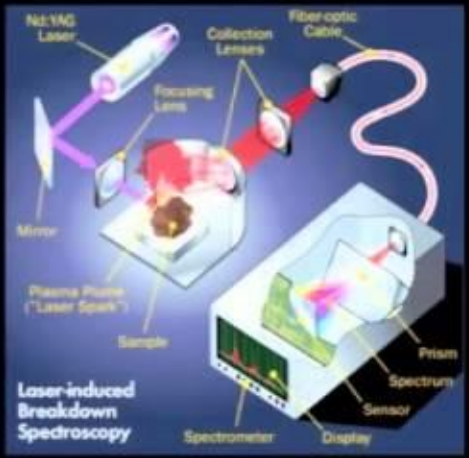
Laser-Induced Breakdown Spectroscopy



1
00:00:09,150 --> 00:00:08,040
my name is Kyla Kurt I'm from the

2
00:00:11,340 --> 00:00:09,160
Astronomy Department at New Mexico State

3
00:00:13,740 --> 00:00:11,350
University I'd like to start by saying

4
00:00:15,480 --> 00:00:13,750
today was the first time I saw rain in a

5
00:00:17,910 --> 00:00:15,490
very long time it's very exciting for me

6
00:00:19,590 --> 00:00:17,920
i was talking something a little

7
00:00:21,029 --> 00:00:19,600
different everyone else this session has

8
00:00:22,770 --> 00:00:21,039
talked about exoplanets and i'll be

9
00:00:26,790 --> 00:00:22,780
changing topics totally by talking about

10
00:00:28,410 --> 00:00:26,800
planets in our solar system first like

11
00:00:29,850 --> 00:00:28,420
to start by acknowledging the many

12
00:00:31,890 --> 00:00:29,860
people who have helped me during this

13
00:00:34,500 --> 00:00:31,900

project especially my advisor non siano

14
00:00:35,729 --> 00:00:34,510
bear so here's a brief overview of what

15
00:00:37,500 --> 00:00:35,739
i'll be talking about today i'll talk

16
00:00:40,319 --> 00:00:37,510
about three types of instruments that

17
00:00:42,810 --> 00:00:40,329
we've been developing at nmsu and also

18
00:00:45,690 --> 00:00:42,820
at goddard space flight center it's an

19
00:00:47,819 --> 00:00:45,700
acousto-optic tunable filter ir

20
00:00:49,380 --> 00:00:47,829
reflectance spectrometer a two-step

21
00:00:51,150 --> 00:00:49,390
laser desorption mass spectrometer and

22
00:01:03,330 --> 00:00:51,160
they lived instrument a laser-induced

23
00:01:05,969 --> 00:01:03,340
breakdown spectroscopy alisis techniques

24
00:01:07,230 --> 00:01:05,979
and spectral on mixing technique and a

25
00:01:08,700 --> 00:01:07,240
principal component analysis to

26
00:01:10,469 --> 00:01:08,710
determine the presence of biotic

27
00:01:12,090 --> 00:01:10,479
activity and we're really trying to

28
00:01:13,559 --> 00:01:12,100
answer this question right here so how

29
00:01:15,090 --> 00:01:13,569
come by adding activity being furred

30
00:01:16,739 --> 00:01:15,100
from the results of multiple instruments

31
00:01:19,620 --> 00:01:16,749
so using these instruments in

32
00:01:21,059 --> 00:01:19,630
combination can help determine the

33
00:01:24,480 --> 00:01:21,069
presence of biotic to be better than any

34
00:01:27,620 --> 00:01:24,490
one instrument of itself so earlier we

35
00:01:30,300 --> 00:01:27,630
talked about biosignatures related to

36
00:01:31,709 --> 00:01:30,310
exoplanets and my definition of

37
00:01:33,660 --> 00:01:31,719
biosignatures is a little bit different

38
00:01:36,779 --> 00:01:33,670

we're looking for processes of

39
00:01:39,209 --> 00:01:36,789
biomineralization or really any any kind

40
00:01:40,949 --> 00:01:39,219
of evidence that shows that biotic

41
00:01:42,480 --> 00:01:40,959
activity has influenced the formation of

42
00:01:43,769 --> 00:01:42,490
these geologic samples so we're looking

43
00:01:45,899 --> 00:01:43,779
for things like evidence of trace

44
00:01:47,669 --> 00:01:45,909
minerals that indicate biotic presence

45
00:01:49,559 --> 00:01:47,679
evidence of a crystal structure that

46
00:01:51,569 --> 00:01:49,569
could indicate some kind of influence of

47
00:01:53,999 --> 00:01:51,579
biology on the profit of formation of

48
00:01:55,859 --> 00:01:54,009
these minerals and also any chemical or

49
00:01:57,239 --> 00:01:55,869
