1
00:00:12,470 --> 00:00:11,110
hello and welcome to what's new in

2
00:00:14,230 --> 00:00:12,480
aerospace

3
00:00:15,669 --> 00:00:14,240
sponsored by boeing thank you for

4
00:00:18,230 --> 00:00:15,679
joining us here at the national air and

5
00:00:20,390 --> 00:00:18,240
space museum in washington dc in our

6
00:00:22,470 --> 00:00:20,400
gallery moving beyond earth

7
00:00:24,790 --> 00:00:22,480
i'm matthew shindel i'm the curator of

8
00:00:27,509 --> 00:00:24,800
planetary science here at the museum and

9
00:00:30,470 --> 00:00:27,519
with me today are dr jim green

10
00:00:33,270 --> 00:00:30,480
the director of nasa's planetary science

11
00:00:35,990 --> 00:00:33,280
division and also dr thomas waters

12
00:00:38,310 --> 00:00:36,000
senior scientist from the museum center

13
00:00:40,790 --> 00:00:38,320

for earth and planetary studies and our

14
00:00:42,950 --> 00:00:40,800
topic today is the moon and it's

15
00:00:45,750 --> 00:00:42,960
inspired by a new exhibition here in the

16
00:00:47,670 --> 00:00:45,760
museum called the new moon rises that

17
00:00:49,590 --> 00:00:47,680
features the camera system from the

18
00:00:52,229 --> 00:00:49,600
lunar reconnaissance orbiter

19
00:00:54,069 --> 00:00:52,239
and some incredible photos or images

20
00:00:55,910 --> 00:00:54,079
that show you the moon probably as

21
00:00:57,510 --> 00:00:55,920
you've never seen it before

22
00:00:59,349 --> 00:00:57,520
tom is going to show us some great

23
00:01:01,110 --> 00:00:59,359
images but before we get to him i just

24
00:01:02,069 --> 00:01:01,120
wanted to show you one of my

25
00:01:05,509 --> 00:01:02,079
favorite

26
00:01:07,910 --> 00:01:05,519
images it features some lunar swirls

27
00:01:09,190 --> 00:01:07,920
that are found on the lunar surface

28
00:01:11,910 --> 00:01:09,200
features that are still somewhat

29
00:01:13,990 --> 00:01:11,920
mysterious to scientists and you can see

30
00:01:15,830 --> 00:01:14,000
a couple of examples of those here in

31
00:01:17,590 --> 00:01:15,840
the gallery

32
00:01:20,950 --> 00:01:17,600
so um

33
00:01:24,870 --> 00:01:20,960
our format today is uh we're going to do

34
00:01:29,190 --> 00:01:27,190
with uh our speakers giving sort of

35
00:01:31,910 --> 00:01:29,200
brief presentations but with the

36
00:01:34,390 --> 00:01:31,920
audience able to ask questions before

37
00:01:36,789 --> 00:01:34,400
and in between those presentations and

38
00:01:37,749 --> 00:01:36,799

i'm also going to try and get our uh

39
00:01:40,230 --> 00:01:37,759
guests

40
00:01:42,950 --> 00:01:40,240
to sort of talk with you and talk with

41
00:01:44,870 --> 00:01:42,960
each other by asking them some questions

42
00:01:47,270 --> 00:01:44,880
so i'll start off with the first

43
00:01:50,550 --> 00:01:47,280
question to dr green

44
00:01:52,310 --> 00:01:50,560
so dr green can you tell us you know

45
00:01:54,310 --> 00:01:52,320
why is the moon scientifically

46
00:01:55,830 --> 00:01:54,320
interesting why are we still going to

47
00:02:01,429 --> 00:01:55,840
the moon

48
00:02:03,670 --> 00:02:01,439
planetary object we've looked out for

49
00:02:06,550 --> 00:02:03,680
millions of years and wondered

50
00:02:08,550 --> 00:02:06,560
about the moon its origin and what it's

51
00:02:10,949 --> 00:02:08,560
made of you know is it made of green

52
00:02:14,070 --> 00:02:10,959
cheese or not well we know it's not

53
00:02:16,869 --> 00:02:14,080
and we know it's made of earth material

54
00:02:19,510 --> 00:02:16,879
because its early origin we believe now

55
00:02:22,550 --> 00:02:19,520
occurred more than four billion years

56
00:02:24,390 --> 00:02:22,560
ago when a planet the size of mars

57
00:02:25,830 --> 00:02:24,400
impacted the earth

58
00:02:28,070 --> 00:02:25,840
creating

59
00:02:30,070 --> 00:02:28,080
the moon and the earth

60
00:02:31,670 --> 00:02:30,080
so they're intimately tied in the

61
00:02:34,229 --> 00:02:31,680
materials they have

62
00:02:37,270 --> 00:02:34,239
and so in fact if we want to know the

63
00:02:39,990 --> 00:02:37,280

origin of the earth when that occurred

64
00:02:41,910 --> 00:02:40,000
we actually can only find that answer by

65
00:02:43,030 --> 00:02:41,920
going to the moon

66
00:02:44,710 --> 00:02:43,040
all right

67
00:02:46,550 --> 00:02:44,720
and let me remind you anytime anyone

68
00:02:48,630 --> 00:02:46,560
from the audience has a question just

69
00:02:51,670 --> 00:02:48,640
come up to the microphone and we do have

70
00:02:54,150 --> 00:02:51,680
a special incentive for you today uh you

71
00:02:56,470 --> 00:02:54,160
can have a nasa lapel pin if you get up

72
00:02:58,390 --> 00:02:56,480
and ask a question um

73
00:03:00,309 --> 00:02:58,400
all right uh while we wait for someone

74
00:03:04,790 --> 00:03:00,319
to come to the microphone oh okay go on

75
00:03:08,550 --> 00:03:06,630
i was always wondering when i heard this

76
00:03:11,030 --> 00:03:08,560
story that

77
00:03:13,509 --> 00:03:11,040
earth has been created in things

78
00:03:16,229 --> 00:03:13,519
i was wondering what would happen

79
00:03:18,869 --> 00:03:16,239
if there was no meteorite no little

80
00:03:21,110 --> 00:03:18,879
austerity so how would the earth today

81
00:03:23,910 --> 00:03:21,120
as we know it would look like

82
00:03:25,350 --> 00:03:23,920
bigger bigger gravity bigger so so how

83
00:03:26,949 --> 00:03:25,360
can

84
00:03:29,190 --> 00:03:26,959
because it's quite an itch it's just

85
00:03:31,589 --> 00:03:29,200
chance that yeah looks like like it's

86
00:03:33,990 --> 00:03:31,599
today great question so how would the

87
00:03:35,830 --> 00:03:34,000
earth today be different if that

88
00:03:38,149 --> 00:03:35,840

mars-sized um

89
00:03:40,710 --> 00:03:38,159
early proto-planet hadn't collided with

90
00:03:43,190 --> 00:03:40,720
it and created well the one thing is

91
00:03:45,750 --> 00:03:43,200
we may not have life as we know it

92
00:03:47,110 --> 00:03:45,760
you know we now believe life started in

93
00:03:49,509 --> 00:03:47,120
the ocean

94
00:03:51,990 --> 00:03:49,519
and the moon of course produces tides

95
00:03:53,910 --> 00:03:52,000
back and forth and for

96
00:03:56,309 --> 00:03:53,920
life in the ocean to move to the land

97
00:03:58,789 --> 00:03:56,319
the tides may have contributed to that

98
00:04:01,429 --> 00:03:58,799
in addition to that the moon provides an

99
00:04:04,070 --> 00:04:01,439
enormous stabilizing force

100
00:04:07,670 --> 00:04:04,080
in terms of our rotation it allows our

101
00:04:09,990 --> 00:04:07,680
axis to spin like a top rather than do a

102
00:04:11,990 --> 00:04:10,000
topsy-turvy thing which then would

103
00:04:14,869 --> 00:04:12,000
change significantly our climate all

104
00:04:17,349 --> 00:04:14,879
over the land and perhaps also inhibit

105
00:04:19,670 --> 00:04:17,359
life as we know it today so the moon

106
00:04:21,909 --> 00:04:19,680
provides a lot of a lot of important

107
00:04:24,710 --> 00:04:21,919
features uh that we want to know more

108
00:04:26,629 --> 00:04:24,720
about and its role in in life no it's a

109
00:04:28,950 --> 00:04:26,639
great question if you

110
00:04:30,790 --> 00:04:28,960
look at the moon too and you'll see this

111
00:04:32,230 --> 00:04:30,800
one of the

112
00:04:34,629 --> 00:04:32,240
amazing

113
00:04:37,670 --> 00:04:34,639

features of the moon is pretty much

114
00:04:40,310 --> 00:04:37,680
it records everything that hit it beyond

115
00:04:43,670 --> 00:04:40,320
a certain point in time and some of

116
00:04:44,469 --> 00:04:43,680
these are really large basins and these

117
00:04:47,030 --> 00:04:44,479
are

118
00:04:49,430 --> 00:04:47,040
a thousand kilometers across in some

119
00:04:52,230 --> 00:04:49,440
cases so we're we're talking about very

120
00:04:54,469 --> 00:04:52,240
very big objects that hit the moon well

121
00:04:57,270 --> 00:04:54,479
think about what would happen if the

122
00:04:59,030 --> 00:04:57,280
moon hadn't been there

123
00:05:01,990 --> 00:04:59,040
some of these objects

124
00:05:04,230 --> 00:05:02,000
may have impacted on the earth which at

125
00:05:07,029 --> 00:05:04,240
times could have also affected the

126
00:05:09,029 --> 00:05:07,039
development of life on this planet

127
00:05:10,469 --> 00:05:09,039
all right great well let's take one more

128
00:05:14,550 --> 00:05:10,479
question from the audience and then

129
00:05:18,950 --> 00:05:16,950
so i was looking at the picture what are

130
00:05:21,029 --> 00:05:18,960
the lunar swords

131
00:05:22,310 --> 00:05:21,039
tom do you want to try and answer that

132
00:05:24,790 --> 00:05:22,320
it's a great question

133
00:05:27,110 --> 00:05:24,800
they're actually really very mysterious

134
00:05:29,029 --> 00:05:27,120
features on the moon it's almost as if

135
00:05:32,310 --> 00:05:29,039
you took the lunar surface

136
00:05:35,670 --> 00:05:32,320
and got a spray can and just sprayed

137
00:05:37,350 --> 00:05:35,680
a very light coat of material on the

138
00:05:39,029 --> 00:05:37,360

surface because that's all it is it's a

139
00:05:40,230 --> 00:05:39,039
very subtle

140
00:05:43,510 --> 00:05:40,240
difference

141
00:05:46,550 --> 00:05:43,520
in the brightness of the material

142
00:05:49,590 --> 00:05:46,560
and we think it's because

143
00:05:53,430 --> 00:05:49,600
when the moon which has no atmosphere is

144
00:05:55,830 --> 00:05:53,440
exposed to solar wind and cosmic rays

145
00:05:57,990 --> 00:05:55,840
it affects the surface fresh material

146
00:06:01,029 --> 00:05:58,000
that's created when an impact occurs

147
00:06:02,870 --> 00:06:01,039
will be lighter but over time it darkens

148
00:06:06,150 --> 00:06:02,880
and that darkening happens because of

149
00:06:07,749 --> 00:06:06,160
this interaction with the solar wind and

150
00:06:10,469 --> 00:06:07,759
and cosmic ray particles and what we

151
00:06:11,749 --> 00:06:10,479
think may be going on is that there are

152
00:06:14,870 --> 00:06:11,759
certain areas of the moon that are

153
00:06:16,710 --> 00:06:14,880
protected by the moon's magnetic field

154
00:06:18,790 --> 00:06:16,720
it doesn't have an active magnetic field

155
00:06:20,950 --> 00:06:18,800
now but it did it one time

156
00:06:23,749 --> 00:06:20,960
and it's preserved in some of the rocks

157
00:06:25,909 --> 00:06:23,759
so it's this remnant field and that may

158
00:06:28,950 --> 00:06:25,919
be shielding or interacting with that

159
00:06:31,670 --> 00:06:28,960
solar wind to kind of help protect

160
00:06:32,710 --> 00:06:31,680
certain areas of the soil from darkening

161
00:06:36,629 --> 00:06:32,720
as

162
00:06:38,309 --> 00:06:36,639
that kind of shielding that's just one

163
00:06:40,550 --> 00:06:38,319

idea

164
00:06:42,469 --> 00:06:40,560
all right great well on that note uh why

165
00:06:44,309 --> 00:06:42,479
don't we turn things over to dr jim

166
00:06:46,230 --> 00:06:44,319
green to tell us a little bit about the

167
00:06:49,029 --> 00:06:46,240
lunar reconnaissance orbiter

168
00:06:50,469 --> 00:06:49,039
thank you very much matt

169
00:06:53,189 --> 00:06:50,479
all right what i'd like to talk about

170
00:06:54,469 --> 00:06:53,199
today if i can have my first slide

171
00:06:56,790 --> 00:06:54,479
is indeed

172
00:06:59,510 --> 00:06:56,800
a little background on the lunar

173
00:07:00,390 --> 00:06:59,520
