1
00:00:10,940 --> 00:00:09,680
hello and welcome to NASA Ames Research

2
00:00:13,070 --> 00:00:10,950
Center today

3
00:00:14,530 --> 00:00:13,080
the science team from the lunar crater

4
00:00:17,420 --> 00:00:14,540
observation and sensing satellite

5
00:00:19,490 --> 00:00:17,430
mission or L cross is presenting their

6
00:00:23,859 --> 00:00:19,500
initial findings from the lunar impacts

7
00:00:26,599 --> 00:00:23,869
on October 9th 2009 on a panel today our

8
00:00:28,450 --> 00:00:26,609
Anthony Cole Preet L cross project

9
00:00:31,460 --> 00:00:28,460
scientists and principal investigator

10
00:00:33,319 --> 00:00:31,470
Greg Delory senior fellow at the

11
00:00:36,889 --> 00:00:33,329
University of California Berkeley's

12
00:00:39,290 --> 00:00:36,899
Space Sciences laboratory Mike Michael

13
00:00:41,780 --> 00:00:39,300

Wargo chief lunar scientists for NASA

14
00:00:43,549 --> 00:00:41,790
headquarters Washington and joining us

15
00:00:46,520 --> 00:00:43,559
remotely from NASA headquarters

16
00:00:48,529 --> 00:00:46,530
Doug Cooke associated associate

17
00:00:51,290 --> 00:00:48,539
administrator for exploration systems

18
00:00:53,180 --> 00:00:51,300
Mission Directorate after each has

19
00:00:55,340 --> 00:00:53,190
spoken we will take questions from

20
00:00:58,569 --> 00:00:55,350
reporters in the audience and then

21
00:01:01,490 --> 00:00:58,579
remotely on the phone before we begin

22
00:01:09,219 --> 00:01:01,500
dr. Pete worden center director for NASA

23
00:01:12,700 --> 00:01:11,990
good morning it's been a great week for

24
00:01:14,899 --> 00:01:12,710
NASA

25
00:01:17,380 --> 00:01:14,909
if you don't know Time magazine

26
00:01:20,420 --> 00:01:17,390
identified a couple of our programs as

27
00:01:23,260 --> 00:01:20,430
as the top inventions the year including

28
00:01:27,160 --> 00:01:23,270
our Ares rockets so we're pretty pumped

29
00:01:30,140 --> 00:01:27,170
it's also a great Friday the 13th the

30
00:01:33,170 --> 00:01:30,150
and it's it's a great day another great

31
00:01:34,819 --> 00:01:33,180
day for NASA and NASA Ames in our

32
00:01:37,130 --> 00:01:34,829
colleagues at all the other centers and

33
00:01:40,100 --> 00:01:37,140
at NASA headquarters and our colleagues

34
00:01:42,319 --> 00:01:40,110
and in industry just a little over a

35
00:01:46,370 --> 00:01:42,329
month ago we were here giving you the

36
00:01:48,289 --> 00:01:46,380
preliminary results from the L cross

37
00:01:50,210 --> 00:01:48,299
mission that showed that we had a lot of

38
00:01:52,219 --> 00:01:50,220

really good data while the team has been

39
00:01:55,010 --> 00:01:52,229
working I think about twenty eight hours

40
00:01:56,539 --> 00:01:55,020
a day I'm amazed they look as bright and

41
00:01:58,340 --> 00:01:56,549
bright-eyed and bushy-tailed as they are

42
00:02:00,679 --> 00:01:58,350
but they're back here to share some

43
00:02:03,560 --> 00:02:00,689
really exciting results these will add

44
00:02:06,289 --> 00:02:03,570
to our understanding of the moon they

45
00:02:08,900 --> 00:02:06,299
will enable a NASA to to plan future

46
00:02:10,609 --> 00:02:08,910
missions including eventually human

47
00:02:12,650 --> 00:02:10,619
missions to the moon and they open a new

48
00:02:13,699 --> 00:02:12,660
chapter in our knowledge about our

49
00:02:16,190 --> 00:02:13,709
nearest neighbor

50
00:02:18,500 --> 00:02:16,200
today's announcement is exciting not

51
00:02:20,300 --> 00:02:18,510
only for NASA in the scientific

52
00:02:20,990 --> 00:02:20,310
community but also for explorers

53
00:02:23,270 --> 00:02:21,000
everywhere

54
00:02:24,800 --> 00:02:23,280
now without further ado I'd like to turn

55
00:02:28,399 --> 00:02:24,810
it over to those that made it happen

56
00:02:30,140 --> 00:02:28,409
Tony thank you thank you it's good to be

57
00:02:32,750 --> 00:02:30,150
here again as as Pete mentioned about

58
00:02:35,179 --> 00:02:32,760
one month ago we we made an impact and

59
00:02:37,220 --> 00:02:35,189
we saw some squiggly lines and we've

60
00:02:41,629 --> 00:02:37,230
been working about 28 hours a day a

61
00:02:44,119 --> 00:02:41,639
large team to understand what those mean

62
00:02:47,119 --> 00:02:44,129
and so I'm here today to tell you that

63
00:02:49,159 --> 00:02:47,129

indeed yes we found water and we didn't

64
00:02:52,490 --> 00:02:49,169
find just a little bit we found a

65
00:02:54,129 --> 00:02:52,500
significant amount if you remember about

66
00:02:57,170 --> 00:02:54,139
a month ago we were talking about

67
00:02:59,449 --> 00:02:57,180
teaspoons going to glasses over football

68
00:03:01,610 --> 00:02:59,459
fields well now I can say today that in

69
00:03:03,740 --> 00:03:01,620
the 20 to 30 meter crater outcross maybe

70
00:03:06,199 --> 00:03:03,750
we found maybe about a dozen of these

71
00:03:08,569 --> 00:03:06,209
two gallon buckets worth of water so

72
00:03:10,759 --> 00:03:08,579
we're this is initial results its

73
00:03:12,289 --> 00:03:10,769
preliminary worst I mean you're good

74
00:03:14,000 --> 00:03:12,299
you're gonna hear how we came to this

75
00:03:16,849 --> 00:03:14,010
conclusion today I'm gonna walk you

76
00:03:19,009 --> 00:03:16,859
through it and it's probably a lower

77
00:03:21,860 --> 00:03:19,019
bound on the total amount of water we've

78
00:03:24,649 --> 00:03:21,870
we've seen here and there's a whole lot

79
00:03:26,750 --> 00:03:24,659
more beyond the water so that's the

80
00:03:28,640 --> 00:03:26,760
exciting part in my mind is it's not

81
00:03:29,960 --> 00:03:28,650
only about the water now there's

82
00:03:32,300 --> 00:03:29,970
actually a lot more here that we're

83
00:03:32,629 --> 00:03:32,310
going to be talking about in the months

84
00:03:35,000 --> 00:03:32,639
ahead

85
00:03:37,759 --> 00:03:35,010
looking at they'll cross data so it's

86
00:03:39,649 --> 00:03:37,769
very exciting time for us science teams

87
00:03:42,379 --> 00:03:39,659
have been working exceedingly hard I'm

88
00:03:45,409 --> 00:03:42,389

very honored to be a part of such a an

89
00:03:48,289 --> 00:03:45,419
awesome group of people who've really

90
00:03:49,969 --> 00:03:48,299
been working pretty much non-stop for

91
00:03:52,159 --> 00:03:49,979
the last month to look into the data

92
00:03:54,229 --> 00:03:52,169
you'll understand why is that's a long

93
00:03:57,439 --> 00:03:54,239
time to come to some of the conclusions

94
00:04:01,249 --> 00:03:57,449
here in a minute so what I'd like to do

95
00:04:03,649 --> 00:04:01,259
is bring us back a month ago I probably

96
00:04:06,649 --> 00:04:03,659
was a little more tired than I am now

97
00:04:08,929 --> 00:04:06,659
then but we and pick up where we left

98
00:04:11,030 --> 00:04:08,939
off with the curtain what we saw with

99
00:04:12,920 --> 00:04:11,040
the ejecta cloud and then just step you

100
00:04:16,580 --> 00:04:12,930
through some of the points of analysis

101
00:04:19,670 --> 00:04:16,590
that we did to come to the conclusion

102
00:04:21,170 --> 00:04:19,680
that I just asserted so with that let's

103
00:04:24,560 --> 00:04:21,180
go to the first slide the first slide

104
00:04:26,420 --> 00:04:24,570
will show a visible camera image of the

105
00:04:27,050 --> 00:04:26,430
ejected cloud this is an image that was

106
00:04:31,159 --> 00:04:27,060
about 20

107
00:04:34,670 --> 00:04:31,169
seconds after impact we saw a nice plume

108
00:04:36,890 --> 00:04:34,680
rice it was in this particular image the

109
00:04:39,440 --> 00:04:36,900
inset shows to the lower left the plume

110
00:04:42,290 --> 00:04:39,450
it was about 10 to 12 kilometers across

111
00:04:44,090 --> 00:04:42,300
at this point this camera we weren't

112
00:04:45,650 --> 00:04:44,100
very hopeful of actually seeing the

113
00:04:49,010 --> 00:04:45,660

ejecta cloud so we were quite pleased

114
00:04:53,300 --> 00:04:49,020
that we saw it it was a nice large plume

115
00:04:55,340 --> 00:04:53,310
that came up in the next slide it shows

116
00:04:56,659 --> 00:04:55,350
the approximate field of view of the

117
00:04:58,730 --> 00:04:56,669
instruments that I'm going to talk about

118
00:05:01,460 --> 00:04:58,740
that did this water detection I just

119
00:05:04,250 --> 00:05:01,470
described the red circle there shows a 1

120
00:05:06,260 --> 00:05:04,260
degree field of view at just shortly

121
00:05:09,310 --> 00:05:06,270
after impact for our instruments and

122
00:05:11,990 --> 00:05:09,320
what's important about this is that that

123
00:05:13,670 --> 00:05:12,000
field of view that red circle is almost

124
00:05:16,580 --> 00:05:13,680
completely filled with ejecta cloud

125
00:05:19,040 --> 00:05:16,590
that's important because that is filling

126
00:05:21,230 --> 00:05:19,050
the instruments with the signal with the

127
00:05:23,270 --> 00:05:21,240
light the the mid you know the the

128
00:05:25,490 --> 00:05:23,280
information we needed to understand what

129
00:05:26,600 --> 00:05:25,500
was in the ejecta cloud so it worked

130
00:05:28,280 --> 00:05:26,610
really well

131
00:05:30,500 --> 00:05:28,290
we picked the time the fields of view

132
00:05:32,420 --> 00:05:30,510
and everything else like we had hoped

133
00:05:33,680 --> 00:05:32,430
and it worked and we we actually filled

134
00:05:37,580 --> 00:05:33,690
the instrument with signal which was

135
00:05:40,909 --> 00:05:37,590
really important the next slide shows

136
00:05:43,400 --> 00:05:40,919
some some of my favorite bits of data

137
00:05:45,590 --> 00:05:43,410
from the mission at the very end we

138
00:05:48,290 --> 00:05:45,600

turned one of our near infrared cameras

139
00:05:52,880 --> 00:05:48,300
to a long exposure and it settled down

140
00:05:55,100 --> 00:05:52,890
settled screamed down into caballos dick

141
00:05:59,420 --> 00:05:55,110
dip below the bright rims what we saw

142
00:06:03,170 --> 00:05:59,430
was a floor kebaya is revealed for the

143
00:06:05,240 --> 00:06:03,180
first time and one or two billion years

144
00:06:07,040 --> 00:06:05,250
we have not seen the floor of Cabiria as

145
00:06:09,170 --> 00:06:07,050
ever of course it's in permanent shadow

146
00:06:11,360 --> 00:06:09,180
but these near infrared cameras were

147
00:06:14,450 --> 00:06:11,370
able to image light that was radiating

148
00:06:16,190 --> 00:06:14,460
from the walls scattering in from the

149
00:06:18,560 --> 00:06:16,200
rims or the craters and whatnot and

150
00:06:20,779 --> 00:06:18,570
field what you see here and eventually

151
00:06:22,700 --> 00:06:20,789
what we could see both in our thermal

152
00:06:25,250 --> 00:06:22,710
cameras we could pick up the heat from

153
00:06:27,409 --> 00:06:25,260
the impact and also this image we could

154
00:06:29,270 --> 00:06:27,419
register them together we could see the

155
00:06:31,129 --> 00:06:29,280
crater the brand-new fresh crater the

156
00:06:33,409 --> 00:06:31,139
Centaur had just made in this field of

157
00:06:34,909 --> 00:06:33,419
view the arrows pointing to it what you

158
00:06:37,310 --> 00:06:34,919
see here are those bright Hills

159
00:06:39,409 --> 00:06:37,320
those are nice sloping hills with

160
00:06:40,970 --> 00:06:39,419
pocketed with smaller craters some

161
00:06:44,150 --> 00:06:40,980
larger craters here this is gay

162
00:06:46,400 --> 00:06:44,160
this this image as a couple kilometers

163
00:06:48,340 --> 00:06:46,410

across or so it's about farmers above

164
00:06:51,110 --> 00:06:48,350
the surface when we took this image and

165
00:06:53,120 --> 00:06:51,120
you can see our crater down there with

166
00:06:56,510 --> 00:06:53,130
the arrow pointed in the next image

167
00:06:58,970 --> 00:06:56,520
shows that crater zoomed in inset we hit

168
00:07:00,710 --> 00:06:58,980
into a nice level flat plane which is

169
00:07:03,170 --> 00:07:00,720
exactly what we want it it is one of the

170
00:07:05,270 --> 00:07:03,180
coldest places in kebaya s-- the diviner

171
00:07:08,210 --> 00:07:05,280
instrument saw our impact crater as well

172
00:07:09,410 --> 00:07:08,220
on the LRO spacecraft and measured the

173
00:07:14,540 --> 00:07:09,420
temperature in the region where we

174
00:07:17,000 --> 00:07:14,550
impact about minus 230 degrees 220

175
00:07:19,370 --> 00:07:17,010
degrees below Celsius below zero Celsius

176
00:07:21,050 --> 00:07:19,380
so very very cold and you can see in

177
00:07:22,700 --> 00:07:21,060
that inset the crater we made the dark

178
00:07:24,560 --> 00:07:22,710
area in the center is the crater the

179
00:07:27,080 --> 00:07:24,570
brighter area is ejecta that has been

180
00:07:30,440 --> 00:07:27,090
spilled out across the crater we made

181
00:07:32,060 --> 00:07:30,450
was 20 to 30 meters across and the

182
00:07:35,000 --> 00:07:32,070
ejecta the bright area there is

183
00:07:36,980 --> 00:07:35,010
approximately 60 to 80 meters we have

184
00:07:38,210 --> 00:07:36,990
information that indicates that the

185
00:07:40,490 --> 00:07:38,220
ejecta blanket actually went much

186
00:07:43,910 --> 00:07:40,500
broader to several hundred meters

187
00:07:47,390 --> 00:07:43,920
outwards really infecting the area we

188
00:07:49,880 --> 00:07:47,400

this is a nice large crater what we

189
00:07:54,400 --> 00:07:49,890
expected in the 22 feet 30 meter class

190
00:07:58,730 --> 00:07:54,410
means we hit in relatively unconsolable

191
00:07:59,840 --> 00:07:58,740
and and that's what resulted in the

192
00:08:02,090 --> 00:07:59,850
ejecta plume that you saw in the

193
00:08:03,800 --> 00:08:02,100
previous slide so what did we see from

194
00:08:05,200 --> 00:08:03,810
the instruments that detected water and

195
00:08:08,270 --> 00:08:05,210
that's what I'm going to talk about next

196
00:08:10,700 --> 00:08:08,280
next slide shows the two instruments

197
00:08:13,970 --> 00:08:10,710
that I'm going to describe in detail to

198
00:08:15,260 --> 00:08:13,980
you the events that we're going to talk

199
00:08:17,440 --> 00:08:15,270
about are spectrometers these

200
00:08:20,840 --> 00:08:17,450
spectrometers measure colors of

201
00:08:22,910 --> 00:08:20,850
wavelengths and and those colors are

202
00:08:25,690 --> 00:08:22,920
affected by various compositions from

203
00:08:29,270 --> 00:08:25,700
various compounds for example water or

204
00:08:30,650 --> 00:08:29,280
carbon dioxide or or whatever they each

205
00:08:32,120 --> 00:08:30,660
of each compound will affect those

206
00:08:34,610 --> 00:08:32,130
lights differently we have two

207
00:08:36,500 --> 00:08:34,620
instruments that we used on on this

208
00:08:39,050 --> 00:08:36,510
mission to look at that plume an

209
00:08:41,060 --> 00:08:39,060
ultraviolet invisible spectrometer the

210
00:08:43,969 --> 00:08:41,070
one indicated there on the lower left

211
00:08:45,320 --> 00:08:43,979
and near infrared spectrometers we had

212
00:08:47,270 --> 00:08:45,330
two near infrared spectrometers one

213
00:08:49,370 --> 00:08:47,280

looking down and one looking to the side

214
00:08:50,870 --> 00:08:49,380
at the Sun today I'm just going to talk

215
00:08:52,820 --> 00:08:50,880
about the two that we're looking down

216
00:08:54,950 --> 00:08:52,830
because those are the two we focused on

217
00:08:58,370 --> 00:08:54,960
to provide the results undescribed

218
00:09:00,100 --> 00:08:58,380
today the next slide then shows some of

219
00:09:03,080 --> 00:09:00,110
the near infrared spectrometer results

220
00:09:04,730 --> 00:09:03,090
and unfortunately spectrometers often

221
00:09:05,390 --> 00:09:04,740
just give squiggly lines not pretty

222
00:09:07,190 --> 00:09:05,400
pictures

223
00:09:08,690 --> 00:09:07,200
however these squiggly lines are really

224
00:09:10,190 --> 00:09:08,700
important because they are as they

225
00:09:12,110 --> 00:09:10,200
mentioned that the change in these

226
00:09:14,750 --> 00:09:12,120
colors and the changes in those lines

227
00:09:18,230 --> 00:09:14,760
really tell us what we're seeing in that

228
00:09:21,020 --> 00:09:18,240
cloud what I have here is a plot of

229
00:09:23,690 --> 00:09:21,030
brightness against color or wavelength

230
00:09:25,820 --> 00:09:23,700
and the black line with the low hash

231
00:09:27,410 --> 00:09:25,830
marks the vertical hash marks is the

232
00:09:30,260 --> 00:09:27,420
date of the observation this is a

233
00:09:31,900 --> 00:09:30,270
average of about 20 to 60 seconds after

234
00:09:34,760 --> 00:09:31,910
an impact we've averaged a number of

235
00:09:37,160 --> 00:09:34,770
instruments scans together the black

236
00:09:39,650 --> 00:09:37,170
vertical hash marks are uncertainty bars

237
00:09:41,600 --> 00:09:39,660
or air bars in the measurement what I

238
00:09:43,070 --> 00:09:41,610

show those is to show that these

239
00:09:45,020 --> 00:09:43,080
measurements these dips you seen the

240
00:09:47,930 --> 00:09:45,030
line are real they're not just noise

241
00:09:49,520 --> 00:09:47,940
they're very real and what you would see

242
00:09:51,800 --> 00:09:49,530
what you would expect to see if if

243
00:09:54,830 --> 00:09:51,810
you're just looking at bright colorless

244
00:09:57,770 --> 00:09:54,840
gray dust of ejecta is shown on the next

245
00:09:59,420 --> 00:09:57,780
slide this red line shows a continuum a

246
00:10:01,400 --> 00:09:59,430
blackbody what we call blackbody

247
00:10:04,970 --> 00:10:01,410
continuum something hot if this is warm

248
00:10:07,730 --> 00:10:04,980
dust coming up at about say 400 or 500

249
00:10:09,560 --> 00:10:07,740
degrees Celsius you'd see this nice red

250
00:10:11,690 --> 00:10:09,570
smooth line all the way across like you

251
00:10:14,330 --> 00:10:11,700
see here that's not what the data series

252
00:10:16,820 --> 00:10:14,340
data has it kind of comes up and meets

253
00:10:19,010 --> 00:10:16,830
that line but then it has all these

254
00:10:21,350 --> 00:10:19,020
notches taken out of it and that each of

255
00:10:23,930 --> 00:10:21,360
those notches is a compound some kind of

256
00:10:26,120 --> 00:10:23,940
material absorbing infrared light

257
00:10:28,310 --> 00:10:26,130
near-infrared light so the first thing

258
00:10:30,410 --> 00:10:28,320
we did was well let's put in some water

259
00:10:33,080 --> 00:10:30,420
and see what happens when you put water

260
00:10:36,200 --> 00:10:33,090
into that model that red line and the

261
00:10:39,290 --> 00:10:36,210
next slide shows that and we get a good

262
00:10:40,700 --> 00:10:39,300
fit into region the two regions are

263
00:10:43,220 --> 00:10:40,710

indicated by the yellow those are the

264
00:10:45,050 --> 00:10:43,230
water bands water vapor and ice bands

265
00:10:47,330 --> 00:10:45,060
there's actually a third to the left

266
00:10:49,340 --> 00:10:47,340
that I don't show here at about 1.27

267
00:10:52,280 --> 00:10:49,350
microns shorter wave links to the left