physical disequilibrium with the rest of

50
00:01:59,209 --> 00:01:57,249
the geologic environment that could

51
00:02:01,319 --> 00:01:59,219
indicate the presence of biology and the

52
00:02:03,059 --> 00:02:01,329
three types of instruments were using

53
00:02:05,099 --> 00:02:03,069
are as i said earlier an ir reflecting

54
00:02:06,599 --> 00:02:05,109
spectrometer so this produce this shows

55
00:02:09,270 --> 00:02:06,609
us the molecular absorption features

56
00:02:11,460 --> 00:02:09,280
within any kind of spectra which could

57
00:02:14,940 --> 00:02:11,470
indicate the presence of biology or just

58
00:02:16,020 --> 00:02:14,950
geologic mineralization we're also

59
00:02:17,670 --> 00:02:16,030
looking at this two-step mass

60
00:02:19,530 --> 00:02:17,680
spectrometer which produces a mass

61
00:02:21,449 --> 00:02:19,540
spectrum which shows elect

62
00:02:23,520 --> 00:02:21,459
elemental and molecular composition of a

63
00:02:25,289 --> 00:02:23,530

sample and also this lived instrument

64
00:02:26,729 --> 00:02:25,299
which gives us an emission spectrum

65
00:02:30,479 --> 00:02:26,739
which shows the elemental composition of

66
00:02:32,670 --> 00:02:30,489
a type of sample so first let's talk

67
00:02:34,080 --> 00:02:32,680
about the aocf point spectrometer which

68
00:02:36,000 --> 00:02:34,090
has been in development since about two

69
00:02:37,800 --> 00:02:36,010
thousand nine this is an interesting

70
00:02:40,050 --> 00:02:37,810
kind of spectrometer what we have is an

71
00:02:42,089 --> 00:02:40,060
IR a light source over on this end and

72
00:02:44,039 --> 00:02:42,099
after going through several optics it

73
00:02:46,259 --> 00:02:44,049
reaches this aocf crystal which is a

74
00:02:48,929 --> 00:02:46,269
tellurium oxide crystal we pulse this

75
00:02:52,589 --> 00:02:48,939
radio wave through about 30 to 80

76
00:02:54,360 --> 00:02:52,599
megahertz and each time we apply some

77
00:02:56,039 --> 00:02:54,370
kind of radio frequency the light passes

78
00:02:58,199 --> 00:02:56,049
through a certain index of refraction

79
00:03:00,300 --> 00:02:58,209
which then lands on the sample one is

80
00:03:02,220 --> 00:03:00,310
reflected back into a detector and after

81
00:03:04,440 --> 00:03:02,230
sweeping through all RF frequencies were

82
00:03:07,830 --> 00:03:04,450
able to build up a spectral image of the

83
00:03:09,599 --> 00:03:07,840
sample so this particular alt f sub

84
00:03:12,509 --> 00:03:09,609
trauma tur has a resolution of about 200

85
00:03:14,399 --> 00:03:12,519
to 400 and we are looking in the 1.6 to

86
00:03:16,979 --> 00:03:14,409
3.6 micron range which is really

87
00:03:18,809 --> 00:03:16,989
important range for looking for hydrated

88
00:03:20,819 --> 00:03:18,819

minerals or the presence of organic

89
00:03:22,649 --> 00:03:20,829
material this is a non-destructive

90
00:03:24,360 --> 00:03:22,659
technique and requires no sample

91
00:03:28,080 --> 00:03:24,370
preparation at all it's also very fast

92
00:03:30,990 --> 00:03:28,090
low-power and does not take up very much

93
00:03:32,550 --> 00:03:31,000
space the second type of instrument is

94
00:03:34,589 --> 00:03:32,560
this two-step laser desorption mass

95
00:03:36,719 --> 00:03:34,599
spectrometer this is very similar to a

96
00:03:39,210 --> 00:03:36,729
typical mass spectrometer but it has two

97
00:03:41,129 --> 00:03:39,220
lasers so the first laser is an IR laser

98
00:03:43,920 --> 00:03:41,139
which ablates some sample material from