reconnaissance orbiter and why it came

174
00:07:03,350 --> 00:07:00,400
about

175
00:07:04,790 --> 00:07:03,360
and what it's currently doing

176
00:07:07,510 --> 00:07:04,800
all right

177
00:07:09,909 --> 00:07:07,520
so as we talked about earlier why do we

178
00:07:12,390 --> 00:07:09,919
study the moon well the moon may indeed

179
00:07:15,189 --> 00:07:12,400
be extremely important to us as we say

180
00:07:17,430 --> 00:07:15,199
uh not only in participating in some way

181
00:07:20,469 --> 00:07:17,440
about harboring life here on earth and

182
00:07:21,510 --> 00:07:20,479
and how life as we know it has evolved

183
00:07:23,430 --> 00:07:21,520
that way

184
00:07:24,550 --> 00:07:23,440
but it also shows that we've been on the

185
00:07:29,270 --> 00:07:24,560
moon

186
00:07:31,670 --> 00:07:29,280
and so there are five basic things i'd

187
00:07:33,350 --> 00:07:31,680
like everyone to know about the moon

188
00:07:35,189 --> 00:07:33,360

the first one is

189
00:07:37,510 --> 00:07:35,199
our astronauts on the moon have actually

190
00:07:40,469 --> 00:07:37,520
brought back lunar material we have more

191
00:07:43,510 --> 00:07:40,479
than 800 pounds of lunar rocks and

192
00:07:45,990 --> 00:07:43,520
regulate which is the soil on the moon

193
00:07:47,990 --> 00:07:46,000
and we're currently analyzing that and

194
00:07:51,110 --> 00:07:48,000
that has been going on for more than 40

195
00:07:53,670 --> 00:07:51,120
years and it constantly surprises

196
00:07:55,430 --> 00:07:53,680
surprises us in new and in in very

197
00:07:56,869 --> 00:07:55,440
important ways

198
00:08:00,070 --> 00:07:56,879
in addition to that

199
00:08:02,710 --> 00:08:00,080
on the surface is six landing spots so

200
00:08:04,790 --> 00:08:02,720
we've had humans down on the ground

201
00:08:06,469 --> 00:08:04,800
working uh and

202
00:08:08,790 --> 00:08:06,479
deploying instruments in addition to

203
00:08:11,350 --> 00:08:08,800
bringing back uh soils

204
00:08:12,869 --> 00:08:11,360
and material these are the uh apollo

205
00:08:14,309 --> 00:08:12,879
sites

206
00:08:16,629 --> 00:08:14,319
the second thing

207
00:08:19,430 --> 00:08:16,639
as tom mentioned

208
00:08:22,230 --> 00:08:19,440
the moon's surface really records what

209
00:08:24,629 --> 00:08:22,240
we call the bombardment history of the

210
00:08:26,869 --> 00:08:24,639
inner part of the solar system when we

211
00:08:29,110 --> 00:08:26,879
look at the moon it's full of these

212
00:08:31,990 --> 00:08:29,120
craters but the earth doesn't have

213
00:08:34,389 --> 00:08:32,000

craters like that not today so what's

214
00:08:36,469 --> 00:08:34,399
happened what's happened on the moon is

215
00:08:39,350 --> 00:08:36,479
without an atmosphere those craters

216
00:08:40,389 --> 00:08:39,360
remain relatively pristine

217
00:08:43,990 --> 00:08:40,399
here on earth

218
00:08:46,230 --> 00:08:44,000
our biospheres literally destroyed any

219
00:08:49,990 --> 00:08:46,240
hint of those kind of craters although

220
00:08:52,150 --> 00:08:50,000
we do see hints of crater like features

221
00:08:53,509 --> 00:08:52,160
in various places but they're very few

222
00:08:55,590 --> 00:08:53,519
in number

223
00:08:57,110 --> 00:08:55,600
and so understanding that bombardment

224
00:08:59,110 --> 00:08:57,120
history is really important

225
00:09:00,389 --> 00:08:59,120
understanding how the earth has evolved

226
00:09:02,150 --> 00:09:00,399
also

227
00:09:05,110 --> 00:09:02,160
now in addition to that

228
00:09:07,670 --> 00:09:05,120
we now know that the moon actually has

229
00:09:08,790 --> 00:09:07,680
some of the coldest places in the solar

230
00:09:10,470 --> 00:09:08,800
system

231
00:09:12,870 --> 00:09:10,480
you know the light from the sun that

232
00:09:15,670 --> 00:09:12,880
shines on the moon

233
00:09:17,829 --> 00:09:15,680
illuminates it everywhere we would think

234
00:09:20,630 --> 00:09:17,839
except when you look at the poles there

235
00:09:23,110 --> 00:09:20,640
are certain craters that are so deep

236
00:09:25,190 --> 00:09:23,120
that indeed the light even over a lunar

237
00:09:27,430 --> 00:09:25,200
day doesn't get into the deep part of

238
00:09:30,389 --> 00:09:27,440

the crater and so it is some of the

239
00:09:31,990 --> 00:09:30,399
coldest places in our solar system

240
00:09:33,910 --> 00:09:32,000
and then finally

241
00:09:35,910 --> 00:09:33,920
with the lunar reconnaissance orbiter

242
00:09:38,710 --> 00:09:35,920
we're really looking at the moon like

243
00:09:40,949 --> 00:09:38,720
we've never done before

244
00:09:43,030 --> 00:09:40,959
and so here are

245
00:09:45,110 --> 00:09:43,040
the six landing sites

246
00:09:45,990 --> 00:09:45,120
they're all on the front side of the

247
00:09:48,870 --> 00:09:46,000
moon

248
00:09:50,630 --> 00:09:48,880
and this image these two images

249
00:09:52,630 --> 00:09:50,640
are not only the front side of the moon

250
00:09:54,870 --> 00:09:52,640
on the on the left but the back side of

251
00:09:58,310 --> 00:09:54,880
the moon on the right all from the lunar

252
00:10:00,150 --> 00:09:58,320
reconnaissance orbiter in huge detail

253
00:10:02,150 --> 00:10:00,160
and we can examine those and understand

254
00:10:04,630 --> 00:10:02,160
those much better

255
00:10:08,310 --> 00:10:04,640
so what about lro well

256
00:10:09,910 --> 00:10:08,320
ll row was designed to study the moon in

257
00:10:12,870 --> 00:10:09,920
great detail

258
00:10:15,590 --> 00:10:12,880
it was really our next step

259
00:10:18,870 --> 00:10:15,600
not only scientifically but providing us

260
00:10:21,269 --> 00:10:18,880
an opportunity if we need to for humans

261
00:10:23,910 --> 00:10:21,279
to go back to the moon it certainly

262
00:10:27,430 --> 00:10:23,920
provides us with high resolution imaging

263
00:10:30,150 --> 00:10:27,440

the opportunity for our rovers and our

264
00:10:32,630 --> 00:10:30,160
landers that many nations are now

265
00:10:35,269 --> 00:10:32,640
sending to the moon to be able to be set

266
00:10:37,350 --> 00:10:35,279
down safely on its surface

267
00:10:39,269 --> 00:10:37,360
now the goal of the lunar reconnaissance

268
00:10:42,710 --> 00:10:39,279
orbiter was really to do that high

269
00:10:44,150 --> 00:10:42,720
resolution imaging to create a new atlas

270
00:10:46,870 --> 00:10:44,160
of the moon

271
00:10:49,590 --> 00:10:46,880
at very high resolution and in fact if

272
00:10:50,470 --> 00:10:49,600
you look at that uh control stand over

273
00:10:52,150 --> 00:10:50,480
there

274
00:10:54,069 --> 00:10:52,160
if that was sitting on the moon you

275
00:10:56,630 --> 00:10:54,079
could easily see it with the lunar

276
00:11:00,550 --> 00:10:56,640
reconnaissance orbiter this stage would

277
00:11:01,590 --> 00:11:00,560
be many pixels and easily picked out

278
00:11:03,750 --> 00:11:01,600
and so

279
00:11:06,310 --> 00:11:03,760
now we've got maps like that through the

280
00:11:08,389 --> 00:11:06,320
entire surface of the moon we also want

281
00:11:10,949 --> 00:11:08,399
to look at it in different ways like its

282
00:11:13,590 --> 00:11:10,959
temperature distribution we also want to

283
00:11:14,470 --> 00:11:13,600
search for resources like potentially

284
00:11:16,470 --> 00:11:14,480
water

285
00:11:17,269 --> 00:11:16,480
particularly if humans go back to the

286
00:11:19,350 --> 00:11:17,279
moon

287
00:11:22,870 --> 00:11:19,360
and want to want to be able to create

288
00:11:24,630 --> 00:11:22,880

colonies or work in in that environment

289
00:11:28,710 --> 00:11:24,640
the lunar reconnaissance orbiter was

290
00:11:30,870 --> 00:11:28,720
launched in 2009 and after a few

291
00:11:32,470 --> 00:11:30,880
months traveling and getting into orbit

292
00:11:35,110 --> 00:11:32,480
around the moon and then commissioning

293
00:11:36,470 --> 00:11:35,120
the instruments it then really began to

294
00:11:38,389 --> 00:11:36,480
do its work

295
00:11:40,069 --> 00:11:38,399
so here's a picture of lunar

296
00:11:41,990 --> 00:11:40,079
reconnaissance orbiter

297
00:11:44,550 --> 00:11:42,000
and it's got seven instruments the first

298
00:11:46,870 --> 00:11:44,560
one's crater this one looks at really

299
00:11:50,310 --> 00:11:46,880
high energy cosmic rays that bombard the

300
00:11:51,509 --> 00:11:50,320
moon diviner this one maps the moon in

301
00:11:55,750 --> 00:11:51,519
temperature

302
00:11:58,230 --> 00:11:55,760
different also on the moon lola is a

303
00:12:01,509 --> 00:11:58,240
laser altimeter tells us the highs and

304
00:12:03,670 --> 00:12:01,519
lows and lrock is that high resolution

305
00:12:05,829 --> 00:12:03,680
imager that allows us to make detailed

306
00:12:09,590 --> 00:12:05,839
measurements of the craters

307
00:12:11,509 --> 00:12:09,600
lamp allows us to look for water vapor

308
00:12:14,790 --> 00:12:11,519
trapped in these permanently shadowed

309
00:12:16,629 --> 00:12:14,800
craters and lynn looks at the neutrons

310
00:12:19,430 --> 00:12:16,639
that come from underneath the surface

311
00:12:20,949 --> 00:12:19,440
that tells us about water and finally

312
00:12:22,949 --> 00:12:20,959
the mini rf

313
00:12:25,750 --> 00:12:22,959

is a synthetic aperture rater that

314
00:12:28,629 --> 00:12:25,760
examines the soils looks at the regulate

315
00:12:31,350 --> 00:12:28,639
its distribution here's lro and it's a

316
00:12:34,310 --> 00:12:31,360
huge spacecraft how big

317
00:12:37,750 --> 00:12:34,320
if lro sat here in this exhibit it would

318
00:12:39,990 --> 00:12:37,760
be about the size of this shuttle

319
00:12:41,269 --> 00:12:40,000
mock-up as you see it right here so very

320
00:12:44,550 --> 00:12:41,279
large

321
00:12:46,470 --> 00:12:44,560
also lro is taking images like this

322
00:12:49,110 --> 00:12:46,480
here's where we've combined the lola

323
00:12:51,829 --> 00:12:49,120
images that are these colored images of

324
00:12:53,590 --> 00:12:51,839
highs and lows blue being low with the l

325
00:12:56,150 --> 00:12:53,600
rock images

326
00:12:59,110 --> 00:12:56,160
here's a basin meaning an impact region

327
00:13:02,069 --> 00:12:59,120
which was absolutely enormous

328
00:13:04,310 --> 00:13:02,079
here's also the tycho crater in great

329
00:13:07,590 --> 00:13:04,320
exquisite detail and sitting on top of

330
00:13:10,150 --> 00:13:07,600
this mountain is a house-sized rock

331
00:13:12,230 --> 00:13:10,160
now aristarchus

332
00:13:14,069 --> 00:13:12,240
is a plateau region that's very

333
00:13:15,990 --> 00:13:14,079
different than what we've seen elsewhere

334
00:13:18,069 --> 00:13:16,000
in the moon and of course

335
00:13:20,629 --> 00:13:18,079
here's evidence of our landing sites

336
00:13:22,550 --> 00:13:20,639
here's apollo 17 you can see where we've

337
00:13:24,790 --> 00:13:22,560
launched from the lander you can see the

338
00:13:26,710 --> 00:13:24,800

rover and you can see the tracks that

339
00:13:29,190 --> 00:13:26,720
have been made by the astronauts that

340
00:13:29,990 --> 00:13:29,200
have transited across the moon

341
00:13:33,110 --> 00:13:30,000
so

342
00:13:35,670 --> 00:13:33,120
lro is in orbit today working in a

343
00:13:38,629 --> 00:13:35,680
spectacular manner making detailed

344
00:13:40,069 --> 00:13:38,639
observations and continuing on doing its

345
00:13:41,990 --> 00:13:40,079
mapping

346
