

COLLECTING A SAMPLE FROM
ASTEROID
BENNU



MONDAY, OCTOBER 19th 5:00 p.m. EDT

Live Q&A with NASA's Dr. Z and Dr. Glaze

Submit your questions using [#ToBennuAndBack](#)

1
00:00:52,229 --> 00:00:49,750
hey this is dr thomas c from lockheed

2
00:00:54,709 --> 00:00:52,239
martin in littleton colorado and there's

3
00:00:57,350 --> 00:00:54,719
energy in the air it's t minus one just

4
00:01:01,029 --> 00:00:57,360
about 24 hours before

5
00:01:06,230 --> 00:01:01,039
this live broadcast starts off the tag

6
00:01:09,910 --> 00:01:08,390
um and i'm dr laurie glaze i'm the

7
00:01:12,710 --> 00:01:09,920
director of the planetary science

8
00:01:15,990 --> 00:01:12,720
division at nasa headquarters and we are

9
00:01:18,550 --> 00:01:16,000
really looking forward to this big event

10
00:01:21,350 --> 00:01:18,560
and we're sitting here with a virgil

11
00:01:23,910 --> 00:01:21,360
massive social and we're answering

12
00:01:26,630 --> 00:01:23,920
questions that you submit with kyle's

13
00:01:28,149 --> 00:01:26,640

back to bennu and back

14

00:01:29,270 --> 00:01:28,159

and we're going to start

15

00:01:31,270 --> 00:01:29,280

asking and

16

00:01:33,030 --> 00:01:31,280

actually answering questions and the

17

00:01:33,910 --> 00:01:33,040

first question we already received is

18

00:01:37,030 --> 00:01:33,920

from

19

00:01:39,350 --> 00:01:37,040

stephen martin what delay will there be

20

00:01:41,270 --> 00:01:39,360

in this signal lori that's a perfect

21

00:01:45,030 --> 00:01:41,280

question there's actually going to be

22

00:01:47,030 --> 00:01:45,040

about 18 and a half minutes of delay the

23

00:01:50,069 --> 00:01:47,040

asteroid bennu and the osiris-rex

24

00:01:52,950 --> 00:01:50,079

spacecraft are about 200 million miles

25

00:01:55,190 --> 00:01:52,960

away from earth and so it takes about 18

26

00:01:57,830 --> 00:01:55,200

and a half minutes for that signal to

27

00:01:59,749 --> 00:01:57,840

travel all the way back to earth so when

28

00:02:03,190 --> 00:01:59,759

we say that the tag event is going to

29

00:02:05,350 --> 00:02:03,200

happen at 6 12 p.m tomorrow

30

00:02:07,670 --> 00:02:05,360

on eastern time that's the time we

31

00:02:09,589 --> 00:02:07,680

actually receive that signal back so the

32

00:02:11,350 --> 00:02:09,599

tag will have happened about 18 and a

33

00:02:13,030 --> 00:02:11,360

half minutes before that

34

00:02:15,830 --> 00:02:13,040

but we'll get the information back here

35

00:02:17,030 --> 00:02:15,840

at 6 12 p.m telling us that the tag was

36

00:02:18,710 --> 00:02:17,040

successful

37

00:02:20,150 --> 00:02:18,720

i saw and say lori this is you know we

38

00:02:23,589 --> 00:02:20,160

learn in school about the speed of

39

00:02:26,390 --> 00:02:23,599

flight is it's like most of our lives

40

00:02:28,710 --> 00:02:26,400

the speed of light is so fast it never

41

00:02:30,390 --> 00:02:28,720

it never matters well it really matters

42

00:02:31,509 --> 00:02:30,400

yeah the speed of light feels really

43

00:02:33,990 --> 00:02:31,519

slowly

44

00:02:35,110 --> 00:02:34,000

if you get uh you know this kind of

45

00:02:37,190 --> 00:02:35,120

activity

46

00:02:38,070 --> 00:02:37,200

we cannot choice like this it has to be

47

00:02:40,390 --> 00:02:38,080

done

48

00:02:43,030 --> 00:02:40,400

autonomously but that here's the next

49

00:02:45,270 --> 00:02:43,040

question by norman gregory fernandez

50

00:02:47,750 --> 00:02:45,280

do you have on board spectrometers so

51
00:02:49,990 --> 00:02:47,760
you can at least get the chemical makeup

52
00:02:51,830 --> 00:02:50,000
of the object prior to sample returning

53
00:02:52,869 --> 00:02:51,840
glory that's a really really good

54
00:02:55,270 --> 00:02:52,879
question

55
00:02:57,110 --> 00:02:55,280
so the whole point of the sample return

56
00:02:59,190 --> 00:02:57,120
is to get those samples back here on

57
00:03:00,470 --> 00:02:59,200
earth so we can really analyze them in

58
00:03:03,190 --> 00:03:00,480
detail

59
00:03:06,149 --> 00:03:03,200
but before that we've spent the last

60
00:03:09,589 --> 00:03:06,159
almost two years orbiting bennett with

61
00:03:12,229 --> 00:03:09,599