268
00:10:54,560 --> 00:10:52,290
dad actually shows us as well we got

269
00:10:56,660 --> 00:10:54,570
good fits this was a unique fit meaning

270
00:10:58,790 --> 00:10:56,670
we could not put other compounds in here

271
00:11:02,450 --> 00:10:58,800
and generate this same fit so we're

272
00:11:04,760 --> 00:11:02,460
really excited it was a pretty tight fit

273
00:11:08,440 --> 00:11:04,770
within the air bars for for water vapor

274
00:11:13,160 --> 00:11:11,180
now all those other bands and bumps

275
00:11:14,690 --> 00:11:13,170
there are interest too and and we've

276
00:11:17,000 --> 00:11:14,700
been studying those and I don't want to

277
00:11:19,010 --> 00:11:17,010
say too much beyond what I've already

278
00:11:21,020 --> 00:11:19,020
said on those bumps and Wiggles except

279
00:11:23,000 --> 00:11:21,030
the next slide shows that we can

280
00:11:24,740 --> 00:11:23,010
actually fit them all pretty well with a

281
00:11:26,300 --> 00:11:24,750
variety of different compounds and

282
00:11:28,490 --> 00:11:26,310
that's when I say this goes beyond the

283
00:11:30,710 --> 00:11:28,500
water it really does there's a lot of

284
00:11:33,050 --> 00:11:30,720
stuff that came out of there and you're

285
00:11:35,300 --> 00:11:33,060
gonna hear about this a little bit more

286
00:11:38,240 --> 00:11:35,310
as we discuss this on the panel but

287
00:11:40,010 --> 00:11:38,250
there was a lot of stuff that came up

288
00:11:43,490 --> 00:11:40,020

out of the floor of Cabela's not just

289
00:11:46,310 --> 00:11:43,500
water that we saw so the next slide then

290
00:11:48,850 --> 00:11:46,320
goes on to the next instrument if we can

291
00:11:51,170 --> 00:11:48,860
have the next slide this is the

292
00:11:54,050 --> 00:11:51,180
ultraviolet visible spectrometer and

293
00:11:55,790 --> 00:11:54,060
what's really important to consider

294
00:11:58,010 --> 00:11:55,800
today as I come forward with these

295
00:12:00,260 --> 00:11:58,020
findings is we see evidence for the

296
00:12:01,580 --> 00:12:00,270
water and to instruments to independent

297
00:12:03,530 --> 00:12:01,590
instruments looking at water two

298
00:12:05,360 --> 00:12:03,540
completely independent ways and that's

299
00:12:08,260 --> 00:12:05,370
what really made us comment in our and

300
00:12:11,120 --> 00:12:08,270
our findings right now this shows the

301
00:12:13,400 --> 00:12:11,130
radiance of the brightness the measured

302
00:12:14,810 --> 00:12:13,410
by the ultraviolet visible spectrometer

303
00:12:17,180 --> 00:12:14,820
again it's measuring the brightness as a

304
00:12:18,680 --> 00:12:17,190
function of color and that's a color or

305
00:12:21,880 --> 00:12:18,690
wavelength is shown across the bottom

306
00:12:24,140 --> 00:12:21,890
axis here the red line shows the

307
00:12:26,270 --> 00:12:24,150
measurement so it's a little bit

308
00:12:29,030 --> 00:12:26,280
brighter towards the right at red

309
00:12:30,980 --> 00:12:29,040
wavelengths 660 nanometers our red

310
00:12:32,630 --> 00:12:30,990
wavelengths what you see though that's

311
00:12:34,210 --> 00:12:32,640
important are some little spikes those

312
00:12:39,079 --> 00:12:34,220
little spikes are calling mission lines

313
00:12:42,290 --> 00:12:39,089

emission lines are our diagnostic of a

314
00:12:46,370 --> 00:12:42,300
variety of different compounds so and

315
00:12:49,100 --> 00:12:46,380
the result from when a compound either a

316
00:12:51,620 --> 00:12:49,110
molecule or an atom is in an excited

317
00:12:54,200 --> 00:12:51,630
state and relaxing out of that excited

318
00:12:55,880 --> 00:12:54,210
high higher energy state it releases

319
00:12:58,220 --> 00:12:55,890
some of the energy in the form of light

320
00:13:00,170 --> 00:12:58,230
and creates a sharp spike and emission

321
00:13:02,540 --> 00:13:00,180
line you can kind of think of it like a

322
00:13:05,840 --> 00:13:02,550
neon sign a neon sign that's going ring

323
00:13:08,240 --> 00:13:05,850
has a particular gas in it gets excited

324
00:13:12,590 --> 00:13:08,250
energized with electricity and as those

325
00:13:14,570 --> 00:13:12,600
atoms in that neon bulb relax they emit

326
00:13:16,160 --> 00:13:14,580
light of a particular color that's what

327
00:13:17,690 --> 00:13:16,170
we're seeing here is species are

328
00:13:20,240 --> 00:13:17,700
emitting light at a particular cover

329
00:13:21,350 --> 00:13:20,250
color and by understanding exactly what

330
00:13:23,269 --> 00:13:21,360
color that

331
00:13:25,519 --> 00:13:23,279
line is that you understand what species

332
00:13:28,310 --> 00:13:25,529
is admitting it so what we were

333
00:13:31,190 --> 00:13:28,320
interested in is some emission lines in

334
00:13:31,460 --> 00:13:31,200
the ultraviolet and if we go to the next

335
00:13:35,720 --> 00:13:31,470
slide

336
00:13:37,190 --> 00:13:35,730
can talk about those emission lines the

337
00:13:41,240 --> 00:13:37,200
emission line we were interested comes

338
00:13:44,889 --> 00:13:41,250

from the the hydroxyl molecule o ho8

339
00:13:47,810 --> 00:13:44,899
can be produced when water vapor h2o is

340
00:13:49,819 --> 00:13:47,820
broken up by by sunlight ultraviolet

341
00:13:53,000 --> 00:13:49,829
sunrays will break up a water molecule

342
00:13:56,480 --> 00:13:53,010
into Oh H and H and that Oh H is

343
00:13:58,790 --> 00:13:56,490
energized its excited and as it relaxes

344
00:14:02,870 --> 00:13:58,800
from an energized state it releases some

345
00:14:05,210 --> 00:14:02,880
light an emission line rate a series of

346
00:14:07,550 --> 00:14:05,220
emission lines even between 306 and

347
00:14:09,530 --> 00:14:07,560
about 310 nanometers in the ultraviolet

348
00:14:12,079 --> 00:14:09,540
and that's the range we're looking at

349
00:14:14,720 --> 00:14:12,089
here so what this figure shows is the

350
00:14:18,620 --> 00:14:14,730
ratio what we've done is we've divided

351
00:14:19,759 --> 00:14:18,630
pre and post impact measurements to get

352
00:14:21,230 --> 00:14:19,769
rid of everything else we're not really

353
00:14:24,079 --> 00:14:21,240
interested in we're just interested in

354
00:14:26,480 --> 00:14:24,089
stuff resulting from the impact and and

355
00:14:29,000 --> 00:14:26,490
plotted it as a function of a cup of

356
00:14:30,650 --> 00:14:29,010
color again here or wavelength and right

357
00:14:33,920 --> 00:14:30,660
in the middle or that blue color is you

358
00:14:36,590 --> 00:14:33,930
see a spike that rises from earlier

359
00:14:39,769 --> 00:14:36,600
scans which are down near the bottom to

360
00:14:42,620 --> 00:14:39,779
later scans which come up in ratio at

361
00:14:44,720 --> 00:14:42,630
time and there's two things occurring

362
00:14:46,610 --> 00:14:44,730
here the the lines near the bottom are

363
00:14:49,370 --> 00:14:46,620

relatively flat and lower levels those

364
00:14:51,500 --> 00:14:49,380
are basically pre impact scans what

365
00:14:53,300 --> 00:14:51,510
those show is pretty they're flat not a

366
00:14:55,880 --> 00:14:53,310
lot going on there and they're a lower

367
00:14:57,949 --> 00:14:55,890
level after the impact an injected cloud

368
00:14:59,840 --> 00:14:57,959
come up it was scattering sunlight

369
00:15:02,540 --> 00:14:59,850
reflecting light and that's why the

370
00:15:04,790 --> 00:15:02,550
levels in general come up higher and

371
00:15:07,250 --> 00:15:04,800
higher what you can see then our spikes

372
00:15:09,380 --> 00:15:07,260
emerge at a variety of places but the

373
00:15:11,150 --> 00:15:09,390
one we're interested and for today's

374
00:15:13,340 --> 00:15:11,160
discussion is right in that blue area

375
00:15:16,460 --> 00:15:13,350
and you see a sharp spike come up right

376
00:15:17,930 --> 00:15:16,470
around 309 nanometers or so and I've

377
00:15:20,750 --> 00:15:17,940
highlighted a couple of those spikes

378
00:15:23,090 --> 00:15:20,760
with green showing that the the type of

379
00:15:26,300 --> 00:15:23,100
those those spikes we call the band

380
00:15:29,300 --> 00:15:26,310
strength that is the strength of that o

381
00:15:30,889 --> 00:15:29,310
H a mission line and the brightness of

382
00:15:32,840 --> 00:15:30,899
that emission and that's related to how

383
00:15:36,079 --> 00:15:32,850
much o H is there and hence

384
00:15:38,210 --> 00:15:36,089
much water is there so buy one seeing

385
00:15:40,819 --> 00:15:38,220
this it confirms that there is water

386
00:15:44,360 --> 00:15:40,829
being photolyze being broken apart by

387
00:15:46,069 --> 00:15:44,370
sunlight above the ejecta cloud or

388
00:15:48,139 --> 00:15:46,079

within the ejecta cloud in the field of

389
00:15:49,879 --> 00:15:48,149
view of this instrument what we can do

390
00:15:51,740 --> 00:15:49,889
then is take that strength of that line

391
00:15:53,540 --> 00:15:51,750
and plot it overtime and actually use it

392
00:15:55,430 --> 00:15:53,550
to figure out how much water was

393
00:15:57,499 --> 00:15:55,440
actually there and in the next slide

394
00:15:59,569 --> 00:15:57,509
that's what we show though the strength

395
00:16:02,240 --> 00:15:59,579
of that band as a function of time and

396
00:16:05,360 --> 00:16:02,250
you can see in the yellow area the pre

397
00:16:07,759 --> 00:16:05,370
impact period there that band strength

398
00:16:10,069 --> 00:16:07,769
is relatively flat within the noise of

399
00:16:13,610 --> 00:16:10,079
the system and shortly after impact you

400
00:16:16,449 --> 00:16:13,620
see it rise up fairly quickly and then

401
00:16:19,730 --> 00:16:16,459
stay steady over two or three minutes

402
00:16:22,340 --> 00:16:19,740
with some variations over time as we

403
00:16:26,389 --> 00:16:22,350
flew in towards the cloud this is really

404
00:16:28,670 --> 00:16:26,399
a good detection of it's a strong

405
00:16:30,559 --> 00:16:28,680
detection well above the noise level so

406
00:16:32,360 --> 00:16:30,569
this combined with the other infrared

407
00:16:34,749 --> 00:16:32,370
absorption lines dips I showed you

408
00:16:36,620 --> 00:16:34,759
earlier are two very strong independent

409
00:16:39,679 --> 00:16:36,630
indicators that there was water vapor

410
00:16:42,350 --> 00:16:39,689
coming up out of kebaya s-- and and

411
00:16:46,249 --> 00:16:42,360
other things as well as I mentioned so

412
00:16:49,280 --> 00:16:46,259
using both those measurements when I

413
00:16:52,550 --> 00:16:49,290

opened with the amount of water we think

414
00:16:54,050 --> 00:16:52,560
we saw we can constrain a rate now how

415
00:16:55,699 --> 00:16:54,060
much water we think is in the field of

416
00:16:57,499 --> 00:16:55,709
view of our increment and that's what I

417
00:16:59,300 --> 00:16:57,509
described there is based on these

418
00:17:00,889 --> 00:16:59,310
measurements there is more than 100

419
00:17:02,900 --> 00:17:00,899
kilograms in the field of view of our

420
00:17:05,000 --> 00:17:02,910
instrument what does that mean 100

421
00:17:07,880 --> 00:17:05,010
kilograms that's the dozen or so two

422
00:17:09,799 --> 00:17:07,890
gallon buckets I described but what that

423
00:17:11,990 --> 00:17:09,809
what that what we need to do next is

424
00:17:13,970 --> 00:17:12,000
actually take all the information the

425
00:17:16,039 --> 00:17:13,980
amount of ejecta the size of the crater

426
00:17:18,169 --> 00:17:16,049
how this all change over time and

427
00:17:20,419 --> 00:17:18,179
actually reconstruct the entire event

428
00:17:22,669 --> 00:17:20,429
understand how it all fits back into the

429
00:17:24,559 --> 00:17:22,679
into the ground along with all the other

430
00:17:26,620 --> 00:17:24,569
things that we've seen in the ejecta

431
00:17:31,100 --> 00:17:26,630
plume to really understand this whole

432
00:17:32,810 --> 00:17:31,110
this whole thing in its entirety I think

433
00:17:35,630 --> 00:17:32,820
what we're presenting today is a status

434
00:17:39,350 --> 00:17:35,640
update where we are it was I know very

435
00:17:41,390 --> 00:17:39,360
important to the public to know the

436
00:17:42,950 --> 00:17:41,400
result of the El cross mission so we

437
00:17:45,320 --> 00:17:42,960
were very compelled to work as hard as

438
00:17:46,370 --> 00:17:45,330

we could to come out with the results

439
00:17:49,640 --> 00:17:46,380
when we did

440
00:17:52,100 --> 00:17:49,650
after the team was confident and had a

441
00:17:54,890 --> 00:17:52,110
consensus that what we found was indeed

442
00:17:58,130 --> 00:17:54,900
and and we could give some kind of

443
00:18:01,040 --> 00:17:58,140
quantifiable amount the last slide again

444
00:18:02,690 --> 00:18:01,050
shows that the the immediate science

445
00:18:06,230 --> 00:18:02,700
team has been working on this result a

446
00:18:08,360 --> 00:18:06,240
very small team focused dedicated and I

447
00:18:10,490 --> 00:18:08,370
just got to say thank you to them for

448
00:18:12,320 --> 00:18:10,500
doing all the hard work that you've seen

449
00:18:13,880 --> 00:18:12,330
presented today and there's much more

450
00:18:17,300 --> 00:18:13,890
that will be presented in the coming

451
00:18:20,300 --> 00:18:17,310
weeks and months at a variety of venues

452
00:18:22,340 --> 00:18:20,310
so with that I will turn it over to Greg

453
00:18:26,570 --> 00:18:22,350
Gloria who will find some context for

454
00:18:29,180 --> 00:18:26,580
this observation and great thank you

455
00:18:31,340 --> 00:18:29,190
first of all let me join my colleagues

456
00:18:33,290 --> 00:18:31,350
here and expressing to you what an

457
00:18:35,390 --> 00:18:33,300
exciting and extraordinary discovery

458
00:18:37,490 --> 00:18:35,400
this really is and our understanding of

459
00:18:38,900 --> 00:18:37,500
the Moon what I'm here to do today is to

460
00:18:40,700 --> 00:18:38,910
try and give you some idea of the

461
00:18:42,830 --> 00:18:40,710
importance and significance of this new

462
00:18:44,810 --> 00:18:42,840
finding in the larger context of lunar

463
00:18:47,030 --> 00:18:44,820

science and and our understanding of the

464
00:18:49,430 --> 00:18:47,040
history of the solar system so let's

465
00:18:50,540 --> 00:18:49,440
talk about polar regions one might start

466
00:18:52,940 --> 00:18:50,550
with a question why are the polar

467
00:18:55,820 --> 00:18:52,950
regions so important and one way to

468
00:18:57,470 --> 00:18:55,830
convey that is to use an analogy many

469
00:18:59,120 --> 00:18:57,480
people may be aware that some of the

470
00:19:01,280 --> 00:18:59,130
best information we have about our own

471
00:19:03,710 --> 00:19:01,290
Earth's climate in fact comes from a

472
00:19:05,810 --> 00:19:03,720
detailed analysis of polar ice cores

473
00:19:08,000 --> 00:19:05,820
things we get from our own poles in the

474
00:19:10,160 --> 00:19:08,010
Arctic and Antarctic and in very much

475
00:19:12,560 --> 00:19:10,170
the same way the lunar poles are sort of

476
00:19:14,750 --> 00:19:12,570
record keepers of conditions throughout

477
00:19:17,120 --> 00:19:14,760
the lunar history and throughout the

478
00:19:18,920 --> 00:19:17,130
solar system's history for very long

479
00:19:20,390 --> 00:19:18,930
periods of time and this is because the

480
00:19:22,220 --> 00:19:20,400
surfaces in these regions and these

481
00:19:24,620 --> 00:19:22,230
permanently shadowed areas such as the

482
00:19:26,870 --> 00:19:24,630
one that L cross impacted are very cold

483
00:19:28,870 --> 00:19:26,880
that means that they tend to trap and

484
00:19:31,640 --> 00:19:28,880
keep things that encounter them

485
00:19:33,530 --> 00:19:31,650
compounds atoms and so forth and so they

486
00:19:35,180 --> 00:19:33,540
act as record keepers perhaps over a

487
00:19:38,000 --> 00:19:35,190
periods as long as several billion years

488
00:19:39,680 --> 00:19:38,010

so they have a story to tell about the

489
00:19:42,140 --> 00:19:39,690
history of the moon and perhaps about

490
00:19:43,640 --> 00:19:42,150
the solar system climate if you will

491
00:19:46,370 --> 00:19:43,650
conditions in the early solar system

492
00:19:48,170 --> 00:19:46,380
that are unique to these regions second

493
00:19:49,340 --> 00:19:48,180
of all let's talk about water the focus

494
00:19:52,490 --> 00:19:49,350
of today's press conference has been

495
00:19:54,650 --> 00:19:52,500
water water is very important it's what

496
00:19:56,540 --> 00:19:54,660
scientists call a volatile that means

497
00:19:58,700 --> 00:19:56,550
it's a compound it's very easily

498
00:20:00,960 --> 00:19:58,710
mobilized by changes in conditions such

499
00:20:02,250 --> 00:20:00,970
as temperature and other

500
00:20:05,159 --> 00:20:02,260
it's very sensitive to thermal

501
00:20:07,500 --> 00:20:05,169
conditions radiation on Barban history

502
00:20:08,700 --> 00:20:07,510
and so it's sort of a record keeper in

503
00:20:10,500 --> 00:20:08,710
that sense and that it tells you

504
00:20:12,840 --> 00:20:10,510
something about the history of the

505
00:20:14,340 --> 00:20:12,850
region from which you obtain it it's

506
00:20:15,750 --> 00:20:14,350
also been suggested that if we find

507
00:20:19,200 --> 00:20:15,760
water and large enough amounts and I

508
00:20:20,730 --> 00:20:19,210
just heard twelve buckets full it's

509
00:20:22,860 --> 00:20:20,740
possibly a resource for human

510
00:20:23,970 --> 00:20:22,870
exploration if human settlers ever go

511
00:20:26,310 --> 00:20:23,980
there so for these and other reasons

512
00:20:29,039 --> 00:20:26,320
water is of extreme interest on the moon

513
00:20:31,710 --> 00:20:29,049

and also other planetary bodies so

514
00:20:34,680 --> 00:20:31,720
getting on to some of the potential

515
00:20:36,900 --> 00:20:34,690
significance of this result as I said El

516
00:20:40,110 --> 00:20:36,910
Cross has made a major discovery a

517
00:20:41,370 --> 00:20:40,120
decade ago we knew from lunar prospector

518
00:20:43,200 --> 00:20:41,380
measurements that there was a large

519
00:20:45,659 --> 00:20:43,210
amount of hydrogen in the polar regions

520
00:20:48,480 --> 00:20:45,669
of the Moon unfortunately we had no idea

521
00:20:49,919 --> 00:20:48,490
the form of that hydrogen because of its

522
00:20:53,490 --> 00:20:49,929
location because it was in the polar

523
00:20:54,810 --> 00:20:53,500
regions a very easily assertion to make

524
00:20:57,780 --> 00:20:54,820
was that it was in the form of water

525
00:20:59,070 --> 00:20:57,790
probably ice but I think because of the

526
00:21:00,450 --> 00:20:59,080
ambiguity of the measurements there was

527
00:21:03,240 --> 00:21:00,460
no firm consensus in the scientific

528
00:21:05,010 --> 00:21:03,250
community that it was in fact water El

529
00:21:07,260 --> 00:21:05,020
Cross has now made that definitive

530
00:21:08,820 --> 00:21:07,270
discovery it's very likely that a lot of

531
00:21:12,270 --> 00:21:08,830