00:13:44,550 --> 00:13:42,000
so with that i'll turn it back over to

347
00:13:46,710 --> 00:13:44,560
matt all right thanks and remember if

348
00:13:48,550 --> 00:13:46,720
the audience has any questions

349
00:13:50,710 --> 00:13:48,560
please step up to the microphone again

350
00:13:52,790 --> 00:13:50,720
there is an incentive if you ask a

351
00:13:55,110 --> 00:13:52,800
question you get a lapel pin

352
00:13:56,949 --> 00:13:55,120
um well looks like we have someone with

353
00:13:59,269 --> 00:13:56,959
a question right away

354
00:14:00,710 --> 00:13:59,279
um how long is it going to stay in orbit

355
00:14:03,110 --> 00:14:00,720
around the moon i know that eventually

356
00:14:04,629 --> 00:14:03,120
orbits decay right so how long have you

357
00:14:05,670 --> 00:14:04,639
guys planned for its mission to go on

358
00:14:08,710 --> 00:14:05,680
for

359
00:14:09,910 --> 00:14:08,720
so lro has an enormous amount of fuel in

360
00:14:12,230 --> 00:14:09,920
fact

361
00:14:14,949 --> 00:14:12,240
more than half of it is fuel and that

362
00:14:17,670 --> 00:14:14,959
has served it well it allows it to just

363
00:14:19,509 --> 00:14:17,680

uh its orbit over and over and it turns

364
00:14:21,590 --> 00:14:19,519
out it absolutely has to do that you

365
00:14:23,590 --> 00:14:21,600
know the the moon actually is very

366
00:14:25,750 --> 00:14:23,600
irregular in terms of how it attracts

367
00:14:28,629 --> 00:14:25,760
spacecraft it has different mass

368
00:14:29,670 --> 00:14:28,639
densities and so those orbits constantly

369
00:14:31,990 --> 00:14:29,680
decay

370
00:14:35,030 --> 00:14:32,000
it has enough fuel to last at least for

371
00:14:36,069 --> 00:14:35,040
another four or five years

372
00:14:37,030 --> 00:14:36,079
all right

373
00:14:38,470 --> 00:14:37,040
uh

374
00:14:39,990 --> 00:14:38,480
we have another person stepping up to

375
00:14:42,230 --> 00:14:40,000
the mic but let me ask you a question

376
00:14:43,829 --> 00:14:42,240
before they do those those images of the

377
00:14:45,670 --> 00:14:43,839
apollo learning

378
00:14:48,150 --> 00:14:45,680
lunar landing sites are really pretty

379
00:14:51,509 --> 00:14:48,160
incredible that even today you can see

380
00:14:53,269 --> 00:14:51,519
where the astronauts walked and roved um

381
00:14:55,750 --> 00:14:53,279
and in fact if you look closely enough

382
00:14:57,590 --> 00:14:55,760
right where the lunar limb stand is you

383
00:14:59,750 --> 00:14:57,600
can see the backpacks so when they

384
00:15:01,430 --> 00:14:59,760
walked into the walked up the ladder and

385
00:15:02,949 --> 00:15:01,440
they threw their backpacks off and

386
00:15:05,030 --> 00:15:02,959
entered the capsule there they are the

387
00:15:07,910 --> 00:15:05,040
two backpacks are laying on the ground

388
00:15:09,590 --> 00:15:07,920

so if we do send another mission um do

389
00:15:11,829 --> 00:15:09,600
you think nasa could bring back one of

390
00:15:13,269 --> 00:15:11,839
those limbs for the museum wow well

391
00:15:15,670 --> 00:15:13,279
that's a good question

392
00:15:18,230 --> 00:15:15,680
um actually we discussed this a little

393
00:15:19,430 --> 00:15:18,240
bit in the sense of these are historic

394
00:15:21,750 --> 00:15:19,440
sites

395
00:15:23,030 --> 00:15:21,760
should we really go back and tamper with

396
00:15:26,790 --> 00:15:23,040
them or not

397
00:15:29,350 --> 00:15:26,800
so um i would say the the uh the story's

398
00:15:32,389 --> 00:15:29,360
not not in on that one okay but maybe we

399
00:15:34,389 --> 00:15:32,399
could just send a curator up there

400
00:15:36,870 --> 00:15:34,399
we may have to

401
00:15:38,310 --> 00:15:36,880
hi my name is fahad and being here was

402
00:15:40,629 --> 00:15:38,320
complete coincidence actually my

403
00:15:41,749 --> 00:15:40,639
research area back at the university of

404
00:15:44,550 --> 00:15:41,759
tennessee

405
00:15:46,550 --> 00:15:44,560
was dr lawrence townsend we're using

406
00:15:48,710 --> 00:15:46,560
crater actually to find water on the

407
00:15:50,710 --> 00:15:48,720
moon in heroes great consonants i don't

408
00:15:53,350 --> 00:15:50,720
know about that anyways um

409
00:15:56,150 --> 00:15:53,360
the images from crater from lro have

410
00:15:58,389 --> 00:15:56,160
helped us to find stuff that was lost on

411
00:16:00,870 --> 00:15:58,399
the moon um

412
00:16:03,110 --> 00:16:00,880
some of those are the soviet landers for

413
00:16:04,949 --> 00:16:03,120

rovers for example

414
00:16:08,069 --> 00:16:04,959
every time in the news we listen like we

415
00:16:10,069 --> 00:16:08,079
have a new thing found on the moon i'm

416
00:16:11,910 --> 00:16:10,079
just wondering are there stuff that are

417
00:16:13,749 --> 00:16:11,920
still lost on the moon that we haven't

418
00:16:15,670 --> 00:16:13,759
found them yet

419
00:16:16,389 --> 00:16:15,680
that are to be found using yeah that's a

420
00:16:19,030 --> 00:16:16,399
good

421
00:16:22,310 --> 00:16:19,040
question so what you're referring to

422
00:16:25,269 --> 00:16:22,320
is uh the soviet union also launched

423
00:16:27,030 --> 00:16:25,279
missions to the moon with rovers and one

424
00:16:29,829 --> 00:16:27,040
rover in particular

425
00:16:31,430 --> 00:16:29,839
after quite a while roving uh actually

426
00:16:34,310 --> 00:16:31,440
they didn't really know exactly where it

427
00:16:37,269 --> 00:16:34,320
was and it really took lro to find it

428
00:16:39,110 --> 00:16:37,279
i think we're pretty safe grounds to say

429
00:16:41,110 --> 00:16:39,120
that's probably one of the last things

430
00:16:44,870 --> 00:16:41,120
that humans have made that's there that

431
00:16:49,110 --> 00:16:47,269
are there any more that we are looking

432
00:16:50,629 --> 00:16:49,120
for no i don't think there's any more

433
00:16:52,310 --> 00:16:50,639
that we're looking for but you can

434
00:16:54,710 --> 00:16:52,320
always scour the image and let me know

435
00:16:57,670 --> 00:16:54,720
if you find something

436
00:16:59,269 --> 00:16:57,680
in fact there is an image in the exhibit

437
00:17:01,670 --> 00:16:59,279
upstairs of

438
00:17:07,750 --> 00:17:01,680

one of the lunar cods

439
00:17:13,990 --> 00:17:11,429
mark goldberg mark goldberg

440
00:17:16,789 --> 00:17:14,000
if we do find resources on the moon if

441
00:17:18,390 --> 00:17:16,799
we if things are found that are valuable

442
00:17:21,110 --> 00:17:18,400
what are the implications

443
00:17:22,949 --> 00:17:21,120
of exploiting those resources

444
00:17:25,029 --> 00:17:22,959
that's a good question and of course

445
00:17:27,510 --> 00:17:25,039
you're talking to a planetary scientist

446
00:17:29,669 --> 00:17:27,520
and the first thing i'm going to say is

447
00:17:31,750 --> 00:17:29,679
we don't know enough about the moon yet

448
00:17:34,150 --> 00:17:31,760
to be able to say it's up for grabs i

449
00:17:37,270 --> 00:17:34,160
mean we would much rather

450
00:17:39,990 --> 00:17:37,280
study it understand it much more closely

451
00:17:42,070 --> 00:17:40,000
really do the analysis of what's there

452
00:17:43,029 --> 00:17:42,080
how did it get there what its evolution

453
00:17:45,350 --> 00:17:43,039
is

454
00:17:47,029 --> 00:17:45,360
before we let planetary resources tear

455
00:17:48,630 --> 00:17:47,039
it up

456
00:17:50,310 --> 00:17:48,640
because it provides us valuable

457
00:17:55,110 --> 00:17:50,320
information

458
00:17:56,549 --> 00:17:55,120
legal basis to prevent the exploitation

459
00:17:58,549 --> 00:17:56,559
of resources

460
00:18:01,669 --> 00:17:58,559
oh that's another good question you know

461
00:18:02,950 --> 00:18:01,679
there has been uh some laws passed now

462
00:18:05,590 --> 00:18:02,960
that allow

463
00:18:08,230 --> 00:18:05,600

um entrepreneurs to be able to go out

464
00:18:11,350 --> 00:18:08,240
and mine asteroids and and i believe the

465
00:18:14,470 --> 00:18:11,360
moon would be probably considered a fair

466
00:18:18,549 --> 00:18:16,070
all right do we have a time for another

467
00:18:20,470 --> 00:18:18,559
question before we move on yes okay

468
00:18:23,590 --> 00:18:20,480
great

469
00:18:25,430 --> 00:18:23,600
i'm sabor schweiner and i'm wondering if

470
00:18:28,150 --> 00:18:25,440
this lro data

471
00:18:30,549 --> 00:18:28,160
will be publicly available so can i

472
00:18:32,630 --> 00:18:30,559
access them through internet

473
00:18:33,750 --> 00:18:32,640
yeah the yellow road data

474
00:18:36,390 --> 00:18:33,760
all of it

475
00:18:38,390 --> 00:18:36,400
and the high resolution images are all

476
00:18:41,350 --> 00:18:38,400
available on the on the

477
00:18:43,190 --> 00:18:41,360
the web so it's very easy to be able to

478
00:18:46,390 --> 00:18:43,200
go and do one of your favorite search

479
00:18:50,789 --> 00:18:46,400
engines and go lrock

480
00:18:53,029 --> 00:18:50,799
observations and go to a site at the at

481
00:18:56,150 --> 00:18:53,039
washu in st louis where they're

482
00:19:01,029 --> 00:18:56,160
archiving and putting online uh the lroc

483
00:19:04,150 --> 00:19:02,630
thomas and i'm interested to know what

484
00:19:06,390 --> 00:19:04,160
we're still discovering from some of the

485
00:19:08,950 --> 00:19:06,400
material that we brought back 40 years

486
00:19:13,029 --> 00:19:08,960
ago if the imagery that you're using now

487
00:19:15,510 --> 00:19:13,039
and that information cross paths

488
00:19:17,430 --> 00:19:15,520

now one of the most startling things

489
00:19:20,470 --> 00:19:17,440
that we discovered when we brought the

490
00:19:22,630 --> 00:19:20,480
lunar material back was their ages you

491
00:19:24,789 --> 00:19:22,640
know as i mentioned

492
00:19:27,669 --> 00:19:24,799
the earth is turned over and over our

493
00:19:30,310 --> 00:19:27,679
biosphere our plate tectonics and it has

494
00:19:32,230 --> 00:19:30,320
created new material in a constant way

495
00:19:33,590 --> 00:19:32,240
you can't go anywhere on the earth and

496
00:19:35,830 --> 00:19:33,600
find a rock

497
00:19:37,669 --> 00:19:35,840
4 billion years old and yet the the

498
00:19:39,750 --> 00:19:37,679
earth is even older than that but you

499
00:19:42,789 --> 00:19:39,760
can on the moon and so when we brought

500
00:19:46,789 --> 00:19:42,799
material back and we started to age data

501
00:19:50,630 --> 00:19:46,799
we found we did indeed find the old rock

502
00:19:52,710 --> 00:19:50,640
the 4.5 billion year old rocks that were

503
00:19:55,110 --> 00:19:52,720
created when the earth immune system

504
00:19:57,669 --> 00:19:55,120
came into being but we also found a

505
00:20:00,310 --> 00:19:57,679
whole series of younger rocks

506
00:20:01,830 --> 00:20:00,320
those in the age range of about 3.8

507
00:20:04,390 --> 00:20:01,840
billion years

508
00:20:07,270 --> 00:20:04,400
and we were very puzzled by that but we

509
00:20:10,549 --> 00:20:07,280
now believe we understand that more

510
00:20:13,830 --> 00:20:10,559
what happened at 3.8 billion years

511
00:20:15,750 --> 00:20:13,840
was an entirely new swarm of material

512
00:20:18,390 --> 00:20:15,760
coming from the outer reaches of our

513
00:20:19,590 --> 00:20:18,400

solar system bombarding the moon the

514
00:20:21,669 --> 00:20:19,600
earth the

515
00:20:24,310 --> 00:20:21,679
mars and all the way into venus and

516
00:20:25,990 --> 00:20:24,320