the osiris-rex spacecraft mapping out

62
00:03:14,550 --> 00:03:12,239
the surface and yes we do carry a couple

63
00:03:16,949 --> 00:03:14,560

of spectrometers an ir spectrometer this

64

00:03:20,070 --> 00:03:16,959

infrared spectrometer and an x-ray

65

00:03:21,990 --> 00:03:20,080

spectrometer and those really help us to

66

00:03:24,390 --> 00:03:22,000

learn about the composition and what the

67

00:03:27,190 --> 00:03:24,400

makeup is of those rocks on the surface

68

00:03:29,030 --> 00:03:27,200

of venue in fact we found out some

69

00:03:31,430 --> 00:03:29,040

really information really interesting

70

00:03:33,990 --> 00:03:31,440

information from those spectrometers we

71

00:03:36,630 --> 00:03:34,000

already thought that manuals had a lot

72

00:03:38,309 --> 00:03:36,640

of carbon there on the surface and we've

73

00:03:39,350 --> 00:03:38,319

confirmed that yes there are these

74

00:03:42,390 --> 00:03:39,360

carbon

75

00:03:45,030 --> 00:03:42,400

bearing minerals uh organic molecules

76
00:03:46,630 --> 00:03:45,040
that are possibly the seeds for life and

77
00:03:52,550 --> 00:03:46,640
we've been able to identify those with

78
00:03:57,350 --> 00:03:55,270
with the same instruments actually

79
00:04:03,830 --> 00:03:57,360
what they call radiation age of a

80
00:04:07,190 --> 00:04:06,149
so it looks really fresh you know

81
00:04:09,509 --> 00:04:07,200
when the

82
00:04:11,270 --> 00:04:09,519
surface gets irradiated by the solar

83
00:04:13,110 --> 00:04:11,280
wind and the energetic particles that

84
00:04:15,830 --> 00:04:13,120
are out there in space

85
00:04:17,670 --> 00:04:15,840
that surface changes it's all so that

86
00:04:19,110 --> 00:04:17,680
the spectrometers are good enough to

87
00:04:21,189 --> 00:04:19,120
actually not even guess what the

88
00:04:23,909 --> 00:04:21,199

composition is overall but even assess

89

00:04:25,749 --> 00:04:23,919

what the age is and so for me that's

90

00:04:29,189 --> 00:04:25,759

just so we're prepared we're going to go

91

00:04:31,189 --> 00:04:29,199

into kind of a recently excavated crater

92

00:04:34,150 --> 00:04:31,199

so to say just even hundreds of

93

00:04:36,230 --> 00:04:34,160

thousands of years it's very very young

94

00:04:38,310 --> 00:04:36,240

as compared to the age of of course the

95

00:04:39,909 --> 00:04:38,320

earth and the solar system so yeah these

96

00:04:41,670 --> 00:04:39,919

instruments are really critical yeah and

97

00:04:44,310 --> 00:04:41,680

it's just amazing to me that we can

98

00:04:46,230 --> 00:04:44,320

using our instruments remotely not even

99

00:04:47,110 --> 00:04:46,240

touching the surface yet we can already

100

00:04:48,950 --> 00:04:47,120

tell

101
00:04:51,270 --> 00:04:48,960
you know generally just how old that

102
00:04:53,030 --> 00:04:51,280
that surface is just incredible

103
00:04:54,710 --> 00:04:53,040
all right so let's go to brian on

104
00:04:57,430 --> 00:04:54,720
twitter who asks

105
00:05:00,150 --> 00:04:57,440
does the head act as a vacuum

106
00:05:02,629 --> 00:05:00,160
and suck up samples or is there any

107
00:05:05,029 --> 00:05:02,639
drilling that happens right that is an

108
00:05:07,670 --> 00:05:05,039
outstanding question this is a really

109
00:05:10,550 --> 00:05:07,680
clever device that was developed here at

110
00:05:11,670 --> 00:05:10,560
lockheed martin in lilton colorado they

111
00:05:14,870 --> 00:05:11,680
developed this

112
00:05:16,629 --> 00:05:14,880
really basic simple uh

113
00:05:18,950 --> 00:05:16,639

head on this arm

114

00:05:21,110 --> 00:05:18,960

that acts like kind of a reverse vacuum

115

00:05:23,990 --> 00:05:21,120

cleaner it's actually really very basic

116

00:05:27,430 --> 00:05:24,000

with no really moving parts and very

117

00:05:30,150 --> 00:05:27,440

simple uh kind of design so that as the

118

00:05:33,110 --> 00:05:30,160

tag the touch and go head touches the

119

00:05:36,469 --> 00:05:33,120

surface of venue they're gonna fire up a

120

00:05:38,950 --> 00:05:36,479

nitrogen canister that blows nitrogen

121

00:05:40,710 --> 00:05:38,960

through and then it acts like um a

122

00:05:43,029 --> 00:05:40,720