99
00:03:46,309 --> 00:03:43,930
a surface a second UV laser intersects

100
00:03:49,289 --> 00:03:46,319
this plasma or this ablative material

101
00:03:51,869 --> 00:03:49,299
ionizing the atoms which are then

102
00:03:54,330 --> 00:03:51,879
extracted into these into this reflector

103
00:03:55,860 --> 00:03:54,340
on tube and by using the time-of-flight

104
00:03:58,860 --> 00:03:55,870
method were able to determine the mass

105
00:04:00,270 --> 00:03:58,870
to charge ratio of the particles so

106
00:04:01,619 --> 00:04:00,280
we're able to determine elemental and

107
00:04:02,879 --> 00:04:01,629
block your composition and the big

108
00:04:06,270 --> 00:04:02,889
advantage to using this type of

109
00:04:08,009 --> 00:04:06,280
technique is that the using two

110
00:04:10,170 --> 00:04:08,019
different lasers actually preserves

111
00:04:11,580 --> 00:04:10,180
these large complex biomarkers much more

112
00:04:13,920 --> 00:04:11,590
effectively than using a single laser

113
00:04:17,129 --> 00:04:13,930

for ablation and ionization at the same

114
00:04:19,499 --> 00:04:17,139
time this is also a very minimally

115
00:04:20,879 --> 00:04:19,509
destructive procedure and requires no

116
00:04:22,740 --> 00:04:20,889
sample preparation so this produces

117
00:04:26,339 --> 00:04:22,750
about a 100 micron crater on the target

118
00:04:27,930 --> 00:04:26,349
and the last type of instrument we're

119
00:04:29,010 --> 00:04:27,940
looking at is a libs instrument which

120
00:04:32,040 --> 00:04:29,020
stands for laser-induced breakdown

121
00:04:33,330 --> 00:04:32,050
spectroscopy and similarly we will use a

122
00:04:35,520 --> 00:04:33,340
UV laser to

123
00:04:37,620 --> 00:04:35,530
wait some material and the resulting

124
00:04:41,850 --> 00:04:37,630
emission spectrum from the plasma is

125
00:04:43,500 --> 00:04:41,860
collected by a spectrometer this is

126
00:04:45,629 --> 00:04:43,510
similar to the chemcam instrument that's

127
00:04:47,520 --> 00:04:45,639
on curiosity right now the big advantage

128
00:04:49,740 --> 00:04:47,530
to using this type of instrument is the

129
00:04:51,450 --> 00:04:49,750
depth profiling so by taking multiple

130
00:04:53,370 --> 00:04:51,460
shots at a sample at the same location

131
00:04:54,659 --> 00:04:53,380
you're able to sort of dig into the

132
00:04:58,740 --> 00:04:54,669
sample and look at the very near

133
00:05:01,320 --> 00:04:58,750
subsurface the type of samples were

134
00:05:02,969 --> 00:05:01,330
looking at are very diverse we're

135
00:05:04,740 --> 00:05:02,979
looking at first non biologic samples

136
00:05:06,629 --> 00:05:04,750
such as the sulfates carbonates and

137
00:05:08,550 --> 00:05:06,639
Clay's which we think could be present

138
00:05:10,770 --> 00:05:08,560

on different planetary surfaces within

139
00:05:13,290 --> 00:05:10,780
our solar system and also on earth are

140
00:05:15,360 --> 00:05:13,300
very good hosts for life we then dope

141
00:05:17,850 --> 00:05:15,370
these samples with certain biologic

142
00:05:21,030 --> 00:05:17,860
materials like amino acids or pahs and

143
00:05:22,950 --> 00:05:21,040
the type of material we're looking at or

144
00:05:24,390 --> 00:05:22,960
just these field samples so here's an

145
00:05:27,029 --> 00:05:24,400
example of desert varnish which is

146
00:05:28,620 --> 00:05:27,039
plentiful down where we live so it's

147
00:05:31,860 --> 00:05:28,630
some kind of substrate with this

148