mercury and that is called the late

517
00:20:27,990 --> 00:20:26,000
heavy bombardment

518
00:20:30,149 --> 00:20:28,000
with that we also believe it brought a

519
00:20:32,230 --> 00:20:30,159
significant amount of water

520
00:20:35,669 --> 00:20:32,240
and so the discussion right now in the

521
00:20:37,750 --> 00:20:35,679
planetary fields are how much water was

522
00:20:40,070 --> 00:20:37,760
brought to earth

523
00:20:42,230 --> 00:20:40,080
based on those events than was here on

524
00:20:44,950 --> 00:20:42,240
earth and the and the answer might be as

525
00:20:47,590 --> 00:20:44,960
high as 60 percent or as low as 10

526
00:20:50,390 --> 00:20:47,600
percent and of course water is critical

527
00:20:51,990 --> 00:20:50,400
for our life to exist here on earth so

528
00:20:53,990 --> 00:20:52,000
there's a lot of clues like that that

529
00:20:55,270 --> 00:20:54,000
we're uncovering now that's just really

530
00:20:57,590 --> 00:20:55,280
fascinating

531
00:20:59,750 --> 00:20:57,600
great well on that note we're gonna oh

532
00:21:02,630 --> 00:20:59,760
sorry

533
00:21:04,789 --> 00:21:02,640
we have a online question

534
00:21:08,070 --> 00:21:04,799
what emission filters are used for the

535
00:21:10,470 --> 00:21:08,080
lroc exposure times correcting for any

536
00:21:12,549 --> 00:21:10,480
movement artifacts

537
00:21:14,390 --> 00:21:12,559
tom you might be the best to answer that

538
00:21:16,549 --> 00:21:14,400

okay well the

539
00:21:18,470 --> 00:21:16,559
uh in fact the the which i'll talk about

540
00:21:20,789 --> 00:21:18,480
here in a minute there there are

541
00:21:22,549 --> 00:21:20,799
multiple cameras the wide-angle camera

542
00:21:25,430 --> 00:21:22,559
does have filters

543
00:21:27,909 --> 00:21:25,440
uh those filters are in fact designed to

544
00:21:30,950 --> 00:21:27,919
look at the visible spectrum they kind

545
00:21:32,710 --> 00:21:30,960
of sample it so we can get information

546
00:21:35,510 --> 00:21:32,720
about the color

547
00:21:39,190 --> 00:21:35,520
properties of the lunar materials the

548
00:21:40,470 --> 00:21:39,200
exposure time really varies um depending

549
00:21:46,070 --> 00:21:40,480
on

550
00:21:47,669 --> 00:21:46,080
are at the time

551
00:21:51,029 --> 00:21:47,679
i hope that answered the question all

552
00:21:54,390 --> 00:21:51,039
right okay one more question

553
00:21:55,909 --> 00:21:54,400
i i would like to ask when you mentioned

554
00:21:59,270 --> 00:21:55,919
that the moon

555
00:22:01,830 --> 00:21:59,280
have one of the coldest place on

556
00:22:05,669 --> 00:22:03,669
those big holes

557
00:22:06,870 --> 00:22:05,679
i suppose as low as you go the coldest

558
00:22:10,390 --> 00:22:06,880
it is

559
00:22:12,630 --> 00:22:10,400
how low have you gone so far and

560
00:22:14,950 --> 00:22:12,640
i suppose if you go as low as deep as

561
00:22:16,710 --> 00:22:14,960
possible you might find ice which means

562
00:22:18,789 --> 00:22:16,720
it's water

563
00:22:20,149 --> 00:22:18,799

oh that's a great question i love it and

564
00:22:22,470 --> 00:22:20,159
the reason why

565
00:22:24,070 --> 00:22:22,480
is we want to go into these permanently

566
00:22:26,149 --> 00:22:24,080
shadowed craters

567
00:22:29,110 --> 00:22:26,159
because the bombardment history of the

568
00:22:31,110 --> 00:22:29,120
moon is not just with rocky material

569
00:22:33,190 --> 00:22:31,120
we believe comets also hit the

570
00:22:35,750 --> 00:22:33,200
environment not only at earth but also

571
00:22:37,190 --> 00:22:35,760
on the moon and when that occurs

572
00:22:39,830 --> 00:22:37,200
that water

573
00:22:42,470 --> 00:22:39,840
one of those volatiles we call it ends

574
00:22:44,470 --> 00:22:42,480
up migrating and ends up in cold traps

575
00:22:46,870 --> 00:22:44,480
which are in these permanently shadowed

576
00:22:49,430 --> 00:22:46,880
craters so if we want to know what the

577
00:22:51,909 --> 00:22:49,440
early solar system cometary material

578
00:22:54,390 --> 00:22:51,919
looked like it may be sitting in the

579
00:22:57,669 --> 00:22:54,400
permanently shadowed crater on the moon

580
00:23:02,230 --> 00:23:00,070
how long how low have you

581
00:23:04,149 --> 00:23:02,240
got into one of those

582
00:23:07,029 --> 00:23:04,159
so there's a couple ways that we look

583
00:23:09,830 --> 00:23:07,039
into this permanently shadowed region we

584
00:23:11,909 --> 00:23:09,840
can't see it with with elrock that's

585
00:23:14,549 --> 00:23:11,919
very hard to do because the sunlight

586
00:23:16,549 --> 00:23:14,559
doesn't shine there but with the lola

587
00:23:18,630 --> 00:23:16,559
instrument which is a laser altimeter

588
00:23:21,110 --> 00:23:18,640

that fires laser beams down to the

589
00:23:24,310 --> 00:23:21,120
surface reflects that and has it come

590
00:23:26,870 --> 00:23:24,320
back up then we can make that time delay

591
00:23:29,190 --> 00:23:26,880
measurement tells us how deep they are

592
00:23:32,470 --> 00:23:29,200
now they're the normal deep craters and

593
00:23:36,549 --> 00:23:32,480
craters are uh have a variety of depth

594
00:23:38,470 --> 00:23:36,559
from uh you know meters to kilometers in

595
00:23:40,310 --> 00:23:38,480
in in size and they're all over the

596
00:23:42,070 --> 00:23:40,320
place in terms of their depth but

597
00:23:44,549 --> 00:23:42,080
they're the normal craters they just are

598
00:23:46,710 --> 00:23:44,559
in an unusually important place

599
00:23:50,149 --> 00:23:46,720
north and south pole where the sun don't

600
00:23:54,549 --> 00:23:52,070
all right now we're going to move on to

601
00:23:56,149 --> 00:23:54,559
uh dr thomas waters from the center for

602
00:23:58,549 --> 00:23:56,159
earth and planetary studies here at the

603
00:24:00,470 --> 00:23:58,559
museum and tom is going to talk to us

604
00:24:02,470 --> 00:24:00,480
about some of the surprising discoveries

605
00:24:04,950 --> 00:24:02,480
that elrock has made and also give us

606
00:24:07,590 --> 00:24:04,960
more of a tour of the elrock exhibit a

607
00:24:08,950 --> 00:24:07,600
new moon rises and the l rock itself yes

608
00:24:11,269 --> 00:24:08,960
which i really

609
00:24:13,110 --> 00:24:11,279
for those of you who that are here i

610
00:24:16,070 --> 00:24:13,120
really do invite you to go up onto the

611
00:24:18,470 --> 00:24:16,080
second floor and and visit the the new

612
00:24:20,070 --> 00:24:18,480
gallery we have over 60

613
00:24:22,630 --> 00:24:20,080

prints

614
00:24:24,390 --> 00:24:22,640
of various landscapes on the moon which

615
00:24:25,909 --> 00:24:24,400
is again one of the things that we did

616
00:24:27,590 --> 00:24:25,919
this exhibit for

617
00:24:29,110 --> 00:24:27,600
was really

618
00:24:32,070 --> 00:24:29,120
we want to teach you something about the

619
00:24:34,230 --> 00:24:32,080
moon but we really want you to walk in

620
00:24:36,149 --> 00:24:34,240
there and just be

621
00:24:38,230 --> 00:24:36,159
surprised by the beauty of the

622
00:24:40,549 --> 00:24:38,240
landscapes of the moon because you don't

623
00:24:42,870 --> 00:24:40,559
really get to see those just looking at

624
00:24:44,149 --> 00:24:42,880
the up the moon at the sky aiming with a

625
00:24:46,470 --> 00:24:44,159
telescope

626
00:24:49,190 --> 00:24:46,480
you really need this perspective from

627
00:24:50,630 --> 00:24:49,200
the spacecraft that lro has given us and

628
00:24:53,350 --> 00:24:50,640
and that's one of the great things about

629
00:24:56,149 --> 00:24:53,360
the lunar reconnaissance orbiter camera

630
00:24:58,830 --> 00:24:56,159
it has really allowed us to see the moon

631
00:25:01,990 --> 00:24:58,840
in ways that we just never were able to

632
00:25:03,269 --> 00:25:02,000
see it before

633
00:25:06,310 --> 00:25:03,279
and it's

634
00:25:07,909 --> 00:25:06,320
a real team effort and i'll move to my

635
00:25:10,789 --> 00:25:07,919
next slide here but i'll talk a little

636
00:25:13,269 --> 00:25:10,799
bit about the cameras

637
00:25:15,430 --> 00:25:13,279
we talk about elrock as a camera but

638
00:25:16,950 --> 00:25:15,440

it's actually three cameras there's

639
00:25:19,909 --> 00:25:16,960
actually two

640
00:25:21,669 --> 00:25:19,919
telescopic cameras on board and these

641
00:25:25,269 --> 00:25:21,679
are literally as i said they're

642
00:25:27,190 --> 00:25:25,279
telescopes they're taking very very high

643
00:25:28,549 --> 00:25:27,200
resolution images

644
00:25:31,110 --> 00:25:28,559
of the moon

645
00:25:33,590 --> 00:25:31,120
as jim was saying they can resolve

646
00:25:35,830 --> 00:25:33,600
features that are on the scale of some

647
00:25:38,710 --> 00:25:35,840
of the smaller objects in this gallery i

648
00:25:43,190 --> 00:25:38,720
mean we literally can image the surface

649
00:25:44,789 --> 00:25:43,200
at less than uh at around 30 centimeters

650
00:25:46,789 --> 00:25:44,799
in some cases

651
00:25:48,710 --> 00:25:46,799
which is a foot and a half again it's

652
00:25:50,710 --> 00:25:48,720
it's amazing these are the pixel scales

653
00:25:53,269 --> 00:25:50,720
we're talking about

654
00:25:54,950 --> 00:25:53,279
we also have the wide angle camera and

655
00:25:56,950 --> 00:25:54,960
the wide angle camera as i mentioned

656
00:25:58,390 --> 00:25:56,960
before has a series of filters where we

657
00:26:00,950 --> 00:25:58,400
can sample

658
00:26:02,390 --> 00:26:00,960
the visible spectrum and part of the uv

659
00:26:05,269 --> 00:26:02,400
spectrum and that's to help us

660
00:26:09,990 --> 00:26:05,279
understand the chemical nuances of the

661
00:26:14,230 --> 00:26:12,230
just want to point out again that

662
00:26:17,750 --> 00:26:14,240
there's an enormous effort that goes

663
00:26:19,909 --> 00:26:17,760

into bringing these images back

664
00:26:21,029 --> 00:26:19,919
and the ones that we have in the gallery

665
00:26:23,029 --> 00:26:21,039
i mean

666
00:26:26,470 --> 00:26:23,039
i can't emphasize enough we're talking

667
00:26:28,870 --> 00:26:26,480
about hundreds of engineers technicians

668
00:26:32,390 --> 00:26:28,880
scientists that are involved in the

669
00:26:34,470 --> 00:26:32,400
design building testing of all these

670
00:26:35,990 --> 00:26:34,480
cameras before they're ever flown and

671
00:26:38,710 --> 00:26:36,000
this is a picture

672
00:26:41,110 --> 00:26:38,720
here of the the narrow angle cameras the

673
00:26:43,430 --> 00:26:41,120
telescopic cameras the two of them

674
00:26:46,149 --> 00:26:43,440
and the wide-angle camera being tested

675
00:26:50,950 --> 00:26:46,159
at the mail and space science systems uh

676
00:26:56,630 --> 00:26:53,590
in addition to that again there's a team

677
00:26:59,990 --> 00:26:56,640
of people led by dr mark robinson at the

678
00:27:01,909 --> 00:27:00,000
arizona state university mark is the

679
00:27:03,269 --> 00:27:01,919
principal investigator of the lroc

680
00:27:06,230 --> 00:27:03,279
camera i have the

681
00:27:08,390 --> 00:27:06,240
great honor of being part of his team

682
00:27:11,830 --> 00:27:08,400
and his team consists of many many

683
00:27:14,789 --> 00:27:11,840
people again scientists technicians

684
00:27:16,950 --> 00:27:14,799
all of which work very hard to bring you

685
00:27:18,630 --> 00:27:16,960
the images that i'm going to show you

686
00:27:22,950 --> 00:27:18,640