reverse vacuum so

123

00:05:44,710 --> 00:05:43,039

uh that it puts pressure inside the head

124

00:05:46,469 --> 00:05:44,720

and then of course there's uh no

125

00:05:48,870 --> 00:05:46,479

pressure outside it's a vacuum and it

126
00:05:51,430 --> 00:05:48,880
wants to suck that nitrogen out and as

127
00:05:54,150 --> 00:05:51,440
it sucks the nitrogen out through this

128
00:05:56,950 --> 00:05:54,160
air filter it'll pull in those particles

129
00:05:58,550 --> 00:05:56,960
and deposit them inside that filter so

130
00:06:00,230 --> 00:05:58,560
that we can capture them and bring them

131
00:06:02,629 --> 00:06:00,240
back

132
00:06:04,390 --> 00:06:02,639
great explanation so let's go to ethan

133
00:06:06,870 --> 00:06:04,400
on twitter who asks

134
00:06:09,510 --> 00:06:06,880
what landing on the asteroid change the

135
00:06:11,510 --> 00:06:09,520
asteroid's trajectory that's a really

136
00:06:13,990 --> 00:06:11,520
interesting question and something that

137
00:06:16,790 --> 00:06:14,000
we think about a lot because as we think

138
00:06:20,150 --> 00:06:16,800

about uh maybe to potentially someday

139

00:06:21,990 --> 00:06:20,160

trying to move an asteroid or adjusted

140

00:06:23,670 --> 00:06:22,000

orbit and we want to understand those

141

00:06:27,029 --> 00:06:23,680

kinds of things of course

142

00:06:29,909 --> 00:06:27,039

but in this particular case benue is so

143

00:06:32,790 --> 00:06:29,919

big it is uh it's really quite a large

144

00:06:34,950 --> 00:06:32,800

asteroid it's about 500 meters across

145

00:06:36,150 --> 00:06:34,960

um so think about five football fields

146

00:06:36,950 --> 00:06:36,160

across

147

00:06:38,629 --> 00:06:36,960

and

148

00:06:40,390 --> 00:06:38,639

with the spacecraft is really fairly

149

00:06:43,510 --> 00:06:40,400

small compared to that the spacecraft is

150

00:06:45,990 --> 00:06:43,520

about the size of a 15 passenger van and

151
00:06:48,070 --> 00:06:46,000
so as it touches the surface of venue

152
00:06:49,909 --> 00:06:48,080
it's really only going to kiss it for

153
00:06:52,230 --> 00:06:49,919
just a couple of seconds and then back

154
00:06:54,710 --> 00:06:52,240
away and so just that combination of the

155
00:06:57,189 --> 00:06:54,720
very very small mass of the spacecraft

156
00:06:59,029 --> 00:06:57,199
relative to the asteroid and the fact

157
00:07:00,629 --> 00:06:59,039
that it really only touches it just for

158
00:07:03,189 --> 00:07:00,639
a very very short time it's going to

159
00:07:04,950 --> 00:07:03,199
have no impact on the trajectory of the

160
00:07:06,790 --> 00:07:04,960
asteroid so it's a really interesting

161
00:07:07,830 --> 00:07:06,800
question right because it's it's both

162
00:07:09,830 --> 00:07:07,840
about

163
00:07:12,790 --> 00:07:09,840

the fundamental physics and it's also

164

00:07:14,230 --> 00:07:12,800

about is it important what's happening

165

00:07:17,670 --> 00:07:14,240

so the answer is of course it won't

166

00:07:18,950 --> 00:07:17,680

change but it's such a tiny tiny tiny

167

00:07:20,710 --> 00:07:18,960

little bit

168

00:07:22,230 --> 00:07:20,720

that really it doesn't matter there's so

169

00:07:24,390 --> 00:07:22,240

many other things

170

00:07:26,550 --> 00:07:24,400

that are much more important for example

171

00:07:28,550 --> 00:07:26,560

the big rocks in the asteroid belt that

172

00:07:30,950 --> 00:07:28,560

are flying by some of them we don't even

173

00:07:33,830 --> 00:07:30,960

know how heavy they really are they're

174

00:07:36,469 --> 00:07:33,840

actually rattling on this uh on this

175

00:07:38,550 --> 00:07:36,479

penguin disaster a lot more

176

00:07:41,110 --> 00:07:38,560

than this particular landing board right

177

00:07:43,510 --> 00:07:41,120

so so just it's important physics work

178

00:07:46,070 --> 00:07:43,520

right yes of course it does

179

00:07:47,990 --> 00:07:46,080

but it's a tiny little bit it really

180

00:07:49,430 --> 00:07:48,000

doesn't matter as compared to all the

181

00:07:51,589 --> 00:07:49,440

other forces

182

00:07:53,029 --> 00:07:51,599

that are out there talking about forces

183

00:07:56,469 --> 00:07:53,039