00:05:33,990 --> 00:05:31,870
magnesium oxide crust or magnesium side

149
00:05:37,020 --> 00:05:34,000
crust sorry there are microbes within

150
00:05:38,940 --> 00:05:37,030
this surface which oxidizes the

151
00:05:40,890 --> 00:05:38,950
magnesium the rock which then gets

152
00:05:42,779 --> 00:05:40,900
excreted as this crust and we're able to

153
00:05:43,860 --> 00:05:42,789
very easily spectroscopically tell the

154
00:05:46,260 --> 00:05:43,870
difference between these types of

155
00:05:48,240 --> 00:05:46,270
surfaces and also we're looking at this

156
00:05:51,300 --> 00:05:48,250
which is a travertine sample with a

157
00:05:52,860 --> 00:05:51,310
microbial colony living within it so

158
00:05:54,240 --> 00:05:52,870
here's some very brief results showing

159
00:05:56,010 --> 00:05:54,250
the capabilities of these instruments

160
00:05:57,480 --> 00:05:56,020
this is the IR reflectance spectrometer

161
00:05:59,610 --> 00:05:57,490
results and you can see very easily

162
00:06:02,360 --> 00:05:59,620
these it's evidence for hydration in

163
00:06:05,490 --> 00:06:02,370

these sulfates and the clay minerals

164
00:06:06,719 --> 00:06:05,500
this is an example of a gypsum material

165
00:06:09,360 --> 00:06:06,729
which we've doped with two types of

166
00:06:11,430 --> 00:06:09,370
amino acids and you can very easily see

167
00:06:15,210 --> 00:06:11,440
the presence of the phthalic acid and

168
00:06:16,980 --> 00:06:15,220
valine and both of these spectra and

169
00:06:18,540 --> 00:06:16,990
here we have the laser desorption

170
00:06:20,790 --> 00:06:18,550
time-of-flight mass spectrometer results

171
00:06:23,300 --> 00:06:20,800
dope with the same types of amino acids

172
00:06:26,520 --> 00:06:23,310
showing these peaks at 116 and 165

173
00:06:28,589 --> 00:06:26,530
Dalton's which represent the more

174
00:06:32,820 --> 00:06:28,599
complex organic materials rather than

175
00:06:34,469 --> 00:06:32,830
just the typical elemental so as I

176
00:06:35,940 --> 00:06:34,479
mentioned earlier we're looking at two

177
00:06:37,620 --> 00:06:35,950
different quantitative analysis

178
00:06:39,629 --> 00:06:37,630
techniques to try and determine the

179
00:06:41,909 --> 00:06:39,639
presence of biotic activity and although

180
00:06:45,140 --> 00:06:41,919
the previous slide show good visual

181
00:06:47,129 --> 00:06:45,150
proof of concepts of these instruments

182
00:06:49,379 --> 00:06:47,139
you know having a quantity

183
00:06:50,909 --> 00:06:49,389
of analysis is much more thorough so

184
00:06:52,559 --> 00:06:50,919
we're using two types the first one is

185
00:06:54,540 --> 00:06:52,569
called the spectral mixture analysis

186
00:06:57,989 --> 00:06:54,550
technique and we'll be using the USGS

187
00:07:00,600 --> 00:06:57,999
spec PR process routines to apply this

188
00:07:02,159 --> 00:07:00,610

type of analysis to the aocf point

189
00:07:04,170 --> 00:07:02,169
spectrometer and what this basically

190
00:07:06,629 --> 00:07:04,180
does is it takes several spectral end

191
00:07:08,730 --> 00:07:06,639
members and combines them in a linear

192
00:07:09,959 --> 00:07:08,740
fashion in order to reproduce the

193
00:07:11,969 --> 00:07:09,969
reflectance spectra that we measure

194
00:07:14,659 --> 00:07:11,979
within the sample the idea here is that

195
00:07:17,159 --> 00:07:14,669
any sample we look at is really just a

196
00:07:21,179 --> 00:07:17,169
sum of a mixture of different kinds of

197
00:07:23,010 --> 00:07:21,189