and that are also

687
00:27:26,149 --> 00:27:25,269
so here's one of the remarkable things

688
00:27:29,350 --> 00:27:26,159

about

689
00:27:32,830 --> 00:27:29,360
lro and elrock in general

690
00:27:37,350 --> 00:27:32,840
we are literally sending or

691
00:27:38,950 --> 00:27:37,360
receiving 440 gigabits of image data a

692
00:27:40,549 --> 00:27:38,960
day

693
00:27:41,510 --> 00:27:40,559
that's

694
00:27:42,630 --> 00:27:41,520
about

695
00:27:45,510 --> 00:27:42,640
60

696
00:27:47,750 --> 00:27:45,520
gigabytes of data a day

697
00:27:49,750 --> 00:27:47,760
coming back from the moon right now the

698
00:27:51,430 --> 00:27:49,760
narrow angle camera

699
00:27:53,909 --> 00:27:51,440
those two those two cameras have

700
00:27:55,750 --> 00:27:53,919
returned well over a million images of

701
00:27:58,950 --> 00:27:55,760
the surface of the moon

702
00:28:00,950 --> 00:27:58,960
it's just an incredible data set

703
00:28:02,470 --> 00:28:00,960
in fact if you give us enough time and i

704
00:28:04,070 --> 00:28:02,480
say this to jim green because he has to

705
00:28:06,149 --> 00:28:04,080
approve our extended mission at some

706
00:28:07,590 --> 00:28:06,159
point uh if we stay in orbit long enough

707
00:28:10,070 --> 00:28:07,600
and somebody asked that question about

708
00:28:11,990 --> 00:28:10,080
how long lro can stay in orbit in fact

709
00:28:14,470 --> 00:28:12,000
we can stay in orbit as jim was saying

710
00:28:16,789 --> 00:28:14,480
for a very very long time if we're in

711
00:28:19,830 --> 00:28:16,799
orbit long enough we will be able to map

712
00:28:20,710 --> 00:28:19,840
the entire surface of the moon

713
00:28:24,070 --> 00:28:20,720

at

714
00:28:27,510 --> 00:28:24,080
half a meter to two meters per pixel

715
00:28:29,830 --> 00:28:27,520
it will be an incredible data set it's

716
00:28:30,950 --> 00:28:29,840
already we're already well on our way to

717
00:28:33,110 --> 00:28:30,960
it

718
00:28:34,470 --> 00:28:33,120
and then the wide angle camera also

719
00:28:38,070 --> 00:28:34,480
produces

720
00:28:41,430 --> 00:28:38,080
a more synoptic view of the moon

721
00:28:44,710 --> 00:28:41,440
and gives us these great again global

722
00:28:45,990 --> 00:28:44,720
views um that we can then again image

723
00:28:47,909 --> 00:28:46,000
the moon with different lighting

724
00:28:49,990 --> 00:28:47,919
geometries which again if you go to the

725
00:28:52,710 --> 00:28:50,000
gallery you will you will see

726
00:28:55,190 --> 00:28:52,720
and this is just an example of the again

727
00:28:57,269 --> 00:28:55,200
jim showed this of one of the landing

728
00:28:59,669 --> 00:28:57,279
sites this is apollo 11 and you can see

729
00:29:01,909 --> 00:28:59,679
the detail

730
00:29:05,990 --> 00:29:01,919
on the surface of where the astronauts

731
00:29:10,710 --> 00:29:08,070
okay so what are some of the big

732
00:29:12,389 --> 00:29:10,720
surprises

733
00:29:14,870 --> 00:29:12,399
because here we've got this wonderful

734
00:29:17,110 --> 00:29:14,880
spacecraft we've got these great

735
00:29:19,269 --> 00:29:17,120
telescopic cameras that are imaging the

736
00:29:20,630 --> 00:29:19,279
moon at resolutions never before

737
00:29:22,630 --> 00:29:20,640
possible

738
00:29:24,389 --> 00:29:22,640

so really what were some of the things

739
00:29:27,110 --> 00:29:24,399
that really

740
00:29:29,669 --> 00:29:27,120
surprised us well again just looking at

741
00:29:31,669 --> 00:29:29,679
these images you can see again we were

742
00:29:33,590 --> 00:29:31,679
talking about craters there are craters

743
00:29:35,669 --> 00:29:33,600
of every size

744
00:29:37,190 --> 00:29:35,679
from very very small

745
00:29:40,070 --> 00:29:37,200
you know

746
00:29:41,430 --> 00:29:40,080
craters again smaller than the the size

747
00:29:43,190 --> 00:29:41,440
of this podium

748
00:29:45,350 --> 00:29:43,200
to craters that are

749
00:29:47,350 --> 00:29:45,360
hundreds to thousands of kilometers

750
00:29:50,070 --> 00:29:47,360
across so the moon

751
00:29:52,630 --> 00:29:50,080
really has preserved this incredible

752
00:29:55,669 --> 00:29:52,640
record of of impacts

753
00:29:57,669 --> 00:29:55,679
so one of the questions is

754
00:30:01,269 --> 00:29:57,679
are there impacts going on on the moon

755
00:30:05,269 --> 00:30:02,389
and

756
00:30:06,310 --> 00:30:05,279
what we do to really answer that

757
00:30:08,870 --> 00:30:06,320
question

758
00:30:10,389 --> 00:30:08,880
is to look at these very high resolution

759
00:30:12,950 --> 00:30:10,399
images we know

760
00:30:15,430 --> 00:30:12,960
in fact from earth-based observations

761
00:30:16,549 --> 00:30:15,440
there have been

762
00:30:21,590 --> 00:30:16,559
flashes

763
00:30:23,750 --> 00:30:21,600

that we have tried to and we assume are

764
00:30:25,669 --> 00:30:23,760
connected to the formation of a new

765
00:30:28,789 --> 00:30:25,679
impact crater

766
00:30:31,110 --> 00:30:28,799
but we didn't really have the the again

767
00:30:34,830 --> 00:30:31,120
the means to really determine how many

768
00:30:36,630 --> 00:30:34,840
of those and how big they were until

769
00:30:38,470 --> 00:30:36,640
elrock

770
00:30:40,149 --> 00:30:38,480
this is just an example yes and the

771
00:30:41,190 --> 00:30:40,159
answer to the question is yes the moon

772
00:30:47,190 --> 00:30:41,200
is still

773
00:30:49,830 --> 00:30:47,200
some reasonable size objects again

774
00:30:53,110 --> 00:30:49,840
here's just an example of an impact

775
00:30:55,990 --> 00:30:53,120
crater that literally was formed

776
00:30:58,630 --> 00:30:56,000
between the time lro got into orbit and

777
00:31:01,990 --> 00:31:00,950
set this is a before and after

778
00:31:03,990 --> 00:31:02,000
picture

779
00:31:05,909 --> 00:31:04,000
so it's just amazing and this is not a

780
00:31:08,389 --> 00:31:05,919
small impact feature i mean again you

781
00:31:10,789 --> 00:31:08,399
can see the scale bar there this this

782
00:31:12,389 --> 00:31:10,799
impact crater is probably 15 to 20

783
00:31:14,710 --> 00:31:12,399
meters across

784
00:31:17,190 --> 00:31:14,720
i mean it's a fairly good size object a

785
00:31:18,389 --> 00:31:17,200
fairly good size impact in fact

786
00:31:21,509 --> 00:31:18,399
we have found

787
00:31:24,389 --> 00:31:21,519
more than 200 new impact craters on the

788
00:31:25,750 --> 00:31:24,399

moon just again from the time we got

789
00:31:27,269 --> 00:31:25,760
into orbit

790
00:31:29,509 --> 00:31:27,279
and now

791
00:31:33,029 --> 00:31:29,519
and those are ranging in size from as

792
00:31:35,190 --> 00:31:33,039
much as a meter and a half to

793
00:31:36,789 --> 00:31:35,200
40 meters i mean again think of that

794
00:31:38,389 --> 00:31:36,799
that's almost the size of a you know

795
00:31:39,990 --> 00:31:38,399
half the size of a football field in

796
00:31:42,470 --> 00:31:40,000
diameter

797
00:31:45,669 --> 00:31:42,480
so it's really helping us to really

798
00:31:47,509 --> 00:31:45,679
understand what that rate of new impacts

799
00:31:48,950 --> 00:31:47,519
are on the moon

800
00:31:51,830 --> 00:31:48,960
much better than we were ever able to

801
00:31:52,950 --> 00:31:51,840
determine it before

802
00:31:54,549 --> 00:31:52,960
well what about

803
00:31:56,389 --> 00:31:54,559
other kinds of

804
00:31:58,830 --> 00:31:56,399
geologic activity

805
00:32:01,750 --> 00:31:58,840
volcanic activity is always a good one

806
00:32:05,029 --> 00:32:01,760
well the moon was a very very active it

807
00:32:07,190 --> 00:32:05,039
was very very active volcanically um

808
00:32:09,430 --> 00:32:07,200
early in its history all those dark

809
00:32:11,110 --> 00:32:09,440
areas you see the big dark areas on the

810
00:32:13,430 --> 00:32:11,120
near side of the moon that you see again

811
00:32:15,590 --> 00:32:13,440
when you look up at the moon those dark

812
00:32:16,870 --> 00:32:15,600
areas are dark because they're filled

813
00:32:19,590 --> 00:32:16,880

with lava

814
00:32:21,909 --> 00:32:19,600
that literally lava flows

815
00:32:24,470 --> 00:32:21,919
flowed in and filled these very very

816
00:32:28,070 --> 00:32:24,480
large basins and that happened billions

817
00:32:31,830 --> 00:32:28,080
of years ago but the real question is is

818
00:32:36,789 --> 00:32:34,070
and the answer is no it did not end

819
00:32:39,190 --> 00:32:36,799
there we thought it did up until lro got

820
00:32:41,509 --> 00:32:39,200
into orbit we were pretty sure that the

821
00:32:44,549 --> 00:32:41,519
last major volcanic activity on the moon

822
00:32:47,430 --> 00:32:44,559
happened well over a billion years ago

823
00:32:48,630 --> 00:32:47,440
now we've found all these

824
00:32:51,269 --> 00:32:48,640
small

825
00:32:54,149 --> 00:32:51,279
patches of smooth volcanic

826
00:32:56,230 --> 00:32:54,159
flows that fill these sort of low-lying

827
00:32:57,590 --> 00:32:56,240
young areas and they appear to be very

828
00:32:59,750 --> 00:32:57,600
young and the reason they appear to be

829
00:33:03,190 --> 00:32:59,760
very young is when you look at them you

830
00:33:05,029 --> 00:33:03,200
see very very few impact craters on them

831
00:33:07,590 --> 00:33:05,039
and that's the indicator if they've got

832
00:33:10,389 --> 00:33:07,600
very few impact craters they're not very

833
00:33:12,470 --> 00:33:10,399
old

834
00:33:14,549 --> 00:33:12,480
and in fact

835
00:33:16,389 --> 00:33:14,559
because of that lack of superimposed

836
00:33:18,789 --> 00:33:16,399
impact craters

837
00:33:21,190 --> 00:33:18,799
it really suggests that these young

838
00:33:24,310 --> 00:33:21,200

volcanic features are less than 100

839
00:33:25,669 --> 00:33:24,320
million years old now that sounds like

840
00:33:27,750 --> 00:33:25,679
gee what are you talking about 100

841
00:33:31,029 --> 00:33:27,760
million years old

842
00:33:33,509 --> 00:33:31,039
in geologic terms that's really young

843
00:33:36,310 --> 00:33:33,519
in fact it's so young

844
00:33:38,470 --> 00:33:36,320
that it wouldn't be at all impossible

845
00:33:44,310 --> 00:33:38,480
for volcanic activity

846
00:33:49,909 --> 00:33:47,430
okay here's my favorite

847
00:33:51,509 --> 00:33:49,919
is the moon shrinking

848
00:33:54,310 --> 00:33:51,519
okay so why would we think the moon is

849
00:33:56,389 --> 00:33:54,320
shrinking at all well

850
00:33:59,110 --> 00:33:56,399
before lro

851
00:34:00,070 --> 00:33:59,120
and elroc the those these fantastic

852
00:34:02,310 --> 00:34:00,080
images

853
00:34:04,630 --> 00:34:02,320
we knew there were evidence of

854
00:34:06,230 --> 00:34:04,640
contraction on the moon things where the

855
00:34:07,430 --> 00:34:06,240
moon was getting squeezed together

856
00:34:09,750 --> 00:34:07,440
locally

857
00:34:12,310 --> 00:34:09,760
and this was all coming from evidence

858
00:34:14,310 --> 00:34:12,320
from these kind of ridges these what we

859
00:34:16,389 --> 00:34:14,320
call wrinkle ridges and they're

860
00:34:19,109 --> 00:34:16,399
literally formed as the volcanic

861
00:34:20,550 --> 00:34:19,119
material that flooded those

862
00:34:23,990 --> 00:34:20,560
big basins

863
00:34:26,310 --> 00:34:24,000

get squeezed and pushed into ridges

864
00:34:28,230 --> 00:34:26,320
but they're really pretty old they

865
00:34:31,030 --> 00:34:28,240
probably formed

866
00:34:34,470 --> 00:34:31,040