that hydrogen is in the form of water

532
00:21:14,010 --> 00:21:12,280
and so now we can move on to much more

533
00:21:16,669 --> 00:21:14,020
important and interesting questions and

534
00:21:19,140 --> 00:21:16,679
so while this discovery is significant

535
00:21:21,450 --> 00:21:19,150
what's equally important is what we do

536
00:21:22,919 --> 00:21:21,460
next and some the really intriguing

537
00:21:25,350 --> 00:21:22,929
questions that come up are the following

538
00:21:27,840 --> 00:21:25,360

where did the water come from how long

539
00:21:29,340 --> 00:21:27,850
has it been there what kind of processes

540
00:21:31,080 --> 00:21:29,350
are involved in putting it there and

541
00:21:32,909 --> 00:21:31,090
modifying it and removing it and

542
00:21:34,950 --> 00:21:32,919
destroying it it's when we get at these

543
00:21:36,810 --> 00:21:34,960
processes that will begin to understand

544
00:21:39,419 --> 00:21:36,820
the story that the lunar polar region

545
00:21:41,220 --> 00:21:39,429
has to tell about the moon's history

546
00:21:44,490 --> 00:21:41,230
about our own history about early

547
00:21:46,710 --> 00:21:44,500
conditions in the solar system so some

548
00:21:48,419 --> 00:21:46,720
examples to what your appetite in terms

549
00:21:50,610 --> 00:21:48,429
of the stories when they learn one

550
00:21:52,530 --> 00:21:50,620
possible source for the water is from

551
00:21:54,720 --> 00:21:52,540
comets the moon hasn't been impacted by

552
00:21:56,930 --> 00:21:54,730
comets in the past and if that's true

553
00:21:59,190 --> 00:21:56,940
and the lunar polar regions really are

554
00:22:00,810 --> 00:21:59,200
repositories for this material that

555
00:22:03,419 --> 00:22:00,820
means that they are a literally literal

556
00:22:06,060 --> 00:22:03,429
treasure trove of information in terms

557
00:22:07,590 --> 00:22:06,070
of the composition of comets which are

558
00:22:09,180 --> 00:22:07,600
themselves indicative of early sources

559
00:22:11,330 --> 00:22:09,190
and conditions that would be extreme

560
00:22:14,609 --> 00:22:11,340
interest to many planetary scientists

561
00:22:16,799 --> 00:22:14,619
another possibility completely differ

562
00:22:19,200 --> 00:22:16,809
water could come and in fact from the

563
00:22:22,019 --> 00:22:19,210

solar wind which is basically an ionized

564
00:22:23,909 --> 00:22:22,029
gas streaming off the Sun composed

565
00:22:26,639 --> 00:22:23,919
mainly of hydrogen it impacts the lunar

566
00:22:28,560 --> 00:22:26,649
surface undergoes chemistry eventually

567
00:22:29,969 --> 00:22:28,570
these molecules hop around the surface

568
00:22:31,379 --> 00:22:29,979
of the Moon and end up concentrating

569
00:22:33,089 --> 00:22:31,389
around the poles because they're cold

570
00:22:35,549 --> 00:22:33,099
traps they trap everything that comes

571
00:22:36,899 --> 00:22:35,559
their way in which case studying those

572
00:22:39,269 --> 00:22:36,909
deposits would tell us something about

573
00:22:41,009 --> 00:22:39,279
solar history also about the history of

574
00:22:42,930 --> 00:22:41,019
chemical reactions occurring on the

575
00:22:44,159 --> 00:22:42,940
surface of the Moon two completely

576
00:22:45,869 --> 00:22:44,169
different theories we don't know which

577
00:22:48,690 --> 00:22:45,879
one is right yet other sources are also

578
00:22:50,489 --> 00:22:48,700
possible giant molecular clouds have

579
00:22:52,019 --> 00:22:50,499
passed through our solar system many

580
00:22:54,539 --> 00:22:52,029
times in the past they have hydrogen

581
00:22:56,219 --> 00:22:54,549
bearing compounds ice Laden dust could

582
00:22:58,560 --> 00:22:56,229
be raining down another intriguing

583
00:22:59,700 --> 00:22:58,570
possibility is that the moon itself may

584
00:23:02,129 --> 00:22:59,710
be the source of the water through

585
00:23:04,229 --> 00:23:02,139
internal activity and so analyzing that

586
00:23:06,269 --> 00:23:04,239
deposit would give you a window into the

587
00:23:08,519 --> 00:23:06,279
interior of the Moon the earth itself

588
00:23:10,229 --> 00:23:08,529

could also be a source so I'm

589
00:23:13,349 --> 00:23:10,239
summarizing all these to give you a

590
00:23:15,239 --> 00:23:13,359
preview of the kinds of stories that the

591
00:23:16,950 --> 00:23:15,249
lunar polar regions could possibly begin

592
00:23:19,200 --> 00:23:16,960
to tell us and now that we know that

593
00:23:21,690 --> 00:23:19,210
water is there thanks to El cross we can

594
00:23:26,070 --> 00:23:21,700
begin in earnest to go to this next set

595
00:23:27,479 --> 00:23:26,080
of questions so in summary this recent

596
00:23:29,159 --> 00:23:27,489
result from El cross together with

597
00:23:31,349 --> 00:23:29,169
emerging results from the lunar

598
00:23:33,779 --> 00:23:31,359
reconnaissance orbiter ongoing lunar

599
00:23:36,119 --> 00:23:33,789
program are really exciting it's

600
00:23:38,279 --> 00:23:36,129
painting a really surprising new picture

601
00:23:39,769 --> 00:23:38,289
of the moon one way to state this is

602
00:23:42,899 --> 00:23:39,779
that this is not your father's moon

603
00:23:45,450 --> 00:23:42,909
rather than a dead and an unchanging

604
00:23:47,909 --> 00:23:45,460
world it could in fact be a very dynamic

605
00:23:50,099 --> 00:23:47,919
and interesting one that could tell us

606
00:23:51,570 --> 00:23:50,109
unique things about the earth moon

607
00:23:54,539 --> 00:23:51,580
system and the early solar system

608
00:23:56,430 --> 00:23:54,549
conditions I'm sure the El Cross team is

609
00:23:57,979 --> 00:23:56,440
going to reveal new exciting discoveries

610
00:24:00,539 --> 00:23:57,989
as they continue to analyze their data

611
00:24:03,239 --> 00:24:00,549
we also have the NASA lunar Science

612
00:24:04,649 --> 00:24:03,249
Institute in place with many scientists

613
00:24:06,539 --> 00:24:04,659

who are poised to help answer these

614
00:24:08,129 --> 00:24:06,549
questions we have exciting upcoming

615
00:24:10,079 --> 00:24:08,139
missions such as the lunar atmosphere

616
00:24:11,669 --> 00:24:10,089
and dust environment Explorer which will

617
00:24:13,379 --> 00:24:11,679
help determine if there are active

618
00:24:14,669 --> 00:24:13,389
present-day processes that are moving

619
00:24:17,159 --> 00:24:14,679
water around the surface of the Moon

620
00:24:19,049 --> 00:24:17,169
it's going to be a very exciting time as

621
00:24:21,149 --> 00:24:19,059
we begin to learn about this new

622
00:24:23,789 --> 00:24:21,159
emerging picture of not just any moon

623
00:24:25,829 --> 00:24:23,799
but our moon and so with that I'm happy

624
00:24:27,820 --> 00:24:25,839
to hand the discussion over to Mike

625
00:24:31,240 --> 00:24:27,830
Wargo of the exploration systems

626
00:24:34,899 --> 00:24:31,250
director thanks a lot Greg well there

627
00:24:37,899 --> 00:24:34,909
you have it we've discovered significant

628
00:24:41,110 --> 00:24:37,909
quantities of water in a permanently

629
00:24:42,730 --> 00:24:41,120
shadowed crater on the moon now an awful

630
00:24:44,740 --> 00:24:42,740
lot of you wanted us to be able to say

631
00:24:46,560 --> 00:24:44,750
that a couple of hours after impact and

632
00:24:49,299 --> 00:24:46,570
we weren't just able to do it that day

633
00:24:51,250 --> 00:24:49,309
and what this is an example of I'm gonna

634
00:24:54,220 --> 00:24:51,260
rewind the clock just like Tony didn't

635
00:24:58,950 --> 00:24:54,230
go back to that day there's this healthy

636
00:25:01,509 --> 00:24:58,960
tension that exists between a really

637
00:25:04,180 --> 00:25:01,519
interesting and exciting story that you

638
00:25:08,409 --> 00:25:04,190

want to tell but then not necessarily

639
00:25:10,360 --> 00:25:08,419
having the the confidence in in what you

640
00:25:13,060 --> 00:25:10,370
know yet because you haven't had a

641
00:25:16,500 --> 00:25:13,070
chance to go through the kind of

642
00:25:20,379 --> 00:25:16,510
analysis that that scientists do as we

643
00:25:23,470 --> 00:25:20,389
as we develop this story in a compelling

644
00:25:25,000 --> 00:25:23,480
way well this is another step along the

645
00:25:28,180 --> 00:25:25,010
way we were you know you were frustrated

646
00:25:29,980 --> 00:25:28,190
that day we were frustrated that day but

647
00:25:32,500 --> 00:25:29,990
now we're starting to be able to tell

648
00:25:36,580 --> 00:25:32,510
you more and more about that story to

649
00:25:38,310 --> 00:25:36,590
the point where we have water at the in

650
00:25:43,000 --> 00:25:38,320
these permanently shadowed craters and

651
00:25:46,110 --> 00:25:43,010
we also are seeing hints of other stuff

652
00:25:50,399 --> 00:25:46,120
that's there and Tony gave an example of

653
00:25:53,139 --> 00:25:50,409
those Wiggly lines getting fit better

654
00:25:55,570 --> 00:25:53,149
but we have to go back and look at what

655
00:25:58,960 --> 00:25:55,580
does it take and what is the uniqueness

656
00:26:01,690 --> 00:25:58,970
of the the solution to those kinds of

657
00:26:04,600 --> 00:26:01,700
problems by uniqueness I just mean can

658
00:26:08,620 --> 00:26:04,610
you get a set of chemical compounds that

659
00:26:11,590 --> 00:26:08,630
only that set in only those in the

660
00:26:12,789 --> 00:26:11,600
concentrations give you that line that's

661
00:26:15,100 --> 00:26:12,799
how we were able to come to the

662
00:26:17,200 --> 00:26:15,110
conclusion that that's water there

663
00:26:19,000 --> 00:26:17,210

because if you didn't have the water you

664
00:26:23,799 --> 00:26:19,010
couldn't have fit those lines the way we

665
00:26:25,330 --> 00:26:23,809
did now we're excited today you can

666
00:26:28,269 --> 00:26:25,340
definitely tell that but it's forward a

667
00:26:31,330 --> 00:26:28,279
whole lot of different reasons I'm going

668
00:26:34,180 --> 00:26:31,340
to go back once more the importance that

669
00:26:37,990 --> 00:26:34,190
this mission has for both exploration

670
00:26:40,870 --> 00:26:38,000
and science Oh Greg did a great job of

671
00:26:42,910 --> 00:26:40,880
telling the impact that this has on

672
00:26:45,820 --> 00:26:42,920
adding to our understanding of the moon

673
00:26:48,310 --> 00:26:45,830
and the solar system and the dynamic

674
00:26:49,750 --> 00:26:48,320
nature of the moon is a planet whom just

675
00:26:51,700 --> 00:26:49,760
a couple of months ago would have

676
00:26:54,610 --> 00:26:51,710
thought that we're talking about not

677
00:26:57,160 --> 00:26:54,620
just water on the moon but lots of water

678
00:27:00,220 --> 00:26:57,170
on the moon and the processes by which

679
00:27:03,730 --> 00:27:00,230
it gets there by which it stays there

680
00:27:06,520 --> 00:27:03,740
these cold traps you know they're really

681
00:27:12,730 --> 00:27:06,530
like the dusty attic of the of the solar

682
00:27:14,740 --> 00:27:12,740
system they collect stuff from the whole

683
00:27:17,290 --> 00:27:14,750
evolution of the solar system to this

684
00:27:19,240 --> 00:27:17,300
time at least over the last few billion

685
00:27:21,460 --> 00:27:19,250
years and there's a Trevor treasure

686
00:27:24,820 --> 00:27:21,470
trove of information in there and we've

687
00:27:26,800 --> 00:27:24,830
only just begun to tap that that

688
00:27:28,630 --> 00:27:26,810

understanding there's an awful lot more

689
00:27:32,320 --> 00:27:28,640
there and it's there for science and

690
00:27:33,550 --> 00:27:32,330
exploration water can be used for you

691
00:27:36,010 --> 00:27:33,560
know the kind of things we think about

692
00:27:39,100 --> 00:27:36,020
everyday drinking water if we have

693
00:27:42,070 --> 00:27:39,110
extended crews on the surface you can

694
00:27:46,000 --> 00:27:42,080
break it down and have breathable air

695
00:27:47,440 --> 00:27:46,010
for for crews to breathe but also if you

696
00:27:50,110 --> 00:27:47,450
have significant quantities of this

697
00:27:51,990 --> 00:27:50,120
stuff water really is the constituents

698
00:27:58,120 --> 00:27:52,000
of one of the most potent rocket fuels

699
00:28:01,030 --> 00:27:58,130
oxygen and hydrogen an important point

700
00:28:04,420 --> 00:28:01,040
though and we each of us has said this

701
00:28:06,460 --> 00:28:04,430
and I think you I need to say it again

702
00:28:09,880 --> 00:28:06,470
and that's this is only another point

703
00:28:11,740 --> 00:28:09,890
another snapshot in time for our

704
00:28:13,900 --> 00:28:11,750
understanding of this wealth of

705
00:28:16,960 --> 00:28:13,910
information that's come that's come out

706
00:28:20,470 --> 00:28:16,970
of the L cross measurements we're going

707
00:28:22,990 --> 00:28:20,480
to be continuing to work to get more and

708
00:28:27,400 --> 00:28:23,000
more details about the other information

709
00:28:28,930 --> 00:28:27,410
that's not the water this time so we're

710
00:28:31,510 --> 00:28:28,940
really not done yet

711
00:28:34,500 --> 00:28:31,520
and we're going to keep you informed as

712
00:28:37,330 --> 00:28:34,510
we progress and as we find more and more

713
00:28:39,730 --> 00:28:37,340

information but we're going to do it in

714
00:28:41,980 --> 00:28:39,740
such a way that we have the same kind of

715
00:28:44,050 --> 00:28:41,990
confidence when we talk to you next that

716
00:28:45,370 --> 00:28:44,060
we have today when we talked about the

717
00:28:48,520 --> 00:28:45,380
the presence of water there and

718
00:28:49,990 --> 00:28:48,530
significant quantities of water so we're

719
00:28:53,380 --> 00:28:50,000
going to be coming back to you but right

720
00:28:53,980 --> 00:28:53,390
now from Washington we have Doug cook

721
00:28:55,660 --> 00:28:53,990
our

722
00:28:58,120 --> 00:28:55,670
seat administrator for exploration

723
00:29:00,220 --> 00:28:58,130
systems and Doug's gonna give us his

724
00:29:06,430 --> 00:29:00,230
perspective on what we've told you today

725
00:29:09,430 --> 00:29:06,440
Doug thank you Mike we're happy to be

726
00:29:12,010 --> 00:29:09,440
here with you I want to congratulate the

727
00:29:13,990 --> 00:29:12,020
entire L cross team and particularly

728
00:29:16,180 --> 00:29:14,000
today the science team and all those who

729
00:29:18,490 --> 00:29:16,190
have helped to get to this point and

730
00:29:21,130 --> 00:29:18,500
understanding results from this recent

731
00:29:25,049 --> 00:29:21,140
mission I continue to be very proud of

732
00:29:28,630 --> 00:29:25,059
this team they have they began with a

733
00:29:30,280 --> 00:29:28,640
project that was capped in cost so they

734
00:29:31,960 --> 00:29:30,290
had to work very effectively and very

735
00:29:34,120 --> 00:29:31,970
efficiently to get to the point of

736
00:29:35,980 --> 00:29:34,130
getting the spacecraft built launched

737
00:29:41,440 --> 00:29:35,990
and out of the point of getting results

738
00:29:44,650 --> 00:29:41,450

so this is been a very very well done

739
00:29:47,740 --> 00:29:44,660
effort on the part of this team they

740
00:29:49,690 --> 00:29:47,750
face some big issues just prior to their

741
00:29:53,530 --> 00:29:49,700
launch and once they were flying in

742
00:29:55,690 --> 00:29:53,540
space in terms of getting the mission

743
00:29:58,510 --> 00:29:55,700
keeping the mission on track and getting

744
00:30:01,000 --> 00:29:58,520
the point of impact the precision of the

745
00:30:03,820 --> 00:30:01,010
of the impact was incredible the

746
00:30:06,430 --> 00:30:03,830
instruments performed exceptionally well

747
00:30:08,890 --> 00:30:06,440
and now we're seeing remarkable results

748
00:30:12,400 --> 00:30:08,900
that are beyond expectations the

749
00:30:14,230 --> 00:30:12,410
discovery of water ice on the moon this

750
00:30:16,060 --> 00:30:14,240
is something that's been in question for

751
00:30:17,950 --> 00:30:16,070
quite a few years now

752
00:30:20,710 --> 00:30:17,960
this is an ice that's potentially been

753
00:30:23,530 --> 00:30:20,720
there for billions of years it has

754
00:30:26,230 --> 00:30:23,540
obviously has implications for science

755
00:30:29,230 --> 00:30:26,240
in terms of understanding the history of

756
00:30:32,350 --> 00:30:29,240
the earth-moon system and the solar

757
00:30:34,750 --> 00:30:32,360
system and the implications that were

758
00:30:39,580 --> 00:30:34,760
described for exploration in the future

759
00:30:43,570 --> 00:30:39,590
as a water as a resource for explorers

760
00:30:45,820 --> 00:30:43,580
in the future so many have said that we

761
00:30:47,890 --> 00:30:45,830
we learned most what there are all what

762
00:30:50,520 --> 00:30:47,900
we needed to learn about the moon from

763
00:30:52,750 --> 00:30:50,530

the Apollo missions I cross is is

764
00:30:55,810 --> 00:30:52,760
demonstrating that there is much more to

765
00:30:57,700 --> 00:30:55,820
learn and there always is we also have

766
00:31:00,400 --> 00:30:57,710
the Lunar Reconnaissance Orbiter that is

767
00:31:04,360 --> 00:31:00,410
in orbit around the moon collecting data

768
00:31:06,280 --> 00:31:04,370
and making high high fidelity 3d maps of

769
00:31:06,970 --> 00:31:06,290
the moon that will be of use in the

770
00:31:09,659 --> 00:31:06,980
future

771
00:31:11,919 --> 00:31:09,669
we continue to learn more about the moon

772
00:31:15,250 --> 00:31:11,929
so stay tuned

773
00:31:17,680 --> 00:31:15,260
the moon has more secrets the further

774
00:31:21,900 --> 00:31:17,690
data from El Cross will reveal some of

775
00:31:24,610 --> 00:31:21,910
these as well data from LRO I think it's

776
00:31:27,760 --> 00:31:24,620
incredibly exciting and I'm really happy

777
00:31:30,340 --> 00:31:27,770
for what part I gets playing this thank

778
00:31:33,520 --> 00:31:30,350
you for for the opportunity and and back

779
00:31:35,860 --> 00:31:33,530
to you guys okay thank you Doug and

780
00:31:38,380 --> 00:31:35,870
panelists we will now be taking

781
00:31:40,330 --> 00:31:38,390
questions if you have a question please

782
00:31:45,100 --> 00:31:40,340
raise your hand and I will direct my

783
00:31:47,440 --> 00:31:45,110
colleagues with the mics and okay and

784
00:31:49,650 --> 00:31:47,450
then before asking your question please

785
00:31:54,460 --> 00:31:49,660
state your name and your organization

786
00:31:56,890 --> 00:31:54,470
thank you Bigler CBS radio my first

787
00:31:58,090 --> 00:31:56,900
question is when at that Anthony when at

788
00:31:59,710 --> 00:31:58,100

that moment when you discovered that

789
00:32:01,720 --> 00:31:59,720
there was indeed water on the moon that

790
00:32:03,520 --> 00:32:01,730
what you've been looking for did you

791
00:32:07,330 --> 00:32:03,530
toast with water or champagne and

792
00:32:10,330 --> 00:32:07,340
describe describe that moment to us well

793
00:32:12,940 --> 00:32:10,340
it was it was about I think about 3 a.m.