here is a question

184

00:07:59,189 --> 00:07:56,479

by a cop star on twitter who asks what's

185

00:08:02,150 --> 00:07:59,199

the gravitational pull of such a small

186

00:08:03,749 --> 00:08:02,160

object spinning through space wow that's

187

00:08:05,830 --> 00:08:03,759

a really really good question and i

188

00:08:07,990 --> 00:08:05,840

don't know that i know the exact

189

00:08:09,589 --> 00:08:08,000

gravitational pull but it is really

190

00:08:11,430 --> 00:08:09,599

really small

191

00:08:13,350 --> 00:08:11,440

um you know compared to

192

00:08:15,749 --> 00:08:13,360

even the moon or other small bodies in

193

00:08:18,629 --> 00:08:15,759

the solar system the gravitational pull

194

00:08:21,510 --> 00:08:18,639

is really really uh low and so trying to

195

00:08:24,150 --> 00:08:21,520

navigate our spacecraft around uh this

196

00:08:25,430 --> 00:08:24,160

asteroid has really been a talent um

197

00:08:28,309 --> 00:08:25,440

because it's

198

00:08:29,670 --> 00:08:28,319

every little every little move uh is

199

00:08:36,550 --> 00:08:29,680

it's

200

00:08:37,829 --> 00:08:36,560

sorry i don't know the exact amount i

201
00:08:39,509 --> 00:08:37,839
have to go look that up it's a great

202
00:08:41,190 --> 00:08:39,519
question all right youngster here's a

203
00:08:44,630 --> 00:08:41,200
commitment to you we're going to give

204
00:08:45,910 --> 00:08:44,640
you on my twitter account which is dr

205
00:08:48,070 --> 00:08:45,920
thomas c

206
00:08:50,070 --> 00:08:48,080
we're going to give you the exact uh

207
00:08:51,750 --> 00:08:50,080
answer there but here's here's what

208
00:08:53,750 --> 00:08:51,760
actually is important and you didn't put

209
00:08:56,230 --> 00:08:53,760
it in your question and actually turns

210
00:08:57,990 --> 00:08:56,240
out it really matters where you are

211
00:08:59,509 --> 00:08:58,000
to assess that gravitational pull

212
00:09:02,310 --> 00:08:59,519
because of the fact that the object is

213
00:09:04,230 --> 00:09:02,320

so small remember it's it's big it's as

214

00:09:06,470 --> 00:09:04,240

big as the entire stone building you

215

00:09:09,110 --> 00:09:06,480

know in in height and even a little bit

216

00:09:09,910 --> 00:09:09,120

bigger around the midsection so if you

217

00:09:12,389 --> 00:09:09,920

say

218

00:09:15,110 --> 00:09:12,399

uh because of that you know if you stand

219

00:09:17,670 --> 00:09:15,120

where if you're right on the surface you

220

00:09:19,750 --> 00:09:17,680

have a given gravitational pull

221

00:09:21,590 --> 00:09:19,760

which is the number we're going to post

222

00:09:23,269 --> 00:09:21,600

but if you're farther back and you're

223

00:09:25,829 --> 00:09:23,279

coming in in orbit you're actually

224

00:09:28,310 --> 00:09:25,839

several you're farther back from that

225

00:09:30,710 --> 00:09:28,320

the gravitational pull goes down the

226
00:09:31,910 --> 00:09:30,720
force with one over the distance squared

227
00:09:34,230 --> 00:09:31,920
or so

228
00:09:35,670 --> 00:09:34,240
off the uh off the uh of the body

229
00:09:37,829 --> 00:09:35,680
standard once you go

230
00:09:40,230 --> 00:09:37,839
twice the distance it goes down to a

231
00:09:42,150 --> 00:09:40,240
fourth uh to 25

232
00:09:43,509 --> 00:09:42,160
of the force so it's a tiny little force

233
00:09:46,150 --> 00:09:43,519
it's breaking all the records we've

234
00:09:47,190 --> 00:09:46,160
never been in orbit and then the smaller

235
00:09:49,350 --> 00:09:47,200
object

236
00:09:50,870 --> 00:09:49,360
that uh the answer to give the answer

237
00:09:53,190 --> 00:09:50,880
we're just going to assume long distance

238
00:09:54,870 --> 00:09:53,200

just so we can answer it with one number

239

00:09:57,430 --> 00:09:54,880

as opposed to something bigger i hope

240

00:09:59,750 --> 00:09:57,440

that that uh helps topstar and i'm

241

00:10:02,069 --> 00:09:59,760

really glad for the question

242

00:10:04,790 --> 00:10:02,079

and here's ray on twitter who asks i

243

00:10:06,630 --> 00:10:04,800

want to know the process of how one

244

00:10:10,150 --> 00:10:06,640

determines something

245

00:10:11,590 --> 00:10:10,160