billions of years ago not long after and

867
00:34:36,710 --> 00:34:34,480
maybe even while these volcanic planes

868
00:34:38,310 --> 00:34:36,720
these volcanic flows were filling the

869
00:34:40,629 --> 00:34:38,320
basins

870
00:34:42,550 --> 00:34:40,639
so we knew there was that evidence of

871
00:34:45,510 --> 00:34:42,560
contraction but

872
00:34:48,710 --> 00:34:45,520
what was really a surprise

873
00:34:50,710 --> 00:34:48,720
to me was the discovery of these very

874
00:34:52,950 --> 00:34:50,720
small scarps

875
00:34:55,270 --> 00:34:52,960
these features that are literally being

876
00:34:57,270 --> 00:34:55,280
formed because the crust of the moon is

877
00:34:59,190 --> 00:34:57,280
being squeezed together and it breaks

878
00:35:01,030 --> 00:34:59,200
and it literally gets pushed one part of

879
00:35:03,750 --> 00:35:01,040
the crust gets pushed up over the other

880
00:35:05,829 --> 00:35:03,760
forming this fault scarp

881
00:35:08,550 --> 00:35:05,839
and in fact

882
00:35:09,589 --> 00:35:08,560
we've now found thousands of these

883
00:35:11,190 --> 00:35:09,599
faults

884
00:35:14,069 --> 00:35:11,200
all over the moon

885
00:35:15,510 --> 00:35:14,079
that really are telling us that the moon

886
00:35:16,710 --> 00:35:15,520
has to be

887
00:35:19,109 --> 00:35:16,720
shrinking

888
00:35:21,670 --> 00:35:19,119

in fact again these faults these these

889
00:35:23,910 --> 00:35:21,680
scarps are so young

890
00:35:25,910 --> 00:35:23,920
that it's really very very likely that

891
00:35:28,630 --> 00:35:25,920
they are actively forming on the moon

892
00:35:32,870 --> 00:35:31,109
okay so lastly well okay so the moon's

893
00:35:34,710 --> 00:35:32,880
shrinking why is the moon shrinking

894
00:35:37,190 --> 00:35:34,720
what's going on well

895
00:35:38,230 --> 00:35:37,200
it turns out that the interior of the

896
00:35:39,990 --> 00:35:38,240
moon

897
00:35:43,190 --> 00:35:40,000
is still hot

898
00:35:46,230 --> 00:35:43,200
the moon's outer liquid core is still

899
00:35:48,950 --> 00:35:46,240
as i said liquid so it's cooling down as

900
00:35:51,109 --> 00:35:48,960
it cools down it contracts and shrinks

901
00:35:51,910 --> 00:35:51,119
and then the whole moon has to adjust to

902
00:35:55,990 --> 00:35:51,920
that

903
00:35:57,829 --> 00:35:56,000
causing it to shrink but the other thing

904
00:35:59,510 --> 00:35:57,839
that we found out by looking at these

905
00:36:01,190 --> 00:35:59,520
thousands of faults

906
00:36:04,069 --> 00:36:01,200
is that there's something else helping

907
00:36:05,349 --> 00:36:04,079
it to shrink and that turns out to be

908
00:36:11,270 --> 00:36:05,359
earth

909
00:36:12,950 --> 00:36:11,280
working and stressing the moon in such a

910
00:36:15,030 --> 00:36:12,960
way that they are contributing to the

911
00:36:17,670 --> 00:36:15,040
shrinking of the moon and it's just

912
00:36:19,510 --> 00:36:17,680
another example of again how intimate

913
00:36:22,069 --> 00:36:19,520

that relationship between the earth and

914
00:36:23,910 --> 00:36:22,079
the moon is that even today

915
00:36:26,870 --> 00:36:23,920
billions of years after the moon has

916
00:36:28,950 --> 00:36:26,880
formed the earth is still helping to

917
00:36:31,190 --> 00:36:28,960
shape the moon

918
00:36:33,990 --> 00:36:31,200
now stop there

919
00:36:35,910 --> 00:36:34,000
all right thank you tom and uh as as

920
00:36:37,430 --> 00:36:35,920
before we are open for questions from

921
00:36:39,990 --> 00:36:37,440
the audience if you want to step up to

922
00:36:42,230 --> 00:36:40,000
the mic if you have a question um i'll

923
00:36:44,710 --> 00:36:42,240
start by throwing out the first question

924
00:36:46,790 --> 00:36:44,720
uh so what is the the end game of a

925
00:36:47,910 --> 00:36:46,800
shrinking moon where are we headed with

926
00:36:52,630 --> 00:36:47,920
that

927
00:36:54,310 --> 00:36:52,640
if the moon is in fact shrinking and

928
00:36:56,150 --> 00:36:54,320
again we have this evidence from these

929
00:36:59,109 --> 00:36:56,160
thousands of small faults but they are

930
00:37:00,870 --> 00:36:59,119
small faults that's the good news so the

931
00:37:02,790 --> 00:37:00,880
amount of shrinking that the moon is

932
00:37:05,109 --> 00:37:02,800
doing is actually

933
00:37:07,349 --> 00:37:05,119
relatively small you don't have to worry

934
00:37:10,550 --> 00:37:07,359
that the moon is going to shrink away

935
00:37:11,349 --> 00:37:10,560
and disappear that will not happen

936
00:37:12,470 --> 00:37:11,359
but

937
00:37:14,710 --> 00:37:12,480
it is

938
00:37:16,870 --> 00:37:14,720

probably going to continue to shrink as

939
00:37:18,470 --> 00:37:16,880
long as that interior

940
00:37:20,790 --> 00:37:18,480
is hot

941
00:37:22,710 --> 00:37:20,800
and you have the tidal forces working

942
00:37:25,030 --> 00:37:22,720
with that that cooling

943
00:37:25,829 --> 00:37:25,040
only in despicable me did it really get

944
00:37:27,750 --> 00:37:25,839
smaller

945
00:37:31,430 --> 00:37:27,760
yes

946
00:37:33,510 --> 00:37:31,440
that's the extreme of the shrinking moon

947
00:37:35,270 --> 00:37:33,520
all right okay we have an online

948
00:37:37,430 --> 00:37:35,280
question

949
00:37:40,230 --> 00:37:37,440
what geological processes powered

950
00:37:42,710 --> 00:37:40,240
volcanic activity on the moon

951
00:37:45,829 --> 00:37:42,720
that's a great question um

952
00:37:46,870 --> 00:37:45,839
it is pretty much the same process uh

953
00:37:54,310 --> 00:37:46,880
that

954
00:37:57,030 --> 00:37:54,320
heating from the interior the interior

955
00:37:59,829 --> 00:37:57,040
is heated enough that the

956
00:38:02,710 --> 00:37:59,839
interior rock begins to melt and that

957
00:38:05,510 --> 00:38:02,720
that melting expands

958
00:38:07,510 --> 00:38:05,520
the material and it has to it wants to

959
00:38:09,589 --> 00:38:07,520
reach the surface it wants to get out

960
00:38:12,310 --> 00:38:09,599
from the from the interior of the body

961
00:38:15,030 --> 00:38:12,320
so that's what really drives it it's

962
00:38:17,670 --> 00:38:15,040
it's the internal heat of the moon both

963
00:38:19,829 --> 00:38:17,680

in the past which was also helped by the

964
00:38:21,589 --> 00:38:19,839
fact that the moon was hit in

965
00:38:23,109 --> 00:38:21,599
in the ancient

966
00:38:25,670 --> 00:38:23,119
volcanic

967
00:38:27,990 --> 00:38:25,680
activity on the moon was helped by the

968
00:38:31,270 --> 00:38:28,000
fact that it was hit by these very very

969
00:38:33,589 --> 00:38:31,280
very big asteroidal size objects that

970
00:38:35,589 --> 00:38:33,599
also help to heat the crust and and

971
00:38:36,630 --> 00:38:35,599
create volcanic activity

972
00:38:38,069 --> 00:38:36,640
okay

973
00:38:39,589 --> 00:38:38,079
all right we have a few questions from

974
00:38:40,790 --> 00:38:39,599
the audience now

975
00:38:43,750 --> 00:38:40,800
all right so

976
00:38:46,950 --> 00:38:43,760
uh by far how many miles of the moon has

977
00:38:49,990 --> 00:38:46,960
elrock taking pictures of

978
00:38:52,550 --> 00:38:50,000
how much of air how much of the moon has

979
00:38:54,870 --> 00:38:52,560
oh okay um that's a great question

980
00:38:56,870 --> 00:38:54,880
the wide angle camera has imaged the

981
00:38:59,270 --> 00:38:56,880
entire moon except for the permanently

982
00:39:01,430 --> 00:38:59,280
shadowed areas that jim was referring to

983
00:39:03,750 --> 00:39:01,440
which we can't really see

984
00:39:06,710 --> 00:39:03,760
easily but the wide-angle camera

985
00:39:09,270 --> 00:39:06,720
literally produces a global view of the

986
00:39:11,510 --> 00:39:09,280
moon every month

987
00:39:14,710 --> 00:39:11,520
now the narrow angle camera the one the

988
00:39:17,270 --> 00:39:14,720

telescopic cameras they take almost it

989
00:39:19,109 --> 00:39:17,280
looks like a postage stamp on the moon

990
00:39:21,190 --> 00:39:19,119
it's a very very small area because

991
00:39:22,550 --> 00:39:21,200
you're taking very very high resolution

992
00:39:24,630 --> 00:39:22,560
images

993
00:39:28,150 --> 00:39:24,640
those take a long time we're probably

994
00:39:30,310 --> 00:39:28,160
right now at about 70 percent of the

995
00:39:33,190 --> 00:39:30,320
surface of the moon that has been imaged

996
00:39:35,349 --> 00:39:33,200
with the narrow angle camera

997
00:39:38,150 --> 00:39:35,359
so we've got a ways to go

998
00:39:40,790 --> 00:39:38,160
yeah the moon's a big place yes

999
00:39:43,589 --> 00:39:40,800
so imagine it being in orbit for six or

1000
00:39:49,270 --> 00:39:43,599
more years and still we have 30 percent

1001
00:39:55,190 --> 00:39:51,910
if the moon is shrinking

1002
00:39:58,390 --> 00:39:55,200
how much could it shrink before it would

1003
00:39:59,510 --> 00:39:58,400
affect the relationship of the earth and

1004
00:40:02,150 --> 00:39:59,520
the moon

1005
00:40:05,030 --> 00:40:02,160
and the tides and the gravitational

1006
00:40:06,470 --> 00:40:05,040
pulls and tugs that's also that's an

1007
00:40:08,870 --> 00:40:06,480
excellent question

1008
00:40:11,910 --> 00:40:08,880
the fact is that that even though the

1009
00:40:13,990 --> 00:40:11,920
moon is shrinking by a small amount by

1010
00:40:15,829 --> 00:40:14,000
by every measure that we have right now

1011
00:40:17,109 --> 00:40:15,839
from the population of these small

1012
00:40:19,510 --> 00:40:17,119
faults

1013
00:40:22,550 --> 00:40:19,520

it isn't changing the mass

1014
00:40:24,470 --> 00:40:22,560
so it's only changing the the diameter

1015
00:40:26,550 --> 00:40:24,480
of the moon by by a small amount and

1016
00:40:28,390 --> 00:40:26,560
that will continue to be the case again

1017
00:40:31,589 --> 00:40:28,400
over the next

1018
00:40:34,550 --> 00:40:31,599
probably billions of years as that outer

1019
00:40:36,550 --> 00:40:34,560
liquid core continues to cool down so

1020
00:40:38,870 --> 00:40:36,560
but the mass of the moon will not change

1021
00:40:40,710 --> 00:40:38,880
so it really shouldn't affect the tides

1022
00:40:42,550 --> 00:40:40,720
what is really going to be the bigger

1023
00:40:44,630 --> 00:40:42,560
effect is the fact that the moon is

1024
00:40:47,510 --> 00:40:44,640
receding away from the earth

1025
00:40:50,950 --> 00:40:47,520
is that that earth moon distance is not

1026
00:40:53,510 --> 00:40:50,960
constant and it's those tidal forces

1027
00:40:55,750 --> 00:40:53,520
that are coming from not only the earth

1028
00:40:58,470 --> 00:40:55,760
creating tides on the physical tides on

1029
00:40:59,829 --> 00:40:58,480
the moon but the moon trying to slowly

1030
00:41:02,309 --> 00:40:59,839
recede away

1031
00:41:04,230 --> 00:41:02,319
that will have that kind of an effect on

1032
00:41:05,670 --> 00:41:04,240
on earth's tides

1033
00:41:07,349 --> 00:41:05,680
i think it does that by about a

1034
00:41:10,430 --> 00:41:07,359
centimeter or so

1035
00:41:13,990 --> 00:41:10,440
a year it's very slow yes about

1036
00:41:17,030 --> 00:41:14,000
3.8 centimeters a year that the moon is

1037
00:41:18,870 --> 00:41:17,040
getting further away from the earth

1038
00:41:20,470 --> 00:41:18,880

okay we have another question from an

1039
00:41:22,790 --> 00:41:20,480
online viewer

1040
00:41:26,230 --> 00:41:22,800
how does the camera on lro compared to

1041