794
00:32:14,500 --> 00:32:12,950
when I was doing the the Fitz I mean and

795
00:32:16,780 --> 00:32:14,510
we've been working on this pretty much

796
00:32:20,260 --> 00:32:16,790
around the clock and and we were working

797
00:32:22,330 --> 00:32:20,270
through the data and I was kept coming

798
00:32:24,340 --> 00:32:22,340
back to that that in particular the one

799
00:32:26,710 --> 00:32:24,350
before micron feature that that earlier

800
00:32:29,200 --> 00:32:26,720
dipped a stronger dip and kept coming

801
00:32:32,770 --> 00:32:29,210
back to that and I've sent out to the

802
00:32:34,659 --> 00:32:32,780
team pose and I said I can't get rid of

803
00:32:36,610 --> 00:32:34,669
this dip can you get rid of it and no

804
00:32:38,919 --> 00:32:36,620
one and some of the other spectroscopy

805
00:32:41,980 --> 00:32:38,929
said no it's it's definitely real and

806
00:32:46,030 --> 00:32:41,990
it's there and so are all these other

807
00:32:47,620 --> 00:32:46,040
dips and and that's where you said okay

808
00:32:49,990 --> 00:32:47,630
this is all noise we got beat this down

809
00:32:51,010 --> 00:32:50,000
that's the average I didn't know it's

810
00:32:53,620 --> 00:32:51,020
real okay

811
00:32:55,570 --> 00:32:53,630
and that's when we kind of sat back and

812
00:32:57,789 --> 00:32:55,580
we said oh my goodness it's a lot more

813
00:33:00,190 --> 00:32:57,799

complicated than we had really

814
00:33:02,289 --> 00:33:00,200
anticipated meaning it wasn't just water

815
00:33:06,370 --> 00:33:02,299
but there was a lot of other interesting

816
00:33:08,289 --> 00:33:06,380
stuff in there and then it was when we

817
00:33:09,669 --> 00:33:08,299
built some of our models and cleaned

818
00:33:12,430 --> 00:33:09,679
them up and we walked through it as a

819
00:33:14,500 --> 00:33:12,440
group we're like okay water does fit

820
00:33:16,730 --> 00:33:14,510
there that's pretty good but then it was

821
00:33:18,860 --> 00:33:16,740
when one of my colleagues

822
00:33:21,350 --> 00:33:18,870
said you know I think I see the OAH line

823
00:33:23,150 --> 00:33:21,360
too and she stuck on she showed it to me

824
00:33:24,799 --> 00:33:23,160
and I said okay that was a Eureka moment

825
00:33:26,870 --> 00:33:24,809
I was like I'm convinced there's water

826
00:33:29,540 --> 00:33:26,880
I've got two independent people working

827
00:33:31,940 --> 00:33:29,550
independent problems and they both came

828
00:33:33,740 --> 00:33:31,950
to the same conclusion and then we

829
00:33:35,390 --> 00:33:33,750
vetted it and we vetted it and we vetted

830
00:33:38,090 --> 00:33:35,400
it and then we've edited some more as a

831
00:33:39,549 --> 00:33:38,100
team and in with support it's

832
00:33:43,730 --> 00:33:39,559
corroborated with a number of other

833
00:33:49,610 --> 00:33:43,740
observations too so I honestly we have

834
00:33:51,560 --> 00:33:49,620
not had time to to enjoy because we are

835
00:33:54,500 --> 00:33:51,570
so interested in everything else that's

836
00:33:57,530 --> 00:33:54,510
in there and we've been working really

837
00:33:59,419 --> 00:33:57,540
hard just to pull it all together I'm

838
00:34:01,810 --> 00:33:59,429

sure I'll be doing some toasting now

839
00:34:04,220 --> 00:34:01,820
though that I can speak openly about it

840
00:34:06,320 --> 00:34:04,230
I'll ask a serious question real quick

841
00:34:08,540 --> 00:34:06,330
is there enough water so that astronauts

842
00:34:12,139 --> 00:34:08,550
can live off the land on the surface of

843
00:34:14,540 --> 00:34:12,149
the Moon that's a that's that's a matter

844
00:34:16,210 --> 00:34:14,550
I think of where we're going to take

845
00:34:20,060 --> 00:34:16,220
this work in the future

846
00:34:23,659 --> 00:34:20,070
you know we hit one plate and KB as' and

847
00:34:24,980 --> 00:34:23,669
we went there because we all the data

848
00:34:28,909 --> 00:34:24,990
said there was a lot of hydrogen there

849
00:34:31,940 --> 00:34:28,919
and I think the number I'm giving right

850
00:34:33,649 --> 00:34:31,950
now is probably a lower limit and as we

851
00:34:35,810 --> 00:34:33,659
refine our analysis we'll be able to

852
00:34:38,570 --> 00:34:35,820
reduce the uncertainty in how much water

853
00:34:40,669 --> 00:34:38,580
is there if you take that and then you

854
00:34:42,919 --> 00:34:40,679
take them observations of hydrogen from

855
00:34:44,869 --> 00:34:42,929
lunar prospector and from the lend

856
00:34:47,570 --> 00:34:44,879
instrument on LRO

857
00:34:51,260 --> 00:34:47,580
we can extrapolate to what exists

858
00:34:52,700 --> 00:34:51,270
globally on the moon and I think it's

859
00:34:54,919 --> 00:34:52,710
gonna be significant but there's going

860
00:34:57,280 --> 00:34:54,929
to be a you know as you take one spot

861
00:34:59,750 --> 00:34:57,290
and you extrapolate it more broadly

862
00:35:01,630 --> 00:34:59,760
there's going to be you know associated

863
00:35:05,330 --> 00:35:01,640

uncertainty that we have to understand

864
00:35:07,460 --> 00:35:05,340
there I put it this way I was impressed

865
00:35:08,990 --> 00:35:07,470
by the strength of the bands so I'm

866
00:35:12,820 --> 00:35:09,000
pretty impressed by the amount of water

867
00:35:19,690 --> 00:35:14,860
okay

868
00:35:21,430 --> 00:35:19,700
reference to other things that might be

869
00:35:24,220 --> 00:35:21,440
out there what are the range of

870
00:35:25,960 --> 00:35:24,230
possibilities some of the things we're

871
00:35:27,760 --> 00:35:25,970
looking at and this is just things we're

872
00:35:31,060 --> 00:35:27,770
considering because as Mike said the

873
00:35:37,240 --> 00:35:31,070
uniqueness is important are a variety of

874
00:35:39,370 --> 00:35:37,250
other CH molecules so you know and one

875
00:35:42,400 --> 00:35:39,380
of the things I did early on was compare

876
00:35:45,190 --> 00:35:42,410
our spectra to some primitive icy bodies

877
00:35:49,140 --> 00:35:45,200
like centaur or Trojan asteroids and

878
00:35:51,730 --> 00:35:49,150
there was a considerable amount of

879
00:35:58,230 --> 00:35:51,740
similarities and so on those bodies

880
00:36:03,690 --> 00:35:58,240
you'll find co2 methane so2 perhaps

881
00:36:07,840 --> 00:36:03,700
other things like ethanol methanol

882
00:36:10,810 --> 00:36:07,850
organics things like that now all those

883
00:36:13,240 --> 00:36:10,820
are possibilities but we need to really

884
00:36:15,040 --> 00:36:13,250
do the work to to see which ones fit

885
00:36:17,230 --> 00:36:15,050
best you saw one fit that we were able

886
00:36:23,320 --> 00:36:17,240
to come up with which combined a variety

887
00:36:25,180 --> 00:36:23,330
of those species but it's it's certainly

888
00:36:27,160 --> 00:36:25,190

that it is certain that some of those

889
00:36:30,820 --> 00:36:27,170
species are in there which ones is what

890
00:36:34,000 --> 00:36:30,830
we need to figure out going forward it's

891
00:36:36,190 --> 00:36:34,010
really a question of how many different

892
00:36:38,950 --> 00:36:36,200
kinds of combinations of things can give

893
00:36:42,010 --> 00:36:38,960
you that same set of squiggly lines and

894
00:36:44,290 --> 00:36:42,020
do you have other ways of understanding

895
00:36:46,120 --> 00:36:44,300
the data that gets you toward that

896
00:36:49,650 --> 00:36:46,130
uniqueness so that's only one

897
00:36:54,600 --> 00:36:49,660
combination of compounds at certain

898
00:36:57,430 --> 00:36:54,610
fractions that that you're confident in

899
00:36:58,720 --> 00:36:57,440
okay well go please state your name in

900
00:37:00,850 --> 00:36:58,730
your organization

901
00:37:02,830 --> 00:37:00,860
Mike meet you with Aviation Week you've

902
00:37:04,780 --> 00:37:02,840
been talking just about instruments that

903
00:37:06,460 --> 00:37:04,790
were on the shepherding spacecraft if I

904
00:37:08,170 --> 00:37:06,470
understand correctly and he had a lot of

905
00:37:10,120 --> 00:37:08,180
other instruments from the ground

906
00:37:12,580 --> 00:37:10,130
observatories as well as other

907
00:37:14,680 --> 00:37:12,590
spacecraft have you started over how

908
00:37:17,470 --> 00:37:14,690
much have you started overlap if that's

909
00:37:19,150 --> 00:37:17,480
the proper word they're data when what

910
00:37:21,610 --> 00:37:19,160
you've got and can you give us an idea

911
00:37:23,980 --> 00:37:21,620
of where they are sure in helping you

912
00:37:28,359 --> 00:37:23,990
we're working very closely with LRO LRO

913
00:37:33,160 --> 00:37:30,579

you know this is as much to their credit

914
00:37:37,720 --> 00:37:33,170
as anyone and to find the spot in kebaya

915
00:37:40,930 --> 00:37:37,730
s-- the and then two instruments observe

916
00:37:43,749 --> 00:37:40,940
the impact on LRO diviner and lamp

917
00:37:45,069 --> 00:37:43,759
they have very exciting results we've

918
00:37:47,079 --> 00:37:45,079
been working very closely with them

919
00:37:49,029 --> 00:37:47,089
they've been participating in some of

920
00:37:51,160 --> 00:37:49,039
our team meetings and we're writing up

921
00:37:52,660 --> 00:37:51,170
our results together I don't want to

922
00:37:55,109 --> 00:37:52,670
speak too much to their results because

923
00:37:58,239 --> 00:37:55,119
that's their results but it is

924
00:38:01,239 --> 00:37:58,249
incredibly complimentary in a lot of

925
00:38:02,440 --> 00:38:01,249
ways not not saying that they see water

926
00:38:04,150 --> 00:38:02,450
I'm not saying that I'm just saying it's

927
00:38:06,700 --> 00:38:04,160
very complimentary and that they're

928
00:38:10,720 --> 00:38:06,710
gonna help constrain of our measurements

929
00:38:12,910 --> 00:38:10,730
and vice versa for ground-based

930
00:38:16,539 --> 00:38:12,920
observing

931
00:38:18,970 --> 00:38:16,549
most of all the observatories made great

932
00:38:20,200 --> 00:38:18,980
observations they were on target but

933
00:38:22,690 --> 00:38:20,210
they knew it was gonna be a difficult

934
00:38:25,120 --> 00:38:22,700
observation once we moved to kebaya us

935
00:38:27,009 --> 00:38:25,130
from kebaya say kebaya say had the best

936
00:38:30,910 --> 00:38:27,019
observing for earth-based observatories

937
00:38:35,109 --> 00:38:30,920
but after a you know continued

938
00:38:38,559 --> 00:38:35,119

observations from LRO which said the the

939
00:38:40,180 --> 00:38:38,569
scientific relevant places campeius that

940
00:38:43,269 --> 00:38:40,190
combined with our instruments working

941
00:38:45,519 --> 00:38:43,279
well in our spacecraft and LRO phasing

942
00:38:47,049 --> 00:38:45,529
its orbit to make the observation I

943
00:38:49,779 --> 00:38:47,059
consulted with the ground-based

944
00:38:51,279 --> 00:38:49,789
observing campaign and I said I'm I want

945
00:38:52,870 --> 00:38:51,289
to move it to kebaya it's going to hurt

946
00:38:54,370 --> 00:38:52,880
your observations they said we

947
00:38:56,739 --> 00:38:54,380
understand we're gonna make them anyways

948
00:38:59,589 --> 00:38:56,749
that said they saw some interesting

949
00:39:03,870 --> 00:38:59,599
things and they are working on analyzing

950
00:39:07,359 --> 00:39:03,880
it now a number of observatories saw

951
00:39:09,249 --> 00:39:07,369
emission lines from sodium rise up high

952
00:39:12,940 --> 00:39:09,259
over the impact site several minutes

953
00:39:15,460 --> 00:39:12,950
after the impact so others have seen

954
00:39:17,559 --> 00:39:15,470
changes in the scattering continuum and

955
00:39:20,289 --> 00:39:17,569
a meaning that they may have seen some

956
00:39:22,870 --> 00:39:20,299
dust come up others have seen changes in

957
00:39:25,450 --> 00:39:22,880
their spectra but they have a much much

958
00:39:27,880 --> 00:39:25,460
harder time than we do in understanding

959
00:39:29,640 --> 00:39:27,890
that data the experiment was set up

960
00:39:32,140 --> 00:39:29,650
perfectly for our shepherding spacecraft

961
00:39:34,539 --> 00:39:32,150
we were flying directly down at the

962
00:39:36,400 --> 00:39:34,549
impact site he had a dust cloud against

963
00:39:39,549 --> 00:39:36,410

a perfectly black background

964
00:39:41,799 --> 00:39:39,559
it was optimum for us for them they had

965
00:39:44,679 --> 00:39:41,809
a look over a hill

966
00:39:50,079 --> 00:39:44,689
you know to get get at the ejecta and

967
00:39:52,269 --> 00:39:50,089
any gas that came up was quickly was

968
00:39:53,829 --> 00:39:52,279
moved quickly in front of a bright moon

969
00:39:56,019 --> 00:39:53,839
and so it made it that their

970
00:39:57,249 --> 00:39:56,029
observations difficult their status

971
00:39:59,499 --> 00:39:57,259
right now is they're stale still

972
00:40:01,029 --> 00:39:59,509
analyzing it and we're gonna they're

973
00:40:07,150 --> 00:40:01,039
probably gonna report in the springtime

974
00:40:10,150 --> 00:40:07,160
I would think as to their findings how

975
00:40:12,459 --> 00:40:10,160
close you came 40 meters thousand meters

976
00:40:16,900 --> 00:40:12,469
how close did you come to perfect

977
00:40:18,969 --> 00:40:16,910
targeting we so we had a three and a

978
00:40:22,959 --> 00:40:18,979
half kilometer goal on the science team

979
00:40:25,209 --> 00:40:22,969
we smashed that I think we we're still

980
00:40:27,519 --> 00:40:25,219
analyzing exactly where we hit and right

981
00:40:30,969 --> 00:40:27,529
now the uncertainty is probably about a

982
00:40:33,160 --> 00:40:30,979
hundred meters or 200 meters but we hit

983
00:40:43,170 --> 00:40:33,170
within probably that it was very close

984
00:40:45,910 --> 00:40:43,180
targeting where we wanted to hit okay

985
00:40:47,769 --> 00:40:45,920
Tony Wayne Friedman ABC 7 News in San

986
00:40:49,779 --> 00:40:47,779
Francisco you talked about water and you

987
00:40:53,620 --> 00:40:49,789
talked about ice if you were to melt

988
00:40:55,299 --> 00:40:53,630

that ice into a beaker what kind of

989
00:40:55,989 --> 00:40:55,309
water would it be would it be water you

990
00:40:58,179 --> 00:40:55,999
could drink

991
00:41:01,569 --> 00:40:58,189
there's methanol in there I wouldn't

992
00:41:03,969 --> 00:41:01,579
drink it because it'd go blind but it

993
00:41:05,589 --> 00:41:03,979
would be water that you could drink its

994
00:41:08,640 --> 00:41:05,599
water like any other water I don't think

995
00:41:11,140 --> 00:41:08,650
based we still need to really sort out

996
00:41:13,120 --> 00:41:11,150
the the flavor of the water meaning how

997
00:41:15,009 --> 00:41:13,130
much is ice is it crystalline ice on the

998
00:41:17,559 --> 00:41:15,019
grains or is it just vapor coming off

999
00:41:19,120 --> 00:41:17,569
absorbed water we still need to do that

1000
00:41:22,089 --> 00:41:19,130
math that's going to take some time

1001
00:41:24,189 --> 00:41:22,099
right now based on the amount I don't

1002
00:41:26,279 --> 00:41:24,199
think it could just be absorbed water

1003
00:41:29,349 --> 00:41:26,289
meaning and add by absorbed I mean water

1004
00:41:31,599 --> 00:41:29,359
that has just formed in films along

1005
00:41:34,719 --> 00:41:31,609
grains boundaries I think there's too

1006
00:41:38,650 --> 00:41:34,729
much some of it has to be ice we're

1007
00:41:40,719 --> 00:41:38,660
sorting that out and if it it that if

1008
00:41:42,669 --> 00:41:40,729