reflectance spectra so after finding the

198
00:07:24,209 --> 00:07:23,020
best fit between the real and model

199
00:07:25,559 --> 00:07:24,219
spectra are you able to determine the

200
00:07:27,300 --> 00:07:25,569
relative abundances of these different

201
00:07:29,219 --> 00:07:27,310
spectral data members so there are

202
00:07:31,619 --> 00:07:29,229
several libraries available online which

203
00:07:34,260 --> 00:07:31,629
have lots of different pure samples like

204
00:07:36,209 --> 00:07:34,270
Jerry site or sulfates and we're also

205
00:07:37,920 --> 00:07:36,219
going to add to these spectral member

206
00:07:40,129 --> 00:07:37,930
libraries different types of organic

207
00:07:43,890 --> 00:07:40,139
materials and lichens that we'll be

208
00:07:45,510 --> 00:07:43,900
trying to observe the second type of

209
00:07:47,610 --> 00:07:45,520
analysis is called principal component

210
00:07:49,110 --> 00:07:47,620
analysis I'll just get a very brief

211
00:07:51,269 --> 00:07:49,120
overview of what that is so this will be

212
00:07:53,519 --> 00:07:51,279
applied to all three instruments using a

213
00:07:55,920 --> 00:07:53,529

commercial in software package called

214
00:07:58,050 --> 00:07:55,930
the unscrambler and the principal

215
00:08:00,119 --> 00:07:58,060
components are really defined as the

216
00:08:01,439 --> 00:08:00,129
dimensions within a sample set along

217
00:08:03,899 --> 00:08:01,449
which the least amount of variance

218
00:08:06,209 --> 00:08:03,909
exists this is a really simple example

219
00:08:08,519 --> 00:08:06,219
showing a two dimensional data set which

220
00:08:10,379 --> 00:08:08,529
is you know just very ambiguous and it

221
00:08:12,600 --> 00:08:10,389
shows that the first principal component

222
00:08:14,519 --> 00:08:12,610
would be along this axis and the second

223
00:08:17,040 --> 00:08:14,529
will be along this axis so this is only

224
00:08:19,079 --> 00:08:17,050
a 2d data set with the libs instrument

225
00:08:21,179 --> 00:08:19,089
for example we're looking at a 13,000

226
00:08:23,010 --> 00:08:21,189
dimensional data set which is much

227
00:08:24,990 --> 00:08:23,020
harder to visualize but the principle is

228
00:08:26,760 --> 00:08:25,000
really the same now this allows you to

229
00:08:28,950 --> 00:08:26,770
determine with the relative quantities

230
00:08:30,149 --> 00:08:28,960
of trace elements within a sample is it

231
00:08:32,219 --> 00:08:30,159
could also help you determine what the

232
00:08:34,380 --> 00:08:32,229
method of formation is based on the

233
00:08:37,380 --> 00:08:34,390
amount of energy that's necessary to

234
00:08:39,959 --> 00:08:37,390
ablate a sample and it also is able to

235
00:08:43,290 --> 00:08:39,969
ver the biologic content of an unknown

236
00:08:46,230 --> 00:08:43,300
sample so I want to show an example that

237
00:08:48,060 --> 00:08:46,240
we've taken very recently this is a very

238
00:08:50,670 --> 00:08:48,070

blurry picture of a mazda night sample

239
00:08:53,880 --> 00:08:50,680
with lichen on top of it so I've only

240
00:08:55,230 --> 00:08:53,890
shown in the picture of the lichen but

241
00:08:57,240 --> 00:08:55,240
we're essentially looking at three

242
00:08:58,949 --> 00:08:57,250
different regions of this sample we have

243
00:09:00,509 --> 00:08:58,959
a very large rock which has this lichen

244
00:09:00,990 --> 00:09:00,519
crust on it and you can see that there

245
00:09:03,840 --> 00:09:01,000
are these

246