00:41:31,750 --> 00:41:29,990
wow that's a great question um in fact

1042
00:41:34,550 --> 00:41:31,760
it depends on which camera we're talking

1043
00:41:37,589 --> 00:41:34,560
about the wide angle camera is kind of

1044
00:41:38,470 --> 00:41:37,599
more like your the the charge coupled

1045
00:41:41,750 --> 00:41:38,480
device

1046
00:41:43,670 --> 00:41:41,760
that's in your cell phone um so

1047
00:41:45,670 --> 00:41:43,680
they're very similar

1048
00:41:47,910 --> 00:41:45,680
the narrow angle camera

1049
00:41:49,589 --> 00:41:47,920
those those two telescopic cameras are

1050
00:41:52,309 --> 00:41:49,599
very different

1051
00:41:55,430 --> 00:41:52,319
they are literally like line scanners

1052
00:41:58,630 --> 00:41:55,440
they scan only a strip of the moon at a

1053
00:41:59,510 --> 00:41:58,640
time and it's literally the motion of

1054
00:42:08,550 --> 00:41:59,520
the

1055
00:42:11,829 --> 00:42:08,560
and

1056
00:42:13,670 --> 00:42:11,839
the the the actually fairly low orbit

1057
00:42:15,829 --> 00:42:13,680
that we're in around the moon the right

1058
00:42:18,790 --> 00:42:15,839
now the lunar constants orbiter only

1059
00:42:23,430 --> 00:42:18,800
gets probably about 150 kilometers away

1060
00:42:27,510 --> 00:42:24,550
we have another question from the

1061
00:42:31,829 --> 00:42:29,589
how is the data sent from

1062
00:42:34,230 --> 00:42:31,839
the lro

1063
00:42:36,790 --> 00:42:34,240

earth and

1064
00:42:38,950 --> 00:42:36,800
what are the biggest challenges

1065
00:42:40,710 --> 00:42:38,960
sending the data back to earth

1066
00:42:42,790 --> 00:42:40,720
i'm sorry the first question was how far

1067
00:42:46,309 --> 00:42:42,800
is sent back to earth oh how is the data

1068
00:42:48,150 --> 00:42:46,319
sent back okay uh this is also that also

1069
00:42:52,150 --> 00:42:48,160
a great question because you

1070
00:42:53,829 --> 00:42:52,160
when you're getting 440 gigabits of data

1071
00:42:55,430 --> 00:42:53,839
a day um

1072
00:42:57,109 --> 00:42:55,440
you've got to have a sort of special

1073
00:42:59,109 --> 00:42:57,119
relationship because most of the data

1074
00:43:00,790 --> 00:42:59,119
that's returned and jim can explain this

1075
00:43:02,630 --> 00:43:00,800
better than i can

1076
00:43:04,870 --> 00:43:02,640
all the data that's returned from any

1077
00:43:07,349 --> 00:43:04,880
planetary

1078
00:43:09,270 --> 00:43:07,359
mission is coming through a series of

1079
00:43:11,990 --> 00:43:09,280
antennas that are distributed around the

1080
00:43:13,910 --> 00:43:12,000
earth called the deep space network

1081
00:43:16,550 --> 00:43:13,920
and those allow us again during

1082
00:43:19,109 --> 00:43:16,560
different times to communicate with

1083
00:43:20,950 --> 00:43:19,119
again every every spacecraft that we

1084
00:43:23,270 --> 00:43:20,960
have operating

1085
00:43:25,750 --> 00:43:23,280
in the solar system right now we are

1086
00:43:29,670 --> 00:43:25,760
very fortunate with lro that we have a

1087
00:43:32,950 --> 00:43:29,680
dedicated 70 meter antenna

1088
00:43:34,230 --> 00:43:32,960

that is literally ours uh for the most

1089
00:43:37,349 --> 00:43:34,240
part um

1090
00:43:39,270 --> 00:43:37,359
to collects that data so um

1091
00:43:41,670 --> 00:43:39,280
it's the only way literally we could we

1092
00:43:43,349 --> 00:43:41,680
could get that much data back

1093
00:43:45,589 --> 00:43:43,359
now that technology is going to change

1094
00:43:47,910 --> 00:43:45,599
in the future because currently uh

1095
00:43:49,750 --> 00:43:47,920
that's done with radio waves and there's

1096
00:43:53,510 --> 00:43:49,760
only so much information you can bring

1097
00:43:55,510 --> 00:43:53,520
down with a radio wave the next big step

1098
00:43:57,990 --> 00:43:55,520
is optical communication where the

1099
00:43:59,910 --> 00:43:58,000
wavelengths are much smaller

1100
00:44:02,069 --> 00:43:59,920
and now we can transfer much more

1101
00:44:04,069 --> 00:44:02,079
information so we're looking ahead to

1102
00:44:05,270 --> 00:44:04,079
the future developing a variety of

1103
00:44:07,990 --> 00:44:05,280
techniques

1104
00:44:09,750 --> 00:44:08,000
where we're going to go perhaps to mars

1105
00:44:12,550 --> 00:44:09,760
or out into

1106
00:44:15,270 --> 00:44:12,560
places farther than the moon and send

1107
00:44:16,710 --> 00:44:15,280
that data back in light and we'll use a

1108
00:44:18,230 --> 00:44:16,720
telescope

1109
00:44:20,470 --> 00:44:18,240
to receive it

1110
00:44:23,750 --> 00:44:20,480
all right we have another question from

1111
00:44:27,510 --> 00:44:23,760
an online viewer

1112
00:44:34,630 --> 00:44:30,790
also very good question we have uh again

1113
00:44:36,710 --> 00:44:34,640

the advantage of being in in lunar orbit

1114
00:44:37,710 --> 00:44:36,720
so you're only

1115
00:44:40,950 --> 00:44:37,720
about

1116
00:44:43,349 --> 00:44:40,960
283 million miles away from the earth so

1117
00:44:45,990 --> 00:44:43,359
you're really not that far away and so

1118
00:44:48,470 --> 00:44:46,000
we use solar panels

1119
00:44:50,710 --> 00:44:48,480
there are solar panels on the spacecraft

1120
00:44:53,829 --> 00:44:50,720
that literally provide all the power it

1121
00:44:55,190 --> 00:44:53,839
needs to operate

1122
00:44:57,670 --> 00:44:55,200
all right and a question from the

1123
00:44:59,510 --> 00:44:57,680
audience now is the earth acting as a

1124
00:45:01,190 --> 00:44:59,520
tidal force on the moon because um the

1125
00:45:03,829 --> 00:45:01,200
moon is facing the earth always in the

1126
00:45:05,030 --> 00:45:03,839
same way so the other way around the

1127
00:45:07,510 --> 00:45:05,040
earth

1128
00:45:09,270 --> 00:45:07,520
rotates and then it sends ripple effects

1129
00:45:11,270 --> 00:45:09,280
through the earth but with the moon that

1130
00:45:12,950 --> 00:45:11,280
shouldn't be the case

1131
00:45:14,550 --> 00:45:12,960
well okay i think if i understand your

1132
00:45:17,190 --> 00:45:14,560
question right it's it's it's a great

1133
00:45:19,750 --> 00:45:17,200
question because most people think of

1134
00:45:22,309 --> 00:45:19,760
when they think of the effect the moon

1135
00:45:25,430 --> 00:45:22,319
has on the earth they think of again

1136
00:45:27,270 --> 00:45:25,440
obviously the tides i mean the ties rise

1137
00:45:28,870 --> 00:45:27,280
and fall and it's it's the moon but it's

1138
00:45:30,790 --> 00:45:28,880

also the sun it's the interaction

1139
00:45:33,910 --> 00:45:30,800
between the two

1140
00:45:36,069 --> 00:45:33,920
but many people don't realize that the

1141
00:45:39,030 --> 00:45:36,079
earth exerts

1142
00:45:41,430 --> 00:45:39,040
solid body tides on the moon so the moon

1143
00:45:44,150 --> 00:45:41,440
doesn't have a body of water but its

1144
00:45:47,349 --> 00:45:44,160
crust is actually pulled

1145
00:45:49,750 --> 00:45:47,359
a little bit it's about at maximum about

1146
00:45:52,870 --> 00:45:49,760
30 centimeters or so

1147
00:45:54,710 --> 00:45:52,880
if it were a body of water you know so

1148
00:45:57,910 --> 00:45:54,720
it's not going to be much

1149
00:46:01,270 --> 00:45:57,920
but it's enough that you literally build

1150
00:46:05,030 --> 00:46:01,280
up stresses from that flexing motion

1151
00:46:06,950 --> 00:46:05,040
again coming from the tidal interactions

1152
00:46:08,790 --> 00:46:06,960
but there's not really any motion

1153
00:46:10,309 --> 00:46:08,800
because um the moon is always facing the

1154
00:46:13,109 --> 00:46:10,319
earth in the same direction right so

1155
00:46:14,870 --> 00:46:13,119
it's oh okay yes but it is yes but it's

1156
00:46:16,710 --> 00:46:14,880
kind of like again it's kind of like

1157
00:46:18,790 --> 00:46:16,720
that one diagram i showed where it's

1158
00:46:20,470 --> 00:46:18,800
being pulled in one direction and then

1159
00:46:21,829 --> 00:46:20,480
it's relaxed

1160
00:46:23,910 --> 00:46:21,839
and then it's pulled again but you're

1161
00:46:27,109 --> 00:46:23,920
right it's always that

1162
00:46:29,990 --> 00:46:27,119
it's always the what we call the sub

1163
00:46:32,710 --> 00:46:30,000

earth point and the anti-sub earth point

1164
00:46:34,870 --> 00:46:32,720
it's all happening around that

1165
00:46:37,750 --> 00:46:34,880
one of the ways to think about it is of

1166
00:46:39,910 --> 00:46:37,760
course some the closer uh these two

1167
00:46:42,550 --> 00:46:39,920
objects are together the stronger that

1168
00:46:45,190 --> 00:46:42,560
tide is the moon is in an elliptical

1169
00:46:47,670 --> 00:46:45,200
orbit it's not circular so as it goes

1170
00:46:49,750 --> 00:46:47,680
around it actually is getting that tugs

1171
00:46:52,150 --> 00:46:49,760
and pulls that constant dissipation of

1172
00:46:53,990 --> 00:46:52,160
that heat that has to go on then another

1173
00:46:56,470 --> 00:46:54,000
thing happens it actually is trying to

1174
00:46:58,230 --> 00:46:56,480
turn on us like this and that's called

1175
00:47:00,470 --> 00:46:58,240
liberation and we can actually see a

1176
00:47:03,589 --> 00:47:00,480
little more than half the moon

1177
00:47:04,390 --> 00:47:03,599
from earth and that also is a tug and

1178
00:47:06,309 --> 00:47:04,400
pull

1179
00:47:08,710 --> 00:47:06,319
uh between the earth and the moon that

1180
00:47:11,190 --> 00:47:08,720
that that heat has to be dissipated too

1181
00:47:13,910 --> 00:47:11,200
yep all right great thanks another

1182
00:47:16,309 --> 00:47:13,920
online question

1183
00:47:18,230 --> 00:47:16,319
if lro is in orbit around earth what

1184
00:47:21,190 --> 00:47:18,240
could we see what would it show us about

1185
00:47:25,750 --> 00:47:24,309
that's a really interesting question um

1186
00:47:29,190 --> 00:47:25,760
i i think

1187
00:47:29,990 --> 00:47:29,200
that the as powerful as the cameras are

1188
00:47:32,230 --> 00:47:30,000

uh

1189
00:47:35,750 --> 00:47:32,240
especially the telescopic telescopic

1190
00:47:40,390 --> 00:47:35,760
cameras on lro um

1191
00:47:42,950 --> 00:47:40,400
they are uh probably not as powerful as

1192
00:47:44,549 --> 00:47:42,960
some of the cameras that are being flown

1193
00:47:46,230 --> 00:47:44,559
on satellites

1194
00:47:49,349 --> 00:47:46,240
uh that are looking at the earth right

1195
00:47:51,990 --> 00:47:49,359
now um that can probably see down to

1196
00:47:53,990 --> 00:47:52,000
several centimeters as opposed to tens

1197
00:47:56,710 --> 00:47:54,000
of centimeters

1198
00:47:58,069 --> 00:47:56,720
you know um one of the really iconic

1199
00:48:00,470 --> 00:47:58,079
images

1200
00:48:02,390 --> 00:48:00,480
that was uh created by one of the apollo

1201
00:48:05,270 --> 00:48:02,400
astronauts as they were orbiting the

1202
00:48:06,390 --> 00:48:05,280
moon was to watch the earth rise above

1203
00:48:08,230 --> 00:48:06,400
the moon

1204
00:48:11,510 --> 00:48:08,240
you know the beautiful

1205
00:48:13,990 --> 00:48:11,520
ocean world earth and it was a view that

1206
00:48:15,829 --> 00:48:14,000
we've never really thought of before and

1207
00:48:18,390 --> 00:48:15,839
it was so captivating

1208
00:48:20,630 --> 00:48:18,400
lro sees that also

1209
00:48:21,430 --> 00:48:20,640
and can make beautiful images of the

1210
00:48:24,870 --> 00:48:21,440
earth

1211
00:48:28,470 --> 00:48:24,880
uh rising above the moon the contrast is