you could clean it it would be drinkable

1009
00:41:45,549 --> 00:41:42,679
water when you talk about ice you were

1010
00:41:48,549 --> 00:41:45,559
talking about a frozen lake in the ideal

1011
00:41:50,469 --> 00:41:48,559
well yeah can you typify wouldn't think

1012
00:41:52,209 --> 00:41:50,479
you hit what a nice a house are we

1013
00:41:54,530 --> 00:41:52,219

talking about chunks of ice are we

1014
00:41:57,000 --> 00:41:54,540
talking about ice within

1015
00:41:59,010 --> 00:41:57,010
that that's going to come out in our

1016
00:42:01,440 --> 00:41:59,020
studies but based on if I had to

1017
00:42:03,500 --> 00:42:01,450
conjecture now we made a nice crater

1018
00:42:06,840 --> 00:42:03,510
meaning we didn't hit something that was

1019
00:42:10,160 --> 00:42:06,850
frozen and and so that says a lot about

1020
00:42:13,140 --> 00:42:10,170
the state of the material that we hit

1021
00:42:16,170 --> 00:42:13,150
that will combine that information with

1022
00:42:18,000 --> 00:42:16,180
the amount of water we derive from our

1023
00:42:20,010 --> 00:42:18,010
spectroscopy from our measurements and

1024
00:42:23,190 --> 00:42:20,020
come up with some kind of ideas of how

1025
00:42:25,200 --> 00:42:23,200
its distributed right now I don't know

1026
00:42:28,170 --> 00:42:25,210
it I don't think I think it's safe to

1027
00:42:30,600 --> 00:42:28,180
say it wasn't a frozen lake with all the

1028
00:42:33,270 --> 00:42:30,610
water wasn't on a on a perfect surface

1029
00:42:35,460 --> 00:42:33,280
at the top on a frozen film but it was

1030
00:42:38,280 --> 00:42:35,470
probably mixed intermixed with in the

1031
00:42:39,930 --> 00:42:38,290
grains frozen granules and whatnot that

1032
00:42:41,700 --> 00:42:39,940
that remains to be seen though I mean

1033
00:42:44,160 --> 00:42:41,710
that's some of the ongoing work we need

1034
00:42:46,860 --> 00:42:44,170
to do really can taking all the datasets

1035
00:42:48,420 --> 00:42:46,870
and combining them into one story if a

1036
00:42:49,890 --> 00:42:48,430
person were to stand there what would it

1037
00:42:51,900 --> 00:42:49,900
look like would it look different I

1038
00:42:53,430 --> 00:42:51,910

don't know that's a good question we've

1039
00:42:55,530 --> 00:42:53,440
been talking about that and based on

1040
00:42:58,320 --> 00:42:55,540
some of the observations it would be an

1041
00:43:01,470 --> 00:42:58,330
interesting place an interesting place

1042
00:43:03,990 --> 00:43:01,480
to walk around I think some of these

1043
00:43:06,510 --> 00:43:04,000
species that we're talking about are

1044
00:43:09,570 --> 00:43:06,520
fairly volatile other than water we hit

1045
00:43:12,000 --> 00:43:09,580
a very cold place - 220 degrees below

1046
00:43:13,830 --> 00:43:12,010
zero centigrade but some of the species

1047
00:43:17,400 --> 00:43:13,840
that we think we may be seeing are

1048
00:43:19,410 --> 00:43:17,410
fairly volatile so meaning they will you

1049
00:43:20,730 --> 00:43:19,420
don't have to warm them up much just by

1050
00:43:25,200 --> 00:43:20,740
twenty or thirty degrees and they're

1051
00:43:26,910 --> 00:43:25,210
gonna bubble off we do have what's

1052
00:43:30,090 --> 00:43:26,920
fantastic is we have these near infrared

1053
00:43:32,310 --> 00:43:30,100
camera images of the florica beds so we

1054
00:43:35,070 --> 00:43:32,320
actually can relate those to what the

1055
00:43:36,810 --> 00:43:35,080
human eye would potentially see and so

1056
00:43:38,250 --> 00:43:36,820
that is our in our plans as we have

1057
00:43:41,220 --> 00:43:38,260
these images that we never really

1058
00:43:43,380 --> 00:43:41,230
anticipated having we've we're gonna go

1059
00:43:45,420 --> 00:43:43,390
look at those very closely understand

1060
00:43:48,480 --> 00:43:45,430
the reflectance and understand exactly

1061
00:43:50,160 --> 00:43:48,490
what the the terrain looks like that is

1062
00:43:55,500 --> 00:43:50,170
important actually to understanding what

1063
00:43:57,510 --> 00:43:55,510

it is we hit no we're not saying we saw

1064
00:43:59,340 --> 00:43:57,520
we never saw the floor of the crater

1065
00:44:01,380 --> 00:43:59,350
before him like we only saw it once we

1066
00:44:04,650 --> 00:44:01,390
got way down low after the impact

1067
00:44:07,420 --> 00:44:04,660
but the brightness of the terrain where

1068
00:44:09,130 --> 00:44:07,430
we hit we can actually understand that

1069
00:44:12,880 --> 00:44:09,140
and say something about what the floor

1070
00:44:15,720 --> 00:44:12,890
looks like okay Thank You Wayne do you

1071
00:44:19,510 --> 00:44:15,730
have any other questions in the audience

1072
00:44:28,420 --> 00:44:19,520
okay we have one up front here yeah what

1073
00:44:30,490 --> 00:44:28,430
up front um yeah I guess I don't know if

1074
00:44:32,950 --> 00:44:30,500
you can talk about the thermal

1075
00:44:35,349 --> 00:44:32,960
characteristics of the impact and you

1076
00:44:37,539 --> 00:44:35,359
know water versus ice and the twelve

1077
00:44:39,609 --> 00:44:37,549
buckets and how much got evaporated or

1078
00:44:42,339 --> 00:44:39,619
went into vapor and that sort of thing

1079
00:44:44,470 --> 00:44:42,349
and and anything about the

1080
00:44:47,230 --> 00:44:44,480
characteristics after the impact of the

1081
00:44:53,319 --> 00:44:47,240
cloud did it all go off or did some of

1082
00:44:56,799 --> 00:44:53,329
it come back or sure yeah we it was a as

1083
00:44:59,859 --> 00:44:56,809
one of our Co investigators put it it

1084
00:45:02,319 --> 00:44:59,869
was a tepid impact meaning cold and his

1085
00:45:07,140 --> 00:45:02,329
his experience meaning it was probably

1086
00:45:12,339 --> 00:45:07,150
about a thousand degrees Kelvin or about

1087
00:45:15,970 --> 00:45:12,349
700 or so degrees Celsius and that's

1088
00:45:17,710 --> 00:45:15,980

called for impacts but that's kind of

1089
00:45:21,220 --> 00:45:17,720
what might be expected with a low

1090
00:45:25,359 --> 00:45:21,230
density rocket you know impacting fairly

1091
00:45:28,240 --> 00:45:25,369
slowly we there is evidence for a vapor

1092
00:45:30,370 --> 00:45:28,250
and debris cloud that came up very at a

1093
00:45:31,900 --> 00:45:30,380
very sharp angle very early or

1094
00:45:35,920 --> 00:45:31,910
immediately after impact

1095
00:45:38,859 --> 00:45:35,930
that rose very quickly and and got to

1096
00:45:42,220 --> 00:45:38,869
altitudes above the crater rim within

1097
00:45:45,279 --> 00:45:42,230
seconds after impact and at the same

1098
00:45:48,160 --> 00:45:45,289
time a lower angle more traditional

1099
00:45:49,960 --> 00:45:48,170
ejecta curtain came up laterally

1100
00:45:51,880 --> 00:45:49,970
outwards and that's what we see actually

1101
00:45:54,130 --> 00:45:51,890
in the image is a as a lower density

1102
00:45:56,470 --> 00:45:54,140
plume coming straight up at us and then

1103
00:45:59,260 --> 00:45:56,480
a higher density plume coming out to the

1104
00:46:01,510 --> 00:45:59,270
sides all of that returned back to the

1105
00:46:03,940 --> 00:46:01,520
moon and there's evidence for actually

1106
00:46:05,740 --> 00:46:03,950
that falling down in the area around the

1107
00:46:08,769 --> 00:46:05,750
crater of several hundred meters to a

1108
00:46:12,430 --> 00:46:08,779
kilometer around our impact site there's

1109
00:46:15,190 --> 00:46:12,440
actually indications of that in our

1110
00:46:16,779 --> 00:46:15,200
thermal imaging we we can what was great

1111
00:46:18,400 --> 00:46:16,789
as our thermal cameras could measure the

1112
00:46:19,630 --> 00:46:18,410
impact plume temperature all the way

1113
00:46:20,829 --> 00:46:19,640

down and then we can measure the

1114
00:46:22,180 --> 00:46:20,839
temperature the crater

1115
00:46:25,420 --> 00:46:22,190
and that's where we're getting some of

1116
00:46:28,630 --> 00:46:25,430
these these the estimates at the four

1117
00:46:30,489 --> 00:46:28,640
minutes after the impact the crater

1118
00:46:34,890 --> 00:46:30,499
temperature and some of the debris

1119
00:46:37,599 --> 00:46:34,900
blanket around the crater was still 200

1120
00:46:38,289 --> 00:46:37,609
minus 40 degrees minus 50 degrees

1121
00:46:40,390 --> 00:46:38,299
centigrade

1122
00:46:42,339 --> 00:46:40,400
that's warm when you're talking about

1123
00:46:44,709 --> 00:46:42,349
it's sitting on top of dirt that was

1124
00:46:46,839 --> 00:46:44,719
originally minus 220 degrees centigrade

1125
00:46:49,170 --> 00:46:46,849
right so and all these things we're

1126
00:46:52,749 --> 00:46:49,180
talking about here including water are

1127
00:46:57,329 --> 00:46:52,759
unstable at those temperatures in a

1128
00:46:59,559 --> 00:46:57,339
vacuum so that really is part of the

1129
00:47:00,969 --> 00:46:59,569
equation or puzzle we're piecing

1130
00:47:03,069 --> 00:47:00,979
together was there's this ejecta and

1131
00:47:05,709 --> 00:47:03,079
plume that came up and there appears to

1132
00:47:07,239 --> 00:47:05,719
be a vapor that was entrained in that as

1133
00:47:09,459 --> 00:47:07,249
part of that that came up very quickly

1134
00:47:11,799 --> 00:47:09,469
so that was the initial impact and then

1135
00:47:14,650 --> 00:47:11,809
there was a continued release perhaps

1136
00:47:16,749 --> 00:47:14,660
maybe vapors from the floor and then the

1137
00:47:19,120 --> 00:47:16,759
ejecta came into sunlight and there was

1138
00:47:20,769 --> 00:47:19,130

any ice grains mixed in with that dust

1139
00:47:22,959 --> 00:47:20,779
and the ejecta and the sunlight it would

1140
00:47:26,229 --> 00:47:22,969
have warm and would have come up as well

1141
00:47:28,809 --> 00:47:26,239
released and volatize as well the the

1142
00:47:31,930 --> 00:47:28,819
one thing I can say is it's very

1143
00:47:35,620 --> 00:47:31,940
complicated very dynamic and very fun to

1144
00:47:36,910 --> 00:47:35,630
study but yeah we are having fun but it

1145
00:47:38,380 --> 00:47:36,920
is very complicated that's what we're

1146
00:47:40,690 --> 00:47:38,390
gonna do is piece together this this

1147
00:47:44,140 --> 00:47:40,700
whole story line of everything that

1148
00:47:46,599 --> 00:47:44,150
occurred yeah okay thank you very much

1149
00:47:47,499 --> 00:47:46,609
and we will now take our first phone

1150
00:47:50,200 --> 00:47:47,509
call

1151
00:47:54,370 --> 00:47:50,210
Richard Kerr from science magazine go

1152
00:47:57,370 --> 00:47:54,380
ahead Richard my question has been

1153
00:48:01,120 --> 00:47:57,380
answered thank you okay will now go to

1154
00:48:05,950 --> 00:48:01,130
Irene klutz from Discovery News Irene

1155
00:48:08,859 --> 00:48:05,960
thanks very much Irene Klotz I am I am

1156
00:48:11,049 --> 00:48:08,869
Tony before the impact you had painted

1157
00:48:13,359 --> 00:48:11,059
out three different scenarios of what

1158
00:48:16,150 --> 00:48:13,369
you thought might happen including one

1159
00:48:18,130 --> 00:48:16,160
which it sounds like you may have kind

1160
00:48:21,279 --> 00:48:18,140
of decided on and used the analogy of

1161
00:48:23,650 --> 00:48:21,289
the raisins in the play could you could

1162
00:48:25,569 --> 00:48:23,660
you talk about if this was a I select

1163
00:48:28,420 --> 00:48:25,579

did you just hit a jackpot and other

1164
00:48:29,890 --> 00:48:28,430
areas of the Moon may not be like this

1165
00:48:34,380 --> 00:48:29,900
or do you really think that this is

1166
00:48:37,330 --> 00:48:34,390
indicative of some kind of overall

1167
00:48:38,350 --> 00:48:37,340
conditioned on the moon thinks a good

1168
00:48:41,410 --> 00:48:38,360
question

1169
00:48:43,000 --> 00:48:41,420
and I think that something will have to

1170
00:48:47,190 --> 00:48:43,010
answer in time it's not something I

1171
00:48:49,270 --> 00:48:47,200
think I can answer right now but we will

1172
00:48:51,220 --> 00:48:49,280
exactly do what you're bringing up is

1173
00:48:54,490 --> 00:48:51,230
take take what we learn from this and

1174
00:48:57,580 --> 00:48:54,500
and then apply it to the potential

1175
00:49:00,220 --> 00:48:57,590
models and it's you heard Greg talk

1176
00:49:01,870 --> 00:49:00,230
about that in terms of what are the next

1177
00:49:04,750 --> 00:49:01,880
step now that we know that there's water

1178
00:49:07,000 --> 00:49:04,760
and once we actually study this impact

1179
00:49:09,340 --> 00:49:07,010
some more and understand how that water

1180
00:49:11,380 --> 00:49:09,350
may have been distributed and what other

1181
00:49:13,840 --> 00:49:11,390
things may be involved with the water

1182
00:49:15,910 --> 00:49:13,850
there's chemistry that can be discussed

1183
00:49:17,950 --> 00:49:15,920
there's distributions or sources and

1184
00:49:21,370 --> 00:49:17,960
sinks and we'll get to exactly that that

1185
00:49:23,890 --> 00:49:21,380
question you had as is did we hit in

1186
00:49:25,240 --> 00:49:23,900
something typical or atypical that's a

1187
00:49:26,560 --> 00:49:25,250
good question I don't know the answer to

1188
00:49:29,950 --> 00:49:26,570

that just yet

1189
00:49:31,660 --> 00:49:29,960
it's and then how's it relate to the

1190
00:49:32,830 --> 00:49:31,670
rest of the moment those are all the

1191
00:49:38,920 --> 00:49:32,840
things that I think are going to come

1192
00:49:40,120 --> 00:49:38,930
out going forward I think you bring up a

1193
00:49:41,800 --> 00:49:40,130
really good point

1194
00:49:43,750 --> 00:49:41,810
Ella cross is sort of pointing the way

1195
00:49:45,850 --> 00:49:43,760
now that we know there's water there

1196
00:49:47,830 --> 00:49:45,860
it's really important to understand how

1197
00:49:49,570 --> 00:49:47,840
it's attributed because that'll give us

1198
00:49:51,850 --> 00:49:49,580
very important clues as to its origin

1199
00:49:53,080 --> 00:49:51,860
what I think this is pointing us to and

1200
00:49:55,060 --> 00:49:53,090
I think we're gonna see an increasing

1201
00:49:57,430 --> 00:49:55,070
interest in is actually going there with

1202
00:49:59,830 --> 00:49:57,440
a robotic mission and actually

1203
00:50:02,410 --> 00:49:59,840
understanding on site how the water is

1204
00:50:04,300 --> 00:50:02,420
distributed if I can just you know make

1205
00:50:11,830 --> 00:50:04,310
a plug for where we might go in the

1206
00:50:15,130 --> 00:50:11,840
future lunar exploration program about

1207
00:50:16,930 --> 00:50:15,140
the possibility of organics I think you

1208
00:50:19,750 --> 00:50:16,940
meant briefly when you were giving your

1209
00:50:20,890 --> 00:50:19,760
laundry list of what could be mixed in

1210
00:50:22,890 --> 00:50:20,900
with the water but could you

1211
00:50:25,360 --> 00:50:22,900
specifically just talk about the

1212
00:50:28,330 --> 00:50:25,370
significance if any organics are found

1213
00:50:30,420 --> 00:50:28,340

in this plume Thanks sure and that was a

1214
00:50:32,500 --> 00:50:30,430
laundry list I want anyone jumping to

1215
00:50:34,120 --> 00:50:32,510
conclusions just yet

1216
00:50:35,830 --> 00:50:34,130
I mean I'm speculating is what could be

1217
00:50:38,560 --> 00:50:35,840
in there but it's in high you know

1218
00:50:40,540 --> 00:50:38,570
hindsight is usually 2020 and if you

1219
00:50:44,930 --> 00:50:40,550
have someplace as cold as what we hit

1220
00:50:47,380 --> 00:50:44,940
and you've had comets and asteroids and