is 4.5 billion years old yes pick up the

246

00:10:13,910 --> 00:10:11,600

rack

247

00:10:16,069 --> 00:10:13,920

and say how old is that how do you know

248

00:10:18,550 --> 00:10:16,079

something is really really old that's a

249

00:10:20,230 --> 00:10:18,560

really good question and there's a

250

00:10:22,870 --> 00:10:20,240

couple of different techniques that are

251
00:10:25,269 --> 00:10:22,880
used um but one of the things that we

252
00:10:27,350 --> 00:10:25,279
can do is take some

253
00:10:29,350 --> 00:10:27,360
some elements that are present in some

254
00:10:31,829 --> 00:10:29,360
of these rocks actually

255
00:10:34,150 --> 00:10:31,839
are radioactive and decay over time and

256
00:10:36,150 --> 00:10:34,160
they change from one type of element to

257
00:10:37,269 --> 00:10:36,160
another type of element as they decay

258
00:10:39,750 --> 00:10:37,279
over time

259
00:10:41,829 --> 00:10:39,760
and by looking at the ratios of these

260
00:10:44,310 --> 00:10:41,839
various different elements it gives us a

261
00:10:45,670 --> 00:10:44,320
sense of just how much time that

262
00:10:47,430 --> 00:10:45,680
particular of the first element was

263
00:10:49,110 --> 00:10:47,440

there and how long it's had that time to

264

00:10:52,069 --> 00:10:49,120

decay and that's how we get a sense of

265

00:10:54,069 --> 00:10:52,079

just how old some of these rocks are

266

00:10:55,590 --> 00:10:54,079

yeah that's a really really good answer

267

00:10:57,350 --> 00:10:55,600

you know what's really what's really

268

00:10:59,269 --> 00:10:57,360

amazing if you look at nature there's

269

00:11:01,670 --> 00:10:59,279

all these clocks around right if you

270

00:11:04,870 --> 00:11:01,680

look at the tree trunk you see these

271

00:11:06,949 --> 00:11:04,880

you see these kind of yearly

272

00:11:08,710 --> 00:11:06,959

kind of rings which are come from slower

273

00:11:10,230 --> 00:11:08,720

and faster growth depending on what

274

00:11:12,310 --> 00:11:10,240

temperature it is you know especially if

275

00:11:15,350 --> 00:11:12,320

there's strong seasons that become even

276

00:11:17,350 --> 00:11:15,360

more just like a very large scale see

277

00:11:19,750 --> 00:11:17,360

the universe which is expanding which

278

00:11:22,069 --> 00:11:19,760

gives another time spell and then in the

279

00:11:24,710 --> 00:11:22,079

middle are these kind of claps these

280

00:11:27,269 --> 00:11:24,720

atomic clocks that really are going down

281

00:11:28,470 --> 00:11:27,279

that's also how we're kind of assessing

282

00:11:30,389 --> 00:11:28,480

for example

283

00:11:32,150 --> 00:11:30,399

how you know if you look at the outer

284

00:11:33,829 --> 00:11:32,160

atmosphere given

285

00:11:36,230 --> 00:11:33,839

a different element of that atmosphere

286

00:11:38,630 --> 00:11:36,240

how long is it there we can measure it

287

00:11:40,230 --> 00:11:38,640

by using the same kind of clock so it's

288

00:11:41,829 --> 00:11:40,240

just a really cool

289

00:11:43,350 --> 00:11:41,839

way of doing that so it's a whole bunch

290

00:11:44,630 --> 00:11:43,360

of things that depending on the question

291

00:11:47,350 --> 00:11:44,640

is you're using

292

00:11:49,110 --> 00:11:47,360

you need to write take the right clock

293

00:11:51,509 --> 00:11:49,120

well now that's what some of my favorite

294

00:11:53,829 --> 00:11:51,519

questions come from elementary school uh

295

00:12:02,150 --> 00:11:53,839

students from virginia who would like to

296

00:12:07,190 --> 00:12:05,350

that is such a good good question and

297

00:12:09,350 --> 00:12:07,200

there are lots of reasons why this

298

00:12:11,350 --> 00:12:09,360

mission is so important so i'll try to

299

00:12:13,670 --> 00:12:11,360

touch on some of these

300

00:12:15,910 --> 00:12:13,680

one of the first reasons is that the

301
00:12:18,870 --> 00:12:15,920
asteroids that are out there in space in

302
00:12:21,110 --> 00:12:18,880
the solar system are these remnants

303
00:12:23,030 --> 00:12:21,120
they're left over from when the solar

304
00:12:25,590 --> 00:12:23,040
system formed four and a half billion

305
00:12:27,910 --> 00:12:25,600