1212
00:48:31,349 --> 00:48:28,480
incredibly striking okay this is the

1213
00:48:32,390 --> 00:48:31,359

blue marble carl sagan called the ocean

1214
00:48:34,870 --> 00:48:32,400
world

1215
00:48:36,710 --> 00:48:34,880
and i i really like what buzz aldrin

1216
00:48:39,589 --> 00:48:36,720
said as he walked around on the surface

1217
00:48:41,829 --> 00:48:39,599
of the moon he he really appreciated the

1218
00:48:44,710 --> 00:48:41,839
vistas and how much different they were

1219
00:48:46,230 --> 00:48:44,720
and he called the moon a magnificent

1220
00:48:48,309 --> 00:48:46,240
desolate

1221
00:48:50,390 --> 00:48:48,319
and so when you were in the museum

1222
00:48:52,549 --> 00:48:50,400
upstairs and you walk around and you see

1223
00:48:55,030 --> 00:48:52,559
the beautiful images think about that

1224
00:48:56,309 --> 00:48:55,040
contrast

1225
00:48:58,790 --> 00:48:56,319
and we have another question from the

1226
00:49:00,630 --> 00:48:58,800
audience hi my name is anna samuels and

1227
00:49:03,190 --> 00:49:00,640
i'm a student at arizona state

1228
00:49:05,750 --> 00:49:03,200
university with friends in the asu

1229
00:49:07,750 --> 00:49:05,760
lunar thing um i have a question so is

1230
00:49:10,790 --> 00:49:07,760
there any possibility in the future

1231
00:49:11,990 --> 00:49:10,800
after the lro finishes in the moon could

1232
00:49:14,309 --> 00:49:12,000
it go to

1233
00:49:16,390 --> 00:49:14,319
say mars or a different planet to

1234
00:49:17,349 --> 00:49:16,400
investigate

1235
00:49:19,109 --> 00:49:17,359
pictures

1236
00:49:22,230 --> 00:49:19,119
okay i can easily answer yes i was going

1237
00:49:24,549 --> 00:49:22,240
to legitimate lro will live out its life

1238
00:49:25,829 --> 00:49:24,559

at the moon it will eventually run out

1239
00:49:27,829 --> 00:49:25,839
of fuel

1240
00:49:30,549 --> 00:49:27,839
and depending on its orbit and there's

1241
00:49:33,030 --> 00:49:30,559
only a few orientations of that orbit

1242
00:49:35,190 --> 00:49:33,040
that actually are stable it'll more than

1243
00:49:37,589 --> 00:49:35,200
likely end up in an orbit for which the

1244
00:49:39,190 --> 00:49:37,599
moon will eventually bring it down and

1245
00:49:42,829 --> 00:49:39,200
it will crash

1246
00:49:48,950 --> 00:49:46,710
lro we have another online question

1247
00:49:50,150 --> 00:49:48,960
are the cameras on lro black and white

1248
00:49:52,069 --> 00:49:50,160
or color

1249
00:49:54,069 --> 00:49:52,079
and maybe you could also clarify the

1250
00:49:55,990 --> 00:49:54,079
non-visible wavelengths that these

1251
00:49:57,270 --> 00:49:56,000
cameras also see in

1252
00:49:59,430 --> 00:49:57,280
well

1253
00:50:01,030 --> 00:49:59,440
it's a very good question again we have

1254
00:50:02,870 --> 00:50:01,040
um

1255
00:50:04,630 --> 00:50:02,880
said between the two different cameras

1256
00:50:06,069 --> 00:50:04,640
the narrow angle camera and the wide

1257
00:50:07,910 --> 00:50:06,079
angle camera

1258
00:50:11,750 --> 00:50:07,920
um

1259
00:50:16,230 --> 00:50:13,349
ways of looking at the moon and the

1260
00:50:18,630 --> 00:50:16,240
narrow angle cameras look strictly

1261
00:50:20,710 --> 00:50:18,640
in uh are black and white so those

1262
00:50:23,190 --> 00:50:20,720
images are literally what just one

1263
00:50:25,030 --> 00:50:23,200

channel we're sampling just one area of

1264
00:50:26,870 --> 00:50:25,040
the visible spectra

1265
00:50:29,349 --> 00:50:26,880
a spectrum to get

1266
00:50:31,589 --> 00:50:29,359
those images

1267
00:50:33,349 --> 00:50:31,599
the wide angle camera again has a series

1268
00:50:36,150 --> 00:50:33,359
of filters which

1269
00:50:37,990 --> 00:50:36,160
sort of slice the visible spectrum up

1270
00:50:40,950 --> 00:50:38,000
into

1271
00:50:42,870 --> 00:50:40,960
sample areas that we then take those

1272
00:50:47,750 --> 00:50:42,880
separate images to put together to

1273
00:50:51,270 --> 00:50:49,430
the channels that matt was just talking

1274
00:50:53,270 --> 00:50:51,280
about we also see out a little bit

1275
00:50:55,750 --> 00:50:53,280
outside of the visible spectrum into the

1276
00:50:58,150 --> 00:50:55,760
uv which is where the

1277
00:50:59,750 --> 00:50:58,160
human eye is not sensitive and again

1278
00:51:03,670 --> 00:50:59,760
that helps us

1279
00:51:05,510 --> 00:51:03,680
to look at specific sort of

1280
00:51:09,430 --> 00:51:05,520
characteristics again of the of the

1281
00:51:11,190 --> 00:51:09,440
materials particularly water

1282
00:51:13,349 --> 00:51:11,200
you know one of the great features about

1283
00:51:15,270 --> 00:51:13,359
lro is the ability for us to be able to

1284
00:51:17,270 --> 00:51:15,280
combine the data from several

1285
00:51:19,430 --> 00:51:17,280
instruments and as you're up walking

1286
00:51:22,470 --> 00:51:19,440
around in the gallery you'll see some

1287
00:51:24,069 --> 00:51:22,480
really beautifully strikingly colored

1288
00:51:25,589 --> 00:51:24,079

images

1289
00:51:26,549 --> 00:51:25,599
deep reds and

1290
00:51:28,150 --> 00:51:26,559
and

1291
00:51:30,870 --> 00:51:28,160
deep blues

1292
00:51:33,670 --> 00:51:30,880
that actually is altitude data that

1293
00:51:36,549 --> 00:51:33,680
comes from one of the other instruments

1294
00:51:38,630 --> 00:51:36,559
called lola this is the lunar

1295
00:51:41,109 --> 00:51:38,640
laser altimeter

1296
00:51:43,349 --> 00:51:41,119
and and that is all about sending radio

1297
00:51:46,470 --> 00:51:43,359
or sorry the laser light down to the

1298
00:51:49,109 --> 00:51:46,480
surface having it reflect coming back

1299
00:51:51,750 --> 00:51:49,119
to the instrument timing that

1300
00:51:54,309 --> 00:51:51,760
and if you're closer the time is shorter

1301
00:51:56,790 --> 00:51:54,319
if you're further away it's longer and

1302
00:51:59,910 --> 00:51:56,800
that information then gets translated

1303
00:52:01,589 --> 00:51:59,920
into an altitude and when you map that

1304
00:52:02,390 --> 00:52:01,599
onto

1305
00:52:07,589 --> 00:52:02,400
the

1306
00:52:10,069 --> 00:52:07,599
data you see those beautiful highs and

1307
00:52:12,150 --> 00:52:10,079
lows the crater rims the deep valleys

1308
00:52:14,150 --> 00:52:12,160
the basins and you really get an

1309
00:52:16,309 --> 00:52:14,160
appreciation of

1310
00:52:18,549 --> 00:52:16,319
of the variation in the altitude on the

1311
00:52:20,630 --> 00:52:18,559
moon and it's huge

1312
00:52:23,109 --> 00:52:20,640
the back side of the moon there's that

1313
00:52:25,430 --> 00:52:23,119

place called the south pole aiken basin

1314
00:52:26,710 --> 00:52:25,440
it's a huge impact region

1315
00:52:29,349 --> 00:52:26,720
and so when you go up there and you look

1316
00:52:31,109 --> 00:52:29,359
at it it's very dark blue that means

1317
00:52:34,069 --> 00:52:31,119
it's very low

1318
00:52:37,270 --> 00:52:34,079
it's about 15 kilometers

1319
00:52:38,069 --> 00:52:37,280
in out in in in depth

1320
00:52:40,069 --> 00:52:38,079
which

1321
00:52:42,549 --> 00:52:40,079
if you go to the earth where can you

1322
00:52:44,069 --> 00:52:42,559
find a place of that out of that

1323
00:52:46,150 --> 00:52:44,079
latitude or

1324
00:52:48,790 --> 00:52:46,160
altitude difference you have to go to

1325
00:52:50,630 --> 00:52:48,800
the top of mount everest and the bottom

1326
00:52:53,589 --> 00:52:50,640
of the marianas trench

1327
00:52:55,990 --> 00:52:53,599
in the ocean to get anywhere near

1328
00:52:59,349 --> 00:52:56,000
that variation in height and yet it's

1329
00:53:00,710 --> 00:52:59,359
common on the back side of the moon

1330
00:53:02,630 --> 00:53:00,720
all right and we have an audience

1331
00:53:07,910 --> 00:53:02,640
question

1332
00:53:11,670 --> 00:53:07,920
dust now without environmental erosion

1333
00:53:13,910 --> 00:53:11,680
is it created by impact pulverization

1334
00:53:15,750 --> 00:53:13,920
yeah the dust is created by impacts over

1335
00:53:18,150 --> 00:53:15,760
and over and over and you take the

1336
00:53:20,549 --> 00:53:18,160
silicate material that's there and you

1337
00:53:22,069 --> 00:53:20,559
shatter it and and when you look at it

1338
00:53:24,150 --> 00:53:22,079

we brought it back and when you look at

1339
00:53:25,589 --> 00:53:24,160
it under the microscope it's really

1340
00:53:29,190 --> 00:53:25,599
spiky

1341
00:53:31,190 --> 00:53:29,200
and actually uh when when

1342
00:53:33,109 --> 00:53:31,200
we found out about that

1343
00:53:34,790 --> 00:53:33,119
that actually can be a hazards to our

1344
00:53:36,950 --> 00:53:34,800
astronauts walking around because if

1345
00:53:39,270 --> 00:53:36,960
that gets into the lungs it can really

1346
00:53:40,150 --> 00:53:39,280
tear up the alveoli and really cause

1347
00:53:41,670 --> 00:53:40,160
some

1348
00:53:42,549 --> 00:53:41,680
lung damage

1349
00:53:44,790 --> 00:53:42,559
so

1350
00:53:46,950 --> 00:53:44,800
understanding the processes that create

1351
00:53:49,990 --> 00:53:46,960
that regulate understanding its

1352
00:53:52,069 --> 00:53:50,000
composition its distribution uh and

1353
00:53:53,430 --> 00:53:52,079
that's that's what

1354
00:53:57,109 --> 00:53:53,440
as i mentioned

1355
00:53:59,349 --> 00:53:57,119
the mini rf is all about on lro yeah the

1356
00:54:01,510 --> 00:53:59,359
moon is constantly again because it has

1357
00:54:02,549 --> 00:54:01,520
no atmosphere the moon is constantly

1358
00:54:05,190 --> 00:54:02,559
being hit

1359
00:54:08,150 --> 00:54:05,200
by some large objects but it's also

1360
00:54:11,829 --> 00:54:08,160
being hit by micro meteorites almost i

1361
00:54:13,030 --> 00:54:11,839
said constantly and that is its primary

1362
00:54:15,109 --> 00:54:13,040
erosive

1363
00:54:17,349 --> 00:54:15,119

power is is

1364
00:54:20,150 --> 00:54:17,359
just this constant relentless

1365
00:54:23,670 --> 00:54:21,750
we're going to take one more online

1366
00:54:26,630 --> 00:54:23,680
question

1367
00:54:29,030 --> 00:54:26,640
will data from elrock help plan future

1368
00:54:30,470 --> 00:54:29,040
landing sites for the moon

1369
00:54:32,390 --> 00:54:30,480
absolutely

1370
00:54:34,470 --> 00:54:32,400
in fact there's a number of space

1371
00:54:37,030 --> 00:54:34,480
agencies

1372
00:54:40,549 --> 00:54:37,040
that have asked us for high resolution

1373
00:54:44,470 --> 00:54:40,559
data the indian space

1374
00:54:46,870 --> 00:54:44,480
agency now is planning a lunar lander

1375
00:54:49,430 --> 00:54:46,880
they need the kind of data that we have

1376
00:54:51,829 --> 00:54:49,440
created and they are considering several

1377
00:54:53,990 --> 00:54:51,839
sites and and that that data is

1378
00:54:55,750 --> 00:54:54,000
available to them like it is everyone

1379
00:54:56,870 --> 00:54:55,760
else in the united states because it's

1380
00:54:58,069 --> 00:54:56,880
online

1381
00:55:00,870 --> 00:54:58,079
so this

1382
00:55:03,510 --> 00:55:00,880
forms a a really important resource for

1383
00:55:05,910 --> 00:55:03,520
all these agencies to use great

1384
00:55:08,390 --> 00:55:05,920
well thank you both for being here and

1385
00:55:10,150 --> 00:55:08,400
sharing all this information about lro

1386
00:55:12,309 --> 00:55:10,160
and the lunar reconnaissance orbiter

1387
00:55:15,510 --> 00:55:12,319
camera and thank you all for coming