00:09:05,550 --> 00:09:03,850
green areas some black areas and then

247
00:09:07,710 --> 00:09:05,560
not shown in the picture is the cut

248
00:09:09,690 --> 00:09:07,720
surface we've cut with the rock sauce so

249
00:09:12,060 --> 00:09:09,700
this is a very smooth surface and a

250
00:09:14,430 --> 00:09:12,070
crust without any lichen at all and when

251
00:09:16,440 --> 00:09:14,440
we apply the PC a technique to this we

252
00:09:19,110 --> 00:09:16,450
see that the different types of surfaces

253
00:09:20,520 --> 00:09:19,120
we observe break it out into these two

254
00:09:23,700 --> 00:09:20,530
differ order to these four different

255
00:09:25,650 --> 00:09:23,710
groups so down here we have the black

256
00:09:28,020 --> 00:09:25,660
lichen area over here we have the green

257
00:09:29,610 --> 00:09:28,030
like an area up here is the crust

258
00:09:31,710 --> 00:09:29,620
without any lichen that's visually

259
00:09:35,790 --> 00:09:31,720
observable and over here is the cut rock

260
00:09:37,290 --> 00:09:35,800
surface so it's difficult to just see

261
00:09:38,610 --> 00:09:37,300
what this really means unless we look at

262
00:09:40,380 --> 00:09:38,620
the what are called the loading plots

263
00:09:43,470 --> 00:09:40,390

which show how the variance is actually

264
00:09:45,150 --> 00:09:43,480
defined and in this case principal

265
00:09:47,550 --> 00:09:45,160
component one is really based on the

266
00:09:49,980 --> 00:09:47,560
amount of silicon in the sample and we

267
00:09:51,900 --> 00:09:49,990
see that the areas with lichen have much

268
00:09:55,020 --> 00:09:51,910
more silicon in them than the areas

269
00:09:57,750 --> 00:09:55,030
without lots of lichens produce a silica

270
00:09:59,700 --> 00:09:57,760
glaze over top of itself as a way of

271
00:10:01,350 --> 00:09:59,710
they think protecting it from the

272
00:10:03,510 --> 00:10:01,360
harmful UV rays so that could be what

273
00:10:05,160 --> 00:10:03,520
we're observing here and also along

274
00:10:08,070 --> 00:10:05,170
principle component two is an increase

275
00:10:09,660 --> 00:10:08,080
in magnesium or magnesium and carbon and

276
00:10:11,490 --> 00:10:09,670
that's shown that the lichen has more

277
00:10:13,230 --> 00:10:11,500
magnesium and carbon we're not quite

278
00:10:14,670 --> 00:10:13,240
sure what this could be but it's

279
00:10:17,220 --> 00:10:14,680
possible that this could indicate the

280
00:10:20,700 --> 00:10:17,230
presence of chlorophyll or chloroplasts

281
00:10:22,020 --> 00:10:20,710
which we're observing here so the

282
00:10:24,450 --> 00:10:22,030
question we're trying to figure out now

283
00:10:27,050 --> 00:10:24,460
is how to apply these results to all

284
00:10:30,390 --> 00:10:27,060
three instruments and for future

285
00:10:32,520 --> 00:10:30,400
acquisition what we plan to do is take

286
00:10:35,880 --> 00:10:32,530
institution measurements in cave regions

287
00:10:37,620 --> 00:10:35,890
so in October will be taking a GF point

288
00:10:41,130 --> 00:10:37,630

spectrometer and the libs instrument

289
00:10:44,040 --> 00:10:41,140
into snowy river cave this is in Fort

290
00:10:46,380 --> 00:10:44,050
stay in New Mexico and it's known that

291
00:10:49,310 --> 00:10:46,390
many different kinds of the speleothems

292
00:10:51,900 --> 00:10:49,320
or cave formations within this cave are

293
00:10:54,060 --> 00:10:51,910
produced through biotic means so their

294
00:10:56,070 --> 00:10:54,070