years ago and so by looking at the

306
00:12:29,750 --> 00:12:27,920
asteroids and studying that setting them

307
00:12:32,550 --> 00:12:29,760
under we can learn and start to

308
00:12:35,190 --> 00:12:32,560
understand what that material was that

309
00:12:37,110 --> 00:12:35,200
turned into and made our planets and so

310
00:12:39,190 --> 00:12:37,120
that's really really important and

311
00:12:41,190 --> 00:12:39,200
fundamental to understand

312
00:12:43,030 --> 00:12:41,200
what that material was

313
00:12:45,190 --> 00:12:43,040

another thing that's really important

314

00:12:47,269 --> 00:12:45,200

about this mission is i talked a little

315

00:12:49,590 --> 00:12:47,279

bit about the carbon molecules and the

316

00:12:51,590 --> 00:12:49,600

organic molecules that are present and

317

00:12:53,430 --> 00:12:51,600

the minerals that might have water tied

318

00:12:55,509 --> 00:12:53,440

up in those minerals

319

00:12:57,829 --> 00:12:55,519

asteroids are one way that those organic

320

00:12:59,670 --> 00:12:57,839

molecules and water molecules get

321

00:13:01,670 --> 00:12:59,680

delivered to earth when asteroids come

322

00:13:03,430 --> 00:13:01,680

in through our atmosphere and they

323

00:13:05,590 --> 00:13:03,440

impact on earth they bring water and

324

00:13:07,670 --> 00:13:05,600

organic molecules and those could be the

325

00:13:10,069 --> 00:13:07,680

things that started life

326

00:13:11,590 --> 00:13:10,079

you know some time ago and

327

00:13:13,350 --> 00:13:11,600

we want to understand what those

328

00:13:14,949 --> 00:13:13,360

building blocks look like and how they

329

00:13:16,790 --> 00:13:14,959

got to earth and how they might be

330

00:13:19,430 --> 00:13:16,800

distributed at other places and how does

331

00:13:21,269 --> 00:13:19,440

life actually form so that's the second

332

00:13:26,790 --> 00:13:21,279

really important reason

333

00:13:29,990 --> 00:13:26,800

sometimes these asteroids can be

334

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

dangerous to us here on earth sometimes

335

00:13:35,269 --> 00:13:33,120

they can come and intersect with our

336

00:13:37,350 --> 00:13:35,279

orbit around the sun at the same time

337

00:13:38,710 --> 00:13:37,360

we're there and if that happens if

338

00:13:41,509 --> 00:13:38,720

they're big enough that could be a

339

00:13:43,670 --> 00:13:41,519

problem it can cause a lot of damage and

340

00:13:45,430 --> 00:13:43,680

so we want to really understand these

341

00:13:47,350 --> 00:13:45,440

asteroids we want to understand how

342

00:13:49,350 --> 00:13:47,360

they're held together what kind of

343

00:13:51,670 --> 00:13:49,360

materials they're made out of what their

344

00:13:54,230 --> 00:13:51,680

trajectories are maybe how do they orbit

345

00:13:57,189 --> 00:13:54,240

around the sun so we can very precisely

346

00:13:59,990 --> 00:13:57,199

predict when and if they might intersect

347

00:14:03,189 --> 00:14:00,000

with earth and impact earth to help us

348

00:14:05,030 --> 00:14:03,199

better be prepared when that happens

349

00:14:05,829 --> 00:14:05,040

i love that answer i mean for me one of

350

00:14:08,470 --> 00:14:05,839

the

351

00:14:11,189 --> 00:14:08,480

things that i learned from really

352

00:14:14,310 --> 00:14:11,199

results from this mission is how

353

00:14:17,269 --> 00:14:14,320

the actual analysis of the astrolage

354

00:14:19,750 --> 00:14:17,279

itself really helps us understand how

355

00:14:22,230 --> 00:14:19,760

radiation shapes the orbit

356

00:14:23,590 --> 00:14:22,240

of of this particular object and then

357

00:14:25,990 --> 00:14:23,600

for our father so it really helps

358

00:14:29,030 --> 00:14:26,000

predict you know and if one of those

359

00:14:31,350 --> 00:14:29,040

bodies came heroin towards the earth

360

00:14:33,509 --> 00:14:31,360

it would give us a much better way of

361

00:14:35,430 --> 00:14:33,519

actually mourning people and move out of

362

00:14:38,230 --> 00:14:35,440

the way and really protect

363

00:14:40,389 --> 00:14:38,240

life you know for those kind of

364

00:14:42,389 --> 00:14:40,399

events that happen unfortunately from