1221
00:50:50,180 --> 00:50:47,390
and interplanetary dust grains

1222
00:50:52,850 --> 00:50:50,190
collecting there for a billion two

1223
00:50:54,890 --> 00:50:52,860
billion years maybe it's actually quite

1224
00:50:57,920 --> 00:50:54,900
reasonable you'd find everything I just

1225
00:51:01,160 --> 00:50:57,930
listed in that whole you know it is dust

1226
00:51:02,570 --> 00:51:01,170
put it as Mike put is like a dusty attic

1227
00:51:07,820 --> 00:51:02,580
actually it's not too dusty it's a

1228
00:51:10,070 --> 00:51:07,830
little wet and but so the significance

1229
00:51:11,600 --> 00:51:10,080
is then getting at what where Greg

1230
00:51:13,970 --> 00:51:11,610
brought up is where did the stuff come

1231
00:51:16,550 --> 00:51:13,980
from and I think that's the chin is if

1232
00:51:18,590 --> 00:51:16,560
indeed we find organics and if they're a

1233
00:51:20,630 --> 00:51:18,600
particular flavor of organics that says

1234
00:51:22,630 --> 00:51:20,640
well maybe it's it's it's commentary

1235
00:51:26,930 --> 00:51:22,640
there is at least some commentary

1236
00:51:30,320 --> 00:51:26,940
contribution or or or if we find

1237
00:51:32,390 --> 00:51:30,330
something else like methane or you know

1238
00:51:34,640 --> 00:51:32,400

what does that mean chemistry wise Ken

1239
00:51:37,820 --> 00:51:34,650
can you actually can make methane from

1240
00:51:40,790 --> 00:51:37,830
the solar wind if not well then it's got

1241
00:51:41,840 --> 00:51:40,800
to be coming from someplace and and what

1242
00:51:43,910 --> 00:51:41,850
we're going to that's what we're going

1243
00:51:45,980 --> 00:51:43,920
to what's going to come out ultimately I

1244
00:51:49,160 --> 00:51:45,990
think from the O cross mission is the

1245
00:51:51,410 --> 00:51:49,170
first hints first clues or additional

1246
00:51:53,690 --> 00:51:51,420
clues to the broader data set as a

1247
00:51:59,210 --> 00:51:53,700
better way to put it as to what's going

1248
00:52:06,260 --> 00:51:59,220
on on the moon now we have Nancy

1249
00:52:09,320 --> 00:52:06,270
Atkinson from universe today Nancy they

1250
00:52:11,240 --> 00:52:09,330
and the day of impact so that that was

1251
00:52:13,580 --> 00:52:11,250
the one supplies that you saw the

1252
00:52:15,230 --> 00:52:13,590
initial spectroscopic data have you been

1253
00:52:19,340 --> 00:52:15,240
able to find anything more about that

1254
00:52:24,800 --> 00:52:19,350
and what it might mean it's again it

1255
00:52:25,970 --> 00:52:24,810
gets to the exact question is I think

1256
00:52:27,860 --> 00:52:25,980
there's a little bit of everything in

1257
00:52:31,070 --> 00:52:27,870
there when we hit we certainly saw

1258
00:52:33,410 --> 00:52:31,080
sodium and it was ground observatories

1259
00:52:35,320 --> 00:52:33,420
saw it as well and they saw it at fairly

1260
00:52:37,850 --> 00:52:35,330
high altitudes this is part of this

1261
00:52:41,390 --> 00:52:37,860
potential plume this high angle plume

1262
00:52:43,280 --> 00:52:41,400
that came up and got very very high we

1263
00:52:45,980 --> 00:52:43,290

see other emission lines that we have

1264
00:52:48,920 --> 00:52:45,990
not yet completely identified in our

1265
00:52:52,340 --> 00:52:48,930
visible spectrometer data set and we're

1266
00:52:54,440 --> 00:52:52,350
still working on those so no I don't

1267
00:52:56,360 --> 00:52:54,450
know what all else is in there just yet

1268
00:52:58,530 --> 00:52:56,370
we've been really focused on the water

1269
00:53:01,320 --> 00:52:58,540
question because that was our scientific

1270
00:53:06,110 --> 00:53:01,330
on this mission but we're going to get

1271
00:53:09,780 --> 00:53:06,120
to some of those other questions soon

1272
00:53:14,070 --> 00:53:09,790
one additional point on this and and

1273
00:53:15,900 --> 00:53:14,080
that is that we're talking about you

1274
00:53:18,980 --> 00:53:15,910
know whether it's commentary or these

1275
00:53:21,900 --> 00:53:18,990
other things or another mechanism that

1276
00:53:24,540 --> 00:53:21,910
the list that Greg went through it could

1277
00:53:27,930 --> 00:53:24,550
actually be all of those and we could be

1278
00:53:29,640 --> 00:53:27,940
seeing is a mixture it's not just an

1279
00:53:33,050 --> 00:53:29,650
attic but it's a junk drawer it's got

1280
00:53:35,850 --> 00:53:33,060
everything in there and so part of the

1281
00:53:40,380 --> 00:53:35,860
the resolution of this puzzle is to try

1282
00:53:42,930 --> 00:53:40,390
to unravel the this level of complexity

1283
00:53:46,110 --> 00:53:42,940
that we're finding there to try to say

1284
00:53:47,730 --> 00:53:46,120
which mechanisms could be in place and I

1285
00:53:50,460 --> 00:53:47,740
think we're all expecting that it's not

1286
00:53:53,400 --> 00:53:50,470
just one right and I should say sodium

1287
00:53:56,250 --> 00:53:53,410
is one of the motor observable gaseous

1288
00:53:59,040 --> 00:53:56,260

species in the lunar atmosphere so we

1289
00:54:01,410 --> 00:53:59,050
know sodium's mobile we know it's it's a

1290
00:54:03,960 --> 00:54:01,420
part of the processes that exist

1291
00:54:05,970 --> 00:54:03,970
currently on the moon so it's not

1292
00:54:07,860 --> 00:54:05,980
necessarily too surprising that you

1293
00:54:10,770 --> 00:54:07,870
would have something that is mobile like

1294
00:54:12,930 --> 00:54:10,780
sodium gathering and concentration and

1295
00:54:14,880 --> 00:54:12,940
some of these dark craters and we

1296
00:54:16,560 --> 00:54:14,890
released it and so now we need to

1297
00:54:18,660 --> 00:54:16,570
actually step back and say well what

1298
00:54:19,920 --> 00:54:18,670
else could be in there actually you know

1299
00:54:22,440 --> 00:54:19,930
this is very interesting

1300
00:54:24,840 --> 00:54:22,450
the moon is alive and it's mobile and

1301
00:54:28,070 --> 00:54:24,850
these places are places we can look for

1302
00:54:31,050 --> 00:54:28,080
some of this stuff and understand it

1303
00:54:33,450 --> 00:54:31,060
okay thank you very much now we have a

1304
00:54:40,350 --> 00:54:33,460
question from Andrea Thompson from space

1305
00:54:42,720 --> 00:54:40,360
comm Andrea or if you can really sort of

1306
00:54:45,810 --> 00:54:42,730
combine your findings with what the

1307
00:54:47,820 --> 00:54:45,820
Chandrayaan found with the signatures of

1308
00:54:49,980 --> 00:54:47,830
water all over the moon and does that

1309
00:54:51,800 --> 00:54:49,990
tell you something more about the source

1310
00:54:54,060 --> 00:54:51,810
of water

1311
00:54:55,740 --> 00:54:54,070
sure I can take that but then I think

1312
00:54:59,450 --> 00:54:55,750
each of the panelists here can can

1313
00:55:02,460 --> 00:54:59,460

comment both Greg and Mike as well the

1314
00:55:04,710 --> 00:55:02,470
what Sean Rhian saw was primarily this

1315
00:55:06,840 --> 00:55:04,720
hydroxyl Oh H that was bound in grains

1316
00:55:09,270 --> 00:55:06,850
as well as some absorbed water kind of

1317
00:55:11,670 --> 00:55:09,280
monolayers just single atomic or

1318
00:55:12,480 --> 00:55:11,680
molecular layers of water and probably

1319
00:55:15,930 --> 00:55:12,490
the top

1320
00:55:18,030 --> 00:55:15,940
microns or so of regolith they there

1321
00:55:20,940 --> 00:55:18,040
they could not see into the shadowed

1322
00:55:23,750 --> 00:55:20,950
craters so their observation is entirely

1323
00:55:26,520 --> 00:55:23,760
unique and complementary to what we did

1324
00:55:28,770 --> 00:55:26,530
we looked inside that permanent shadow

1325
00:55:32,070 --> 00:55:28,780
craters where they couldn't look and and

1326
00:55:35,130 --> 00:55:32,080
the mounts that we saw and the flavors

1327
00:55:37,680 --> 00:55:35,140
that we saw could be distinctly

1328
00:55:40,170 --> 00:55:37,690
different meaning they saw water bound

1329
00:55:42,900 --> 00:55:40,180
in grains and maybe absorbed on grains

1330
00:55:47,550 --> 00:55:42,910
we saw potentially real crystalline

1331
00:55:49,200 --> 00:55:47,560
water ice and lots of water vapour

1332
00:55:50,850 --> 00:55:49,210
meaning it came from something probably

1333
00:55:53,010 --> 00:55:50,860
in addition to the edge orb water

1334
00:55:56,340 --> 00:55:53,020
probably came from water ice and we saw

1335
00:55:57,750 --> 00:55:56,350
these other species that I mentioned so

1336
00:55:59,820 --> 00:55:57,760
they're they're kind of two bookends

1337
00:56:03,960 --> 00:55:59,830
they're due they're two facets of the

1338
00:56:06,170 --> 00:56:03,970

total puzzle here that we're trying to

1339
00:56:09,300 --> 00:56:06,180
unravel so they're really complementary

1340
00:56:10,650 --> 00:56:09,310
and and I think there's the other aspect

1341
00:56:17,390 --> 00:56:10,660
then we need to understand is how those

1342
00:56:19,260 --> 00:56:17,400
two bodies are those two observations

1343
00:56:20,910 --> 00:56:19,270
communicate with each other and that's

1344
00:56:22,650 --> 00:56:20,920
an you know through the atmosphere of

1345
00:56:24,390 --> 00:56:22,660
the Moon perhaps and through then

1346
00:56:26,460 --> 00:56:24,400
delivery processes from other species

1347
00:56:27,900 --> 00:56:26,470
and whatnot so I think you know Gregg

1348
00:56:29,430 --> 00:56:27,910
might you might want to comment on that

1349
00:56:31,109 --> 00:56:29,440
no I mean I think Tony's framed the

1350
00:56:33,690 --> 00:56:31,119
question very well it's important to

1351
00:56:35,310 --> 00:56:33,700
note that while this is dining with elk

1352
00:56:37,260 --> 00:56:35,320
Ross discovering large amounts of water

1353
00:56:39,570 --> 00:56:37,270
you know within the regolith within the

1354
00:56:42,570 --> 00:56:39,580
soil a bunch of us were already reeling

1355
00:56:44,640 --> 00:56:42,580
from an earlier discovery from m3 which

1356
00:56:47,400 --> 00:56:44,650
discovered as Tony described a very thin

1357
00:56:49,349 --> 00:56:47,410
layer superficial water and so the

1358
00:56:50,760 --> 00:56:49,359
question becomes how does this fit into

1359
00:56:52,800 --> 00:56:50,770
the overall water picture on the moon

1360
00:56:55,020 --> 00:56:52,810
and I'll say right now that there could

1361
00:56:57,870 --> 00:56:55,030
be no relationship between what m3 is

1362
00:57:00,450 --> 00:56:57,880
seeing that and what L cross is found

1363
00:57:02,460 --> 00:57:00,460

that's more of a static moon okay but

1364
00:57:04,800 --> 00:57:02,470
it's also possible that the water that

1365
00:57:06,720 --> 00:57:04,810
m3 found is sort of already on its

1366
00:57:09,090 --> 00:57:06,730
journey towards the poles in an active

1367
00:57:10,349 --> 00:57:09,100
process and that really describes some

1368
00:57:13,080 --> 00:57:10,359
of the variety of ideas that we're

1369
00:57:15,090 --> 00:57:13,090
trying to work with here so as I said

1370
00:57:17,550 --> 00:57:15,100
earlier it's just a very exciting time

1371
00:57:18,540 --> 00:57:17,560
we have all this new data and now we're

1372
00:57:20,010 --> 00:57:18,550
going to work through it and try and

1373
00:57:21,960 --> 00:57:20,020
figure out exactly what the moon is

1374
00:57:24,690 --> 00:57:21,970
telling us and so I think that's just

1375
00:57:26,030 --> 00:57:24,700
incredibly exciting yeah I think that

1376
00:57:30,050 --> 00:57:26,040
one of the hallmarks

1377
00:57:32,990 --> 00:57:30,060
today is complexity what we're seeing is

1378
00:57:36,470 --> 00:57:33,000
a fairly complicated puzzle potentially

1379
00:57:38,870 --> 00:57:36,480
with a number of different facets one of

1380
00:57:42,950 --> 00:57:38,880
the things that we found out from from

1381
00:57:44,810 --> 00:57:42,960
El cross is with the water that's a

1382
00:57:47,540 --> 00:57:44,820
that's present in the permanently

1383
00:57:50,060 --> 00:57:47,550
shadowed regions that could be one of

1384
00:57:53,240 --> 00:57:50,070
the end points for the hydration cycle

1385
00:57:55,910 --> 00:57:53,250
on the moon that when once things hop

1386
00:57:57,770 --> 00:57:55,920
into these very very cold permanently

1387
00:58:00,080 --> 00:57:57,780
shadowed craters they can't hop out

1388
00:58:03,770 --> 00:58:00,090

again so it's you can think of it as a

1389
00:58:06,500 --> 00:58:03,780
sink oh and there are a number of

1390
00:58:08,900 --> 00:58:06,510
potential different mechanisms for the

1391
00:58:11,570 --> 00:58:08,910
water to show up at the moon and a

1392
00:58:13,670 --> 00:58:11,580
number of different transport mechanisms

1393
00:58:16,190 --> 00:58:13,680
that can move it around the moon and

1394
00:58:18,170 --> 00:58:16,200
what we're seeing from both the Chandra

1395
00:58:22,190 --> 00:58:18,180
on measurements as well as the L cross

1396
00:58:25,160 --> 00:58:22,200
measurements is the a much bigger

1397
00:58:27,950 --> 00:58:25,170
potentially more complicated picture for

1398
00:58:29,720 --> 00:58:27,960
for water on the moon and if you just

1399
00:58:31,460 --> 00:58:29,730
step back not more than a few months

1400
00:58:33,380 --> 00:58:31,470
who would have really thought that we'd

1401
00:58:36,890 --> 00:58:33,390
be talking about a hydration cycle on

1402
00:58:39,410 --> 00:58:36,900
the moon as greg indicated before this

1403
00:58:44,090 --> 00:58:39,420
is not your your father's moon this is

1404
00:58:46,790 --> 00:58:44,100
not a dead planetary body but one with

1405
00:58:50,330 --> 00:58:46,800
an awful lot of dynamism in and that

1406
00:58:54,680 --> 00:58:50,340
dynamism really engenders an awful lot

1407
00:58:57,320 --> 00:58:54,690
of new questions and an interest in our

1408
00:58:59,840 --> 00:58:57,330
closest neighbor okay thank you very

1409
00:59:01,610 --> 00:58:59,850
much our next question is from Peter

1410
00:59:04,630 --> 00:59:01,620
spots of the Christian Science Monitor

1411
00:59:06,830 --> 00:59:04,640
go ahead Peter yeah thank you very much

1412
00:59:09,260 --> 00:59:06,840
try and squeeze two really quick ones in

1413
00:59:12,680 --> 00:59:09,270

here if I can first of all thinking back

1414
00:59:15,620 --> 00:59:12,690
on the on the Chandrayaan LRO etc had

1415
00:59:17,570 --> 00:59:15,630
all results they were able to at least

1416
00:59:19,820 --> 00:59:17,580
in a back-of-the-envelope way relate

1417
00:59:21,500 --> 00:59:19,830
that to a concentration I think it was

1418
00:59:23,750 --> 00:59:21,510
something like you'd have to process a

1419
00:59:26,720 --> 00:59:23,760
ton of soil in order in principle to get

1420
00:59:29,150 --> 00:59:26,730
a quart or a liter of water out it's

1421
00:59:32,150 --> 00:59:29,160
been a way to relate what you folks have

1422
00:59:35,210 --> 00:59:32,160
detected to some sort of concentration

1423
00:59:37,730 --> 00:59:35,220
at least at the impact point sure and

1424
00:59:39,620 --> 00:59:37,740
that is the ultimate goal or one of many

1425
00:59:44,449 --> 00:59:39,630
ultimate goals that we

1426
00:59:46,880 --> 00:59:44,459
in front of us we need to understand

1427
00:59:49,579 --> 00:59:46,890
really the the cratering process how

1428
00:59:51,650 --> 00:59:49,589
much was excavated what we observed of

1429
00:59:54,380 --> 00:59:51,660
that excavation to really get at that

1430
00:59:57,039 --> 00:59:54,390
question so I'm not going to yet put a

1431
01:00:00,289 --> 00:59:57,049