influence through microbial activity and

295
00:10:58,290 --> 00:10:56,080
we'll be trying to use these analysis

296
00:10:59,490 --> 00:10:58,300
techniques to determine which types of

297
00:11:01,410 --> 00:10:59,500
cave formations are produced through

298
00:11:03,930 --> 00:11:01,420
biology and which types are produced

299
00:11:05,250 --> 00:11:03,940
through abiotic mechanisms and the whole

300
00:11:07,980 --> 00:11:05,260
point to this or the astrobiological

301
00:11:09,840 --> 00:11:07,990
context of this is where we're trying to

302
00:11:13,079 --> 00:11:09,850
determine how each of these instruments

303
00:11:14,580 --> 00:11:13,089
can be used to look for life in the

304
00:11:16,980 --> 00:11:14,590
solar system in that

305
00:11:18,720 --> 00:11:16,990
if you are planning a roving or landing

306
00:11:20,040 --> 00:11:18,730
mission to another solar system body and

307
00:11:22,110 --> 00:11:20,050
you have an idea of what kinds of life

308
00:11:23,610 --> 00:11:22,120
you're able to find will be able to tell

309
00:11:25,560 --> 00:11:23,620
you which types of instruments or

310
00:11:27,060 --> 00:11:25,570
multiple types of instruments are best

311
00:11:30,660 --> 00:11:27,070
suited to observe those kinds of

312
00:11:44,190 --> 00:11:30,670
biological mechanisms that's it take any

313
00:11:45,660 --> 00:11:44,200

questions thank you yes now the question

314
00:11:50,370 --> 00:11:45,670
was how big does the mineral need to be

315
00:11:52,580 --> 00:11:50,380
the DA OTF basically produces that size

316
00:11:56,550 --> 00:11:52,590
limit and it has a spot size of about

317
00:11:58,470 --> 00:11:56,560
one millimeter in diameter so anything

318
00:12:03,390 --> 00:11:58,480
about twice as big as that is usually

319
00:12:05,040 --> 00:12:03,400
pretty good for us so that to start with

320
00:12:06,960 --> 00:12:05,050
to build a spectral a member library we

321
00:12:10,610 --> 00:12:06,970
use the pure minerals and we're starting

322
00:12:20,079 --> 00:12:10,620
on using these mixtures or field samples

323
00:12:23,449 --> 00:12:22,130
it's not something we thought about but

324
00:12:25,699 --> 00:12:23,459
it's something maybe we should look into

325
00:12:28,610 --> 00:12:25,709
I know those are usually used for

326
00:12:29,720 --> 00:12:28,620
sending permeable membranes I think so

327
00:12:39,980 --> 00:12:29,730
that's definitely a good indicator for

328
00:12:41,750 --> 00:12:39,990
life yes well we're not able to measure

329
00:12:44,120 --> 00:12:41,760
the different isotope ratios for carbon

330
00:12:45,829 --> 00:12:44,130
the laser desorption time-of-flight mass

331
00:12:47,300 --> 00:12:45,839
spectrometer might but the signal tone

332
00:12:59,329 --> 00:12:47,310
oysters isn't good enough for us to do

333
00:13:02,810 --> 00:12:59,339
that yes shows those in particular yeah

334
00:13:04,639 --> 00:13:02,820
can you repeat what you said about which

335
00:13:07,610 --> 00:13:04,649
amino acids you spiked your samples with

336
00:13:10,220 --> 00:13:07,620
and why you chose those particular amino

337
00:13:11,540 --> 00:13:10,230
acids sure we chose phthalic acid and

338
00:13:12,740 --> 00:13:11,550

valine and I think they were chosen

339
00:13:16,670 --> 00:13:12,750
because those were the ones we had

340
00:13:18,500 --> 00:13:16,680
available sorry can you distinguish

341
00:13:21,740 --> 00:13:18,510
between the different isomers of veiling

342
00:13:28,610 --> 00:13:21,750
with your methods I'm sorry I don't