365

00:14:44,230 --> 00:14:42,399

time to time yeah and in addition to

366

00:14:46,629 --> 00:14:44,240

helping us prepare so we can get out of

367

00:14:48,710 --> 00:14:46,639

the way which is very important

368

00:14:50,949 --> 00:14:48,720

if we know about them soon enough if we

369

00:14:52,870 --> 00:14:50,959

have a long enough warning

370

00:14:55,110 --> 00:14:52,880

we might even be able to

371

00:14:57,509 --> 00:14:55,120

send another spacecraft out that could

372

00:15:00,069 --> 00:14:57,519

make small tiny adjustments in the orbit

373

00:15:02,629 --> 00:15:00,079

of the asteroid so that when it crosses

374

00:15:04,230 --> 00:15:02,639

path we're not there and so that would

375

00:15:05,910 --> 00:15:04,240

be that would help keep us safe as well

376

00:15:07,110 --> 00:15:05,920

so there's a variety of things we could

377

00:15:08,629 --> 00:15:07,120

do

378

00:15:11,110 --> 00:15:08,639

have you ever

379

00:15:14,389 --> 00:15:11,120

done this bumped

380

00:15:16,230 --> 00:15:14,399

do that i'm um glad you asked um in fact

381

00:15:17,670 --> 00:15:16,240

we're in the process right now of

382

00:15:20,949 --> 00:15:17,680

building a mission that's gonna be the

383

00:15:24,310 --> 00:15:20,959

first ever test of how we can

384

00:15:26,550 --> 00:15:24,320

uh move or gently bump or nudge an

385

00:15:28,790 --> 00:15:26,560

asteroid out of the way and we actually

386

00:15:31,350 --> 00:15:28,800

have a mission called double asteroid

387

00:15:33,990 --> 00:15:31,360

redirection test uh that's going to

388

00:15:36,629 --> 00:15:34,000

launch next summer in 2021 and it's

389

00:15:38,710 --> 00:15:36,639

going to intersect with another asteroid

390

00:15:40,629 --> 00:15:38,720

called crowded

391

00:15:43,030 --> 00:15:40,639

and we're going to run through the front

392

00:15:44,790 --> 00:15:43,040

bottom to its little small moon and

393

00:15:46,629 --> 00:15:44,800

hopefully change its orbit we can test

394

00:15:48,870 --> 00:15:46,639

that technique and see just how well it

395

00:15:51,590 --> 00:15:48,880

works all right so why is it important

396

00:15:53,269 --> 00:15:51,600

number one it tells us about the history

397

00:15:55,269 --> 00:15:53,279

of the solar system

398

00:15:57,350 --> 00:15:55,279

number two it gives us important

399

00:16:00,389 --> 00:15:57,360

information about the history of life

400

00:16:02,629 --> 00:16:00,399

itself and number three it's useful

401
00:16:05,189 --> 00:16:02,639
because it helps us get better warning

402
00:16:07,990 --> 00:16:05,199
for objects that may hurt us on earth

403
00:16:10,389 --> 00:16:08,000
that in fact even potentially help us

404
00:16:13,350 --> 00:16:10,399
bump those out of the way based on the

405
00:16:15,670 --> 00:16:13,360
information we have exactly so here is

406
00:16:17,829 --> 00:16:15,680
uh a question from

407
00:16:21,509 --> 00:16:17,839
cosmo

408
00:16:24,310 --> 00:16:21,519
wow that's the most amazing name ever on

409
00:16:26,710 --> 00:16:24,320
twitter because mariositis scientists

410
00:16:29,189 --> 00:16:26,720
say that samples or cyrus rex will

411
00:16:30,790 --> 00:16:29,199
collect will be very important because

412
00:16:33,590 --> 00:16:30,800
they will reveal us a lot about

413
00:16:37,749 --> 00:16:33,600

information about our solar system

414

00:16:40,949 --> 00:16:37,759

but how will they do it can actually 60

415

00:16:42,550 --> 00:16:40,959

grams of rock and dust give us that much

416

00:16:45,269 --> 00:16:42,560

information

417

00:16:47,350 --> 00:16:45,279

yes so 60 grams doesn't sound like very

418

00:16:49,670 --> 00:16:47,360

much in fact i think if i remember

419

00:16:52,230 --> 00:16:49,680

correctly it's about two ounces it's

420

00:16:54,629 --> 00:16:52,240

about if you are holding a candy bar

421

00:16:57,189 --> 00:16:54,639

it's about as heavy as a candy bar so it

422

00:17:00,230 --> 00:16:57,199

doesn't seem like very much but actually

423

00:17:02,230 --> 00:17:00,240

this is going to be the biggest sample

424

00:17:04,789 --> 00:17:02,240

that we've collected

425

00:17:06,549 --> 00:17:04,799