it was percent ten percent or whatever

1432
01:00:01,670 --> 01:00:00,299
to that yet what I can say is what I

1433
01:00:05,269 --> 01:00:01,680
said at the beginning is within our

1434
01:00:07,039 --> 01:00:05,279
field of view we saw some water the

1435
01:00:09,920 --> 01:00:07,049
instruments had a narrow field of view

1436
01:00:11,719 --> 01:00:09,930
we saw some water within that field of

1437
01:00:14,059 --> 01:00:11,729
view if I took the water just in that

1438
01:00:16,699 --> 01:00:14,069

field of view and added it up it was

1439
01:00:18,890 --> 01:00:16,709
greater than 100 kilograms so if you

1440
01:00:20,930 --> 01:00:18,900
recall yeah they had to excavate a I

1441
01:00:24,189 --> 01:00:20,940
think a football field to get glass full

1442
01:00:27,469 --> 01:00:24,199
of water or so in our field of view

1443
01:00:30,049 --> 01:00:27,479
which is some fraction of the 20 meter

1444
01:00:31,459 --> 01:00:30,059
crater we made because there was stuff

1445
01:00:36,439 --> 01:00:31,469
that went on outside of our field of

1446
01:00:39,410 --> 01:00:36,449
view we had about 25 gallons or so of

1447
01:00:41,059 --> 01:00:39,420
water so that's that's the total

1448
01:00:44,120 --> 01:00:41,069
abundance we can talk about right now

1449
01:00:46,789 --> 01:00:44,130
but we I can't yet put a concentration

1450
01:00:51,049 --> 01:00:46,799
into the as to the amount in the dirt

1451
01:00:54,140 --> 01:00:51,059
just yet and just quickly sort of

1452
01:00:56,420 --> 01:00:54,150
context and I think alluding to just

1453
01:00:58,609 --> 01:00:56,430
just a few seconds ago we said

1454
01:01:00,349 --> 01:00:58,619
astronauts to to the moon and they came

1455
01:01:02,630 --> 01:01:00,359
back with moon rocks that sort of took

1456
01:01:04,759 --> 01:01:02,640
us you know one sort of increment

1457
01:01:06,259 --> 01:01:04,769
farther along in our understanding of

1458
01:01:08,569 --> 01:01:06,269
the moon and it's processes their

1459
01:01:11,269 --> 01:01:08,579
geological processes than we had before

1460
01:01:13,939 --> 01:01:11,279
could you sort of put this into that

1461
01:01:15,979 --> 01:01:13,949
context I mean what in terms of our

1462
01:01:17,180 --> 01:01:15,989
scientific understanding of the moon or

1463
01:01:20,979 --> 01:01:17,190

at least the questions that are being

1464
01:01:26,390 --> 01:01:20,989
raised what does this represent in

1465
01:01:28,880 --> 01:01:26,400
contrast with the Apollo stir well I was

1466
01:01:35,569 --> 01:01:28,890
born July 16th 1969 so I missed a lot of

1467
01:01:39,189 --> 01:01:35,579
the Apollo stuff but just joking the the

1468
01:01:41,089 --> 01:01:39,199
you know it there was been a lot of a

1469
01:01:43,370 --> 01:01:41,099
reassessing of that that information

1470
01:01:46,719 --> 01:01:43,380
actually as of late and in particular

1471
01:01:48,920 --> 01:01:46,729
with the M cube at all discoveries I

1472
01:01:51,499 --> 01:01:48,930
think people are going back and

1473
01:01:53,240 --> 01:01:51,509
rethinking was that contamination we

1474
01:01:55,370 --> 01:01:53,250
they detected water

1475
01:01:57,380 --> 01:01:55,380
they detected methane they detected some

1476
01:01:59,600 --> 01:01:57,390
organics they all wrote those off to

1477
01:02:02,510 --> 01:01:59,610
contamination as they brought the

1478
01:02:03,950 --> 01:02:02,520
samples back to earth some of it could

1479
01:02:06,170 --> 01:02:03,960
still be it could very well be

1480
01:02:09,380 --> 01:02:06,180
contamination we don't but people are at

1481
01:02:10,580 --> 01:02:09,390
least now re-examining those those those

1482
01:02:14,020 --> 01:02:10,590
measurements

1483
01:02:18,200 --> 01:02:14,030
remember we landed very near the equator

1484
01:02:19,790 --> 01:02:18,210
for the Apollo missions and and so much

1485
01:02:22,220 --> 01:02:19,800
further away from the poles and then

1486
01:02:24,470 --> 01:02:22,230
what we're talking about today and

1487
01:02:27,170 --> 01:02:24,480
that's relevant too so it matters where

1488
01:02:29,300 --> 01:02:27,180

the samples been collected of course but

1489
01:02:31,970 --> 01:02:29,310
I think what this shows is we are really

1490
01:02:34,670 --> 01:02:31,980
exploring a new part of the moon that we

1491
01:02:39,200 --> 01:02:34,680
hadn't yet explored yet with the

1492
01:02:41,720 --> 01:02:39,210
orbiters that have gone ahead of LRO and

1493
01:02:46,340 --> 01:02:41,730
now with LRO and LCROSS were really mean

1494
01:02:49,040 --> 01:02:46,350
to places we had a handgun 240 years ago

1495
01:02:50,780 --> 01:02:49,050
and so it's just revealing another part

1496
01:02:53,510 --> 01:02:50,790
of the Moon another aspect of the Moon

1497
01:02:56,240 --> 01:02:53,520
that we didn't entirely probably fully

1498
01:02:58,120 --> 01:02:56,250
appreciate that and Greg you may know I

1499
01:03:00,400 --> 01:02:58,130
think you described most of it I might

1500
01:03:02,540 --> 01:03:00,410
put it in a little bit stronger terms

1501
01:03:04,610 --> 01:03:02,550
one of the scientists involved in

1502
01:03:06,110 --> 01:03:04,620
analyzing early lunar samples I was

1503
01:03:08,870 --> 01:03:06,120
quoted recently as saying he was going

1504
01:03:11,120 --> 01:03:08,880
to eat his shorts because this has

1505
01:03:13,460 --> 01:03:11,130
really turned our understanding of lunar

1506
01:03:15,620 --> 01:03:13,470
water on its head it was assumed that

1507
01:03:17,600 --> 01:03:15,630
the water but that was found on lunar

1508
01:03:20,090 --> 01:03:17,610
grains was terrestrial contamination

1509
01:03:21,860 --> 01:03:20,100
this actually comes not from just an

1510
01:03:24,680 --> 01:03:21,870
assumption but from a detailed isotopic

1511
01:03:26,780 --> 01:03:24,690
chemical analysis that and of itself

1512
01:03:28,730 --> 01:03:26,790
they have yet another message for how

1513
01:03:30,650 --> 01:03:28,740

terrestrial and lunar water may be

1514
01:03:32,690 --> 01:03:30,660
connected I don't want to go too far

1515
01:03:33,830 --> 01:03:32,700
down that road here but the point is is

1516
01:03:35,840 --> 01:03:33,840
that we should really keep our minds

1517
01:03:37,760 --> 01:03:35,850
open about what the moon is telling us

1518
01:03:39,710 --> 01:03:37,770
and not be afraid to revisit our

1519
01:03:42,020 --> 01:03:39,720
assumptions during Apollo so back to

1520
01:03:45,560 --> 01:03:42,030
that same message it's not Apollo's moon

1521
01:03:48,160 --> 01:03:45,570
it's it's Arman yeah and when you take a

1522
01:03:52,130 --> 01:03:48,170
look at what's been learned since Apollo

1523
01:03:53,840 --> 01:03:52,140
lunar prospector with the measurements

1524
01:03:56,780 --> 01:03:53,850
that it made indicating that they were

1525
01:03:58,940 --> 01:03:56,790
there was this increased level of

1526
01:04:00,650 --> 01:03:58,950
hydrogen at the lunar poles really

1527
01:04:03,260 --> 01:04:00,660
showed us that there is a different

1528
01:04:04,730 --> 01:04:03,270
aspect of the moon that we didn't know

1529
01:04:07,490 --> 01:04:04,740
about during Apollo

1530
01:04:09,800 --> 01:04:07,500
and the continuing missions with

1531
01:04:11,810 --> 01:04:09,810
Chandrayaan and with L cross is giving

1532
01:04:14,030 --> 01:04:11,820
us additional information about these

1533
01:04:15,770 --> 01:04:14,040
really mysterious area that we didn't

1534
01:04:19,760 --> 01:04:15,780
know very much about and we're only

1535
01:04:22,070 --> 01:04:19,770
starting to scrape the surface now thank

1536
01:04:25,280 --> 01:04:22,080
you okay thank you very much our next

1537
01:04:29,960 --> 01:04:25,290
question is from mark Matthews with the

1538
01:04:32,840 --> 01:04:29,970

Orlando Sentinel red mark if you could

1539
01:04:34,730 --> 01:04:32,850
real quick tell me how how big was the

1540
01:04:36,830 --> 01:04:34,740
plume eventually what what were the

1541
01:04:38,990 --> 01:04:36,840
measurements in terms of height and

1542
01:04:42,109 --> 01:04:39,000
width and was it as big as you hoped it

1543
01:04:48,290 --> 01:04:42,119
was going to be thanks you can never

1544
01:04:50,600 --> 01:04:48,300
have too big a plume right so it was in

1545
01:04:52,970 --> 01:04:50,610
terms of dimensions it was actually very

1546
01:04:55,490 --> 01:04:52,980
much in line with our expectations that

1547
01:04:57,650 --> 01:04:55,500
one figure I showed image was about 20

1548
01:05:00,590 --> 01:04:57,660
seconds after impact and it was about

1549
01:05:03,170 --> 01:05:00,600
ten to eleven twelve kilometers across

1550
01:05:05,720 --> 01:05:03,180
in diameter and that's what we expected

1551
01:05:08,240 --> 01:05:05,730
it we could observe the plume in our

1552
01:05:09,980 --> 01:05:08,250
images for about 30 or 40 seconds after

1553
01:05:12,380 --> 01:05:09,990
the impact our spectrometers had

1554
01:05:14,150 --> 01:05:12,390
detectable signal of the plume as long

1555
01:05:16,220 --> 01:05:14,160
as potentially 150 seconds two minutes

1556
01:05:19,550 --> 01:05:16,230
after an impact that's actually an

1557
01:05:20,480 --> 01:05:19,560
excess of what we expected so that's

1558
01:05:23,660 --> 01:05:20,490
telling us something about the material

1559
01:05:25,609 --> 01:05:23,670
we threw up that this high angle plume

1560
01:05:30,050 --> 01:05:25,619
potentially had a lot of fines in it

1561
01:05:32,359 --> 01:05:30,060
smaller particles and they blasted in

1562
01:05:34,940 --> 01:05:32,369
above the surface for a longer period

1563
01:05:39,800 --> 01:05:34,950

than we had anticipated you know this

1564
01:05:42,920 --> 01:05:39,810
was we we had enough margin so to speak

1565
01:05:45,530 --> 01:05:42,930
in in our observations to to account for

1566
01:05:47,630 --> 01:05:45,540
these potential variabilities in terms

1567
01:05:49,400 --> 01:05:47,640
of height it certainly got into sunlight

1568
01:05:50,930 --> 01:05:49,410
that's how we can see the ejecta cloud

1569
01:05:53,930 --> 01:05:50,940
and the shadow line was about a

1570
01:05:56,300 --> 01:05:53,940
kilometer it's hard to really tell right

1571
01:05:59,390 --> 01:05:56,310
now exactly how high something gets when

1572
01:06:01,160 --> 01:05:59,400
you're looking straight down at it but

1573
01:06:02,930 --> 01:06:01,170
we are going to be able to actually

1574
01:06:05,150 --> 01:06:02,940
constrain the height better going

1575
01:06:07,280 --> 01:06:05,160
forward combining some of our various

1576
01:06:10,490 --> 01:06:07,290
observations but it got one or two

1577
01:06:12,470 --> 01:06:10,500
kilometers above the surface just a just

1578
01:06:15,349 --> 01:06:12,480
below the rim height where would have

1579
01:06:18,289 --> 01:06:15,359
been very observable from Earth that

1580
01:06:22,009 --> 01:06:18,299
said vapor did get as high as our mature

1581
01:06:24,229 --> 01:06:22,019
real vapor distinctly got as high as 20

1582
01:06:26,269 --> 01:06:24,239
30 40 kilometers above the surface and

1583
01:06:30,859 --> 01:06:26,279
we know that from observations from LRO

1584
01:06:33,319 --> 01:06:30,869
and from ground-based assets so material

1585
01:06:35,900 --> 01:06:33,329
Gigot did get very high the vapor in

1586
01:06:40,640 --> 01:06:35,910
particular hopefully that answers your

1587
01:06:43,569 --> 01:06:40,650
question okay thank you very much now we

1588
01:06:50,239 --> 01:06:43,579

have a question from Stephen Clarke

1589
01:06:53,329 --> 01:06:50,249
Space Flight now read Stephen I just

1590
01:06:55,189 --> 01:06:53,339
have a couple of questions first how

1591
01:06:56,539 --> 01:06:55,199
long did it take you know Tony mentioned

1592
01:07:01,279 --> 01:06:56,549
that Eureka moment when when did that

1593
01:07:03,620 --> 01:07:01,289
occur that that Eureka well that Eureka

1594
01:07:07,429 --> 01:07:03,630
moment really came about two weeks ago

1595
01:07:12,109 --> 01:07:07,439
two to naff weeks ago maybe and last

1596
01:07:13,609 --> 01:07:12,119
week we had a meeting was that last week

1597
01:07:16,609 --> 01:07:13,619
I guess it was last week last week

1598
01:07:19,489 --> 01:07:16,619
Tuesday what Wednesday we had a team

1599
01:07:21,410 --> 01:07:19,499
meeting with LRO participating all of

1600
01:07:23,900 --> 01:07:21,420
our team participating and we went

1601
01:07:27,289 --> 01:07:23,910
through the entire data set

1602
01:07:29,809 --> 01:07:27,299
lots of good discussion debate and then

1603
01:07:31,640 --> 01:07:29,819
on the second day I had a session based

1604
01:07:34,579 --> 01:07:31,650
on just the case for water and we said

1605
01:07:36,799 --> 01:07:34,589
you know we asked is this or is everyone

1606
01:07:39,259 --> 01:07:36,809
happy with this result can we go forward

1607
01:07:41,779 --> 01:07:39,269
with this I want to say something soon

1608
01:07:44,029 --> 01:07:41,789
as we feel comfortable and we basically

1609
01:07:47,179 --> 01:07:44,039
had a vote and people said let's have

1610
01:07:49,239 --> 01:07:47,189
let's go public right now and so at that

1611
01:07:56,569 --> 01:07:49,249
point it was a scramble to make slides

1612
01:08:02,359 --> 01:07:56,579
and and so it was I

1613
01:08:06,769 --> 01:08:02,369

honestly every day we were the day after

1614
01:08:08,329 --> 01:08:06,779
impact a number of us gathered tired got

1615
01:08:10,400 --> 01:08:08,339
some donuts got to get their coffee

1616
01:08:12,049 --> 01:08:10,410
started looking through the data and we

1617
01:08:15,259 --> 01:08:12,059
all walked out of there with giant grins

1618
01:08:16,999 --> 01:08:15,269
on our faces the next day someone would

1619
01:08:19,849 --> 01:08:17,009
come up did you see this and the data to

1620
01:08:24,589 --> 01:08:19,859
the next every day it was an incremental

1621
01:08:27,140 --> 01:08:24,599
discovery in the data and and every day

1622
01:08:29,419 --> 01:08:27,150
we still were finding things that are

1623
01:08:32,029 --> 01:08:29,429
just were blown away that we actually

1624
01:08:36,319 --> 01:08:32,039
captured and you know so to speak

1625
01:08:39,229 --> 01:08:36,329
about the impact so it wasn't any aha

1626
01:08:41,209 --> 01:08:39,239
moments been pretty much been a holy cow

1627
01:08:47,689 --> 01:08:41,219
moment ever every single day since

1628
01:08:49,669 --> 01:08:47,699
impact so question you mentioned that

1629
01:08:52,399 --> 01:08:49,679
you found more water than than you

1630
01:08:54,289 --> 01:08:52,409
expected I guess compared to the Lind

1631
01:08:55,519 --> 01:08:54,299
and the prospector data I think I was

1632
01:08:57,740 --> 01:08:55,529
understanding

1633
01:09:01,189 --> 01:08:57,750
can you describe exactly you know how

1634
01:09:03,649 --> 01:09:01,199
much more water was there than land and

1635
01:09:06,200 --> 01:09:03,659
where prospector would indicate well I I

1636
01:09:07,819 --> 01:09:06,210
think I said I by the I was supposed by

1637
01:09:11,769 --> 01:09:07,829
the DEP of the bands which he relates to

1638
01:09:15,349 --> 01:09:11,779

the total amount of water vapor and

1639
01:09:17,930 --> 01:09:15,359
maybe I was I was a pessimist and so

1640
01:09:21,490 --> 01:09:17,940
that's why I was surprised I can't yet

1641
01:09:24,890 --> 01:09:21,500
compare it to a retrieval from lend or

1642
01:09:27,649 --> 01:09:24,900
or known a prospector yet because we

1643
01:09:29,660 --> 01:09:27,659
haven't put it into the ground yet we

1644
01:09:30,740 --> 01:09:29,670
haven't developed a concentration yet

1645
01:09:33,169 --> 01:09:30,750
which is something that those

1646
01:09:34,959 --> 01:09:33,179
instruments do you know they say there's

1647
01:09:38,029 --> 01:09:34,969
one or two percent by weight watt

1648
01:09:40,490 --> 01:09:38,039
equivalent hydrogen we haven't done that

1649
01:09:43,220 --> 01:09:40,500
yet what I have been impressed with is

1650
01:09:46,700 --> 01:09:43,230
by yet yeah that the the bands are clear

1651
01:09:50,720 --> 01:09:46,710
and strong and evident and we have such

1652
01:09:55,189 --> 01:09:50,730
good detection point here is that the

1653
01:09:57,319 --> 01:09:55,199
footprint for lunar prospector was on

1654
01:10:01,100 --> 01:09:57,329
the order of a hundred kilometres and

1655
01:10:04,759 --> 01:10:01,110
the footprint for the lunar exploration

1656
01:10:07,970 --> 01:10:04,769
Neutron detector on LRO is about 10

1657
01:10:10,819 --> 01:10:07,980
kilometers whereas the area that was

1658
01:10:13,520 --> 01:10:10,829
excavated was only about 20 meters in

1659
01:10:16,339 --> 01:10:13,530
diameter so there are length scales here

1660
01:10:19,339 --> 01:10:16,349
where if we try to judge too much and

1661
01:10:22,060 --> 01:10:19,349
move across to - too far across these

1662
01:10:24,919 --> 01:10:22,070
linked scales we could get in trouble

1663
01:10:28,549 --> 01:10:24,929

because we don't we're not sure of the

1664
01:10:32,839 --> 01:10:28,559
uniformity that is integrated into the

1665
01:10:37,160 --> 01:10:32,849
the datasets for for lunar prospector

1666
01:10:40,729 --> 01:10:37,170
and we have a real significant physical

1667
01:10:42,770 --> 01:10:40,739
point for the for the L cross

1668
01:10:44,330 --> 01:10:42,780
measurements and we're gonna that's

1669
01:10:45,830 --> 01:10:44,340
going to fit into this larger picture

1670
01:10:49,250 --> 01:10:45,840
and we're going to have to be

1671
01:10:51,260 --> 01:10:49,260
talking to those teams to to look at the

1672
01:10:55,040 --> 01:10:51,270
relationship between and among the

1673
01:10:57,910 --> 01:10:55,050
datasets Thanks okay thank you very much

1674
01:11:02,060 --> 01:10:57,920
now we have a question from Anne Ryman

1675
01:11:03,709 --> 01:11:02,070
Arizona Republic yes thank you

1676
01:11:05,870 --> 01:11:03,719
you had mentioned you're still kind of

1677
01:11:09,500 --> 01:11:05,880
analyzing you know the percentage of

1678
01:11:11,750 --> 01:11:09,510
water that may be there is it still fair

1679
01:11:13,790 --> 01:11:11,760
to say I've heard the moon described is

1680
01:11:17,330 --> 01:11:13,800
it still drier than our driest deserts

1681
01:11:20,419 --> 01:11:17,340
here on earth given what you found is

1682
01:11:21,560 --> 01:11:20,429
that still a kind of a valid comment or

1683
01:11:26,660 --> 01:11:21,570
could that be

1684
01:11:28,250 --> 01:11:26,670
perhaps wrong for the 20 meter crater we

1685
01:11:31,459 --> 01:11:28,260
hit with fewer standing on that nice

1686
01:11:33,260 --> 01:11:31,469
little beach that we hear if you

1687
01:11:36,979 --> 01:11:33,270
remember the image it was kind of slow

1688
01:11:40,399 --> 01:11:36,989

flat plains that for the numbers the

1689
01:11:42,680 --> 01:11:40,409
amount of water I've stated it is wetter

1690
01:11:44,649 --> 01:11:42,690
than some deserts on earth now those

1691
01:11:48,260 --> 01:11:44,659
deserts like the Anna comedy is

1692
01:11:51,560 --> 01:11:48,270
exceedingly exceedingly dry but it would

1693
01:11:53,870 --> 01:11:51,570
I think be probably safe to say that it

1694
01:12:01,760 --> 01:11:53,880
is on par or maybe a little bit wetter

1695
01:12:06,680 --> 01:12:01,770
than that desert in chile atacama excuse

1696
01:12:08,990 --> 01:12:06,690
me thank you okay thank you very much

1697
01:12:14,320 --> 01:12:09,000
now our next question is from Ron Coan

1698
01:12:17,589 --> 01:12:14,330
science news go ahead Ron yeah so before

1699
01:12:21,620 --> 01:12:17,599
L cross crashed in there had been a

1700
01:12:23,660 --> 01:12:21,630
prediction that even backyard telescopes

1701
01:12:26,810 --> 01:12:23,670
10 or 12 inch telescopes could have seen

1702
01:12:29,899 --> 01:12:26,820
the plume so why do you think the plume

1703
01:12:32,899 --> 01:12:29,909
was smaller or less than you thought and

1704
01:12:37,070 --> 01:12:32,909
is that why it took more time to extract

1705
01:12:39,439 --> 01:12:37,080
the water signal sure it was as bright

1706
01:12:42,800 --> 01:12:39,449
as we thought it would be except it was

1707
01:12:45,439 --> 01:12:42,810
behind a hill basically based on our

1708
01:12:50,450 --> 01:12:45,449
calculations the brightness of the plume

1709
01:12:53,930 --> 01:12:50,460
was on par with a magnitude 8 magnitude

1710
01:12:56,590 --> 01:12:53,940
8 star or so per arcseconds squared

1711
01:12:59,560 --> 01:12:56,600
which is quite observable with

1712
01:13:02,320 --> 01:12:59,570
a tenner inch telescope the issue was

1713
01:13:04,960 --> 01:13:02,330

when we decided to go to campus it made

1714
01:13:08,710 --> 01:13:04,970
it required that that ejecta get even

1715
01:13:11,400 --> 01:13:08,720
higher than we had had hoped needed to

1716
01:13:16,360 --> 01:13:11,410
before so that was part of the issue

1717
01:13:19,120 --> 01:13:16,370
another issue was this high angle plume

1718
01:13:22,780 --> 01:13:19,130
that the material that got the highest

1719
01:13:24,670 --> 01:13:22,790
was of lower density than the material

1720
01:13:27,430 --> 01:13:24,680
that went more lateral so a lot of the

1721
01:13:30,190 --> 01:13:27,440
higher density brighter material stayed

1722
01:13:33,220 --> 01:13:30,200
on a much more shallow lateral course as

1723
01:13:34,840 --> 01:13:33,230
it came up and so while that was good

1724
01:13:37,420 --> 01:13:34,850
for instruments because it filled our

1725
01:13:40,920 --> 01:13:37,430
apertures with a very bright material it

1726
01:13:44,860 --> 01:13:40,930
was bad for earth-based observers even

1727
01:13:47,770 --> 01:13:44,870
regardless of the dish size or aperture

1728
01:13:49,900 --> 01:13:47,780
size you know because the material just

1729
01:13:50,920 --> 01:13:49,910
didn't get high enough over the ridge

1730
01:13:55,990 --> 01:13:50,930
line of kebaya

1731
01:14:00,430 --> 01:13:56,000
to be very visible I mean I I remember I

1732
01:14:02,290 --> 01:14:00,440
remember when I was watching the event

1733
01:14:03,550 --> 01:14:02,300
with del cross it didn't it almost look

1734
01:14:07,470 --> 01:14:03,560
like nothing happened

1735
01:14:09,670 --> 01:14:07,480
so was was there were you surprised or

1736
01:14:11,920 --> 01:14:09,680
it didn't look like there was much of a

1737
01:14:14,110 --> 01:14:11,930
plume when people were watching it in

1738
01:14:18,460 --> 01:14:14,120

real-time so to speak from the L cross

1739
01:14:21,180 --> 01:14:18,470
camera data sir I I was not necessarily

1740
01:14:23,800 --> 01:14:21,190
surprised it was in line with our

1741
01:14:26,290 --> 01:14:23,810
expectations for our cameras we wanted a

1742
01:14:28,030 --> 01:14:26,300
higher exposure our near-infrared camera

1743
01:14:30,760 --> 01:14:28,040
that would have made it more more

1744
01:14:34,480 --> 01:14:30,770
visible and we are hoping for that but

1745
01:14:37,270 --> 01:14:34,490
we were battling data bandwidth issues

1746
01:14:41,590 --> 01:14:37,280
all the way down trying to maintain our

1747
01:14:44,110 --> 01:14:41,600
our bandwidth so we didn't get a longer

1748
01:14:46,210 --> 01:14:44,120
exposure call in at the time we should

1749
01:14:48,520 --> 01:14:46,220
have perhaps to make those cameras a

1750
01:14:51,010 --> 01:14:48,530
little bit show the plume or more

1751
01:14:52,750 --> 01:14:51,020
clearly I mean going back to the cameras

1752
01:14:55,000 --> 01:14:52,760
we can clearly see that the plume and

1753
01:14:56,650 --> 01:14:55,010
the cameras real-time it just wasn't as

1754
01:14:59,920 --> 01:14:56,660
obvious as it would have been nice to

1755
01:15:04,090 --> 01:14:59,930
have that's for sure thank you very much

1756
01:15:06,700 --> 01:15:04,100
and our last question is from David

1757
01:15:09,670 --> 01:15:06,710
Hirsh of NHK go ahead David

1758
01:15:10,120 --> 01:15:09,680
one quick confirmatory question if I

1759
01:15:13,240 --> 01:15:10,130
could

1760
01:15:15,610 --> 01:15:13,250
the just to confirm that the the water

1761
01:15:18,430 --> 01:15:15,620
was observed both in ice and vapor form

1762
01:15:20,410 --> 01:15:18,440
as part of this I don't want to say too

1763
01:15:23,320 --> 01:15:20,420

much about how much was water ice or how

1764
01:15:25,870 --> 01:15:23,330
much was vapor rating out strong a

1765
01:15:27,040 --> 01:15:25,880
signature and the OAH signature is just

1766
01:15:29,410 --> 01:15:27,050
with respect to vapor

1767
01:15:32,230 --> 01:15:29,420
it's a you know it's a it's a

1768
01:15:34,290 --> 01:15:32,240
sublimation and fatalis event for the

1769
01:15:37,210 --> 01:15:34,300
ultra viable spectrometer that data is

1770
01:15:40,030 --> 01:15:37,220
strictly vapor for the NIR and Fred

1771
01:15:42,760 --> 01:15:40,040
spectroscopy that has water vapor in it

1772
01:15:45,460 --> 01:15:42,770
and some ice and exactly the exact

1773
01:15:48,430 --> 01:15:45,470
concentration between the two needs to

1774
01:15:50,140 --> 01:15:48,440
be you know refined but yeah there

1775
01:15:53,050 --> 01:15:50,150
appears to be both water vapor and some

1776
01:15:56,800 --> 01:15:53,060
ice and then I don't know doing the line

1777
01:15:59,560 --> 01:15:56,810
but this this finding well how does that

1778
01:16:01,570 --> 01:15:59,570
impact if at all the human spaceflight

1779
01:16:07,570 --> 01:16:01,580
review that's going on within that at

1780
01:16:10,620 --> 01:16:07,580
the moment that one for Doug the

1781
01:16:14,770 --> 01:16:10,630
information that we're getting here is

1782
01:16:17,830 --> 01:16:14,780
has is and it has been available to our

1783
01:16:21,610 --> 01:16:17,840
senior management within NASA as we've

1784
01:16:25,080 --> 01:16:21,620
as we've developed it and so information

1785
01:16:29,620 --> 01:16:25,090
is going to be available as a way to

1786
01:16:31,810 --> 01:16:29,630
ensure that the administration is well

1787
01:16:35,320 --> 01:16:31,820
informed for them to be able to make

1788
01:16:38,980 --> 01:16:35,330

their decision so we have the

1789
01:16:40,900 --> 01:16:38,990
information it's useful now and for the

1790
01:16:42,220 --> 01:16:40,910
decision making process and it's also

1791
01:16:47,260 --> 01:16:42,230
going to be useful in the future

1792
01:16:49,210 --> 01:16:47,270
as we continue to explore report which

1793
01:16:51,640 --> 01:16:49,220
as I understood it now a couple weeks

1794
01:16:52,810 --> 01:16:51,650
after reading it I think one of the

1795
01:16:56,440 --> 01:16:52,820
options they talked about was even

1796
01:16:57,670 --> 01:16:56,450
bypass in the moon how much more sexy if

1797
01:17:01,510 --> 01:16:57,680
you will does the moon look to you now

1798
01:17:03,990 --> 01:17:01,520
these findings well as we find out more

1799
01:17:07,960 --> 01:17:04,000
and more about the moon we realize that

1800
01:17:10,240 --> 01:17:07,970
it's not a closed book for lunar science

1801
01:17:12,250 --> 01:17:10,250
and lunar exploration but it's just the

1802
01:17:13,900 --> 01:17:12,260
first chapter of the book that we were

1803
01:17:16,720 --> 01:17:13,910
able to do an Apollo and up until now

1804
01:17:18,190 --> 01:17:16,730
and the rest of those chapters are yet

1805
01:17:20,050 --> 01:17:18,200
to be written and I think they're going

1806
01:17:22,250 --> 01:17:20,060
to be really exciting chapters in

1807
01:17:23,660 --> 01:17:22,260
conclusion if I couldn't follow up to

1808
01:17:28,100 --> 01:17:23,670
one of the questions for my colleagues

1809
01:17:30,620 --> 01:17:28,110
the answer was that the the moon is the

1810
01:17:32,810 --> 01:17:30,630
area that was impacted might be a little

1811
01:17:34,490 --> 01:17:32,820
bit wetter than some of the driest

1812
01:17:37,190 --> 01:17:34,500
deserts on earth and if that's the case

1813
01:17:39,740 --> 01:17:37,200

just for a general a popular audience

1814
01:17:41,390 --> 01:17:39,750
why is does that have you so excited to

1815
01:17:45,970 --> 01:17:41,400
find a place that's just about as dry as

1816
01:17:50,570 --> 01:17:45,980
a desert on ice there's that question

1817
01:17:53,930 --> 01:17:50,580
who wants to go down let me take a real

1818
01:17:57,290 --> 01:17:53,940
practical point of view if there is a a

1819
01:18:00,830 --> 01:17:57,300
choice of having no water available to

1820
01:18:04,700 --> 01:18:00,840
you and a little bit of water available

1821
01:18:08,150 --> 01:18:04,710
to you by comparison to our earth-based

1822
01:18:09,290 --> 01:18:08,160
environment I'll take the the situation

1823
01:18:11,900 --> 01:18:09,300
where we have a little bit of water

1824
01:18:14,540 --> 01:18:11,910
available because it's so valuable to us

1825
01:18:16,310 --> 01:18:14,550
for so many different reasons for the

1826
01:18:19,160 --> 01:18:16,320
scientific reasons that Greg talked

1827
01:18:21,620 --> 01:18:19,170
about or the exploration reasons that

1828
01:18:25,040 --> 01:18:21,630
water could be the key to sustainability

1829
01:18:27,440 --> 01:18:25,050
for for exploration so having it there

1830
01:18:29,660 --> 01:18:27,450
is going to be extremely valued valuable

1831
01:18:32,300 --> 01:18:29,670
to us even if right now we can't go

1832
01:18:34,520 --> 01:18:32,310
swimming in it I just add a science

1833
01:18:36,080 --> 01:18:34,530
perspective one might ask what's so

1834
01:18:37,880 --> 01:18:36,090
interesting about the driest desert on

1835
01:18:41,030 --> 01:18:37,890
earth and yet the atacama right now is a

1836
01:18:42,820 --> 01:18:41,040
hotbed of scientific activity because it

1837
01:18:46,280 --> 01:18:42,830
tells us new things about our own planet

1838
01:18:47,510 --> 01:18:46,290

by the same token going to a region of

1839
01:18:50,240 --> 01:18:47,520
the Moon is going to tell us really

1840
01:18:51,470 --> 01:18:50,250
exciting things about lunar history the

1841
01:18:53,450 --> 01:18:51,480
solar system history and perhaps the

1842
01:18:56,540 --> 01:18:53,460
earth obtaining a sample and analyzing

1843
01:18:59,240 --> 01:18:56,550
it so just understanding the record that

1844
01:19:00,680 --> 01:18:59,250
it keeps is just an incredible

1845
01:19:02,450 --> 01:19:00,690
scientific interest and I think that

1846
01:19:04,550 --> 01:19:02,460
we're gonna see an increasing priority

1847
01:19:07,100 --> 01:19:04,560
in the polar regions as a result in part

1848
01:19:10,400 --> 01:19:07,110
because of the L cross discovering okay

1849
01:19:12,860 --> 01:19:10,410
and that's it

1850
01:19:15,650 --> 01:19:12,870
I'd like to thank our panelists and our

1851
01:19:18,170 --> 01:19:15,660
audience here and watching on NASA TV

1852
01:19:22,640 --> 01:19:18,180
and on the web for the latest on the L

1853
01:19:25,610 --> 01:19:22,650
cross mission visit www.nasa.gov/twan