that um so the sir facility was

339
00:14:50,890 --> 00:14:48,800
extremely cooperative with our efforts

340
00:14:53,020 --> 00:14:50,900
so it did take a fair amount of time and

341
00:14:55,000 --> 00:14:53,030
logistical planning in terms of the

342
00:14:57,340 --> 00:14:55,010
transportation and the actual drilling

343
00:14:59,370 --> 00:14:57,350
those were technically complicated and

344
00:15:01,630 --> 00:14:59,380
were met with a variety of you know

345
00:15:02,950 --> 00:15:01,640
partial success and failures we would do

346
00:15:05,740 --> 00:15:02,960
lots of drill bits and that kind of

347
00:15:07,150 --> 00:15:05,750
thing but we had great cooperation from

348
00:15:09,940 --> 00:15:07,160
the facility in terms of actually

349
00:15:11,500 --> 00:15:09,950
implementing this plan it's sort of like

350
00:15:13,270 --> 00:15:11,510
a government lab it's a lot of paperwork

351
00:15:15,010 --> 00:15:13,280
anytime you want to do anything but once

352
00:15:19,030 --> 00:15:15,020
you get permission it goes pretty