in outer space except for the apollo

426

00:17:08,870 --> 00:17:06,559

samples where we had astronauts that

427

00:17:10,710 --> 00:17:08,880

picked up rocks on the surface of the of

428

00:17:12,390 --> 00:17:10,720

the moon so this is going to actually be

429

00:17:14,870 --> 00:17:12,400

the biggest sample we've brought back

430

00:17:17,750 --> 00:17:14,880

since apollo and there is actually an

431

00:17:21,829 --> 00:17:17,760

incredible amount we can

432

00:17:23,909 --> 00:17:21,839

grams and in fact even that 60 grams

433

00:17:27,829 --> 00:17:23,919

we're gonna put three quarters of that

434

00:17:30,070 --> 00:17:27,839

75 of that sample we're going to save it

435

00:17:31,669 --> 00:17:30,080

for our future for people to use in the

436

00:17:33,270 --> 00:17:31,679

future so this mission we're just going

437

00:17:36,470 --> 00:17:33,280

to look at a small part and we can look

438

00:17:38,950 --> 00:17:36,480

at little tiny brains we can look at

439

00:17:40,710 --> 00:17:38,960

all aspects and very tiny bits of that

440

00:17:42,789 --> 00:17:40,720

sample so it's really going to be

441

00:17:44,710 --> 00:17:42,799

amazing we'll take those little samples

442

00:17:46,310 --> 00:17:44,720

and we'll put them in our state

443

00:17:48,549 --> 00:17:46,320

state-of-the-art instruments that are

444

00:17:50,630 --> 00:17:48,559

here on earth um and we'll really be

445

00:17:53,909 --> 00:17:50,640

able to learn an incredible amount about

446

00:17:57,110 --> 00:17:53,919

what what makes up those rocks on dinner

447

00:17:59,510 --> 00:17:57,120

we had a mission called stardust quite a

448

00:18:00,390 --> 00:17:59,520

while ago and it brought back tiny

449

00:18:03,909 --> 00:18:00,400

little

450

00:18:07,270 --> 00:18:03,919

grains from a comet the first suction

451

00:18:09,430 --> 00:18:07,280

has you know grain samples to come back

452

00:18:11,590 --> 00:18:09,440

and those tiny little brand if you added

453

00:18:13,750 --> 00:18:11,600

them up i don't know where they were a

454

00:18:16,390 --> 00:18:13,760

single

455

00:18:18,789 --> 00:18:16,400

have to tell you there are you know many

456

00:18:21,110 --> 00:18:18,799

many different publications that came

457

00:18:22,950 --> 00:18:21,120

from that and one of the key reasons

458

00:18:25,510 --> 00:18:22,960

many people forget

459

00:18:27,669 --> 00:18:25,520

is the analysis techniques are so

460

00:18:29,270 --> 00:18:27,679

sophisticated

461

00:18:30,950 --> 00:18:29,280

scientists can basically take the

462

00:18:33,669 --> 00:18:30,960

tiniest amount

463

00:18:36,470 --> 00:18:33,679

of data and answer the questions

464

00:18:38,310 --> 00:18:36,480

of the topic that that we talked about

465

00:18:41,350 --> 00:18:38,320

earlier you know these compositional

466

00:18:43,669 --> 00:18:41,360

questions and so if you look at this uh

467

00:18:47,029 --> 00:18:43,679

you know what take a few sugar packs for

468

00:18:49,590 --> 00:18:47,039

like 30 super packs of of material

469

00:18:51,909 --> 00:18:49,600

there's a lot of samples there for many

470

00:18:53,430 --> 00:18:51,919

many years to come so we really look

471

00:18:56,070 --> 00:18:53,440

forward to that

472

00:18:58,789 --> 00:18:56,080

that's another question okay

473

00:19:00,870 --> 00:18:58,799

since this is a sample return mission

474

00:19:03,350 --> 00:19:00,880

are there any planetary protection

475

00:19:05,029 --> 00:19:03,360

measures that need to be put in place

476

00:19:06,870 --> 00:19:05,039

for this kind of mission do you mind

477

00:19:09,110 --> 00:19:06,880

first explaining what planet protection

478

00:19:11,590 --> 00:19:09,120

is and then answering the questions sure

479

00:19:14,710 --> 00:19:11,600

that's a really good question so when we

480

00:19:16,789 --> 00:19:14,720

talk about planetary protection uh this

481

00:19:19,830 --> 00:19:16,799

is an important topic um both

482

00:19:22,150 --> 00:19:19,840

scientifically and for people's health

483

00:19:24,789 --> 00:19:22,160

uh when we send a mission for example

484

00:19:27,190 --> 00:19:24,799

when we go to mars we want to be very

485

00:19:29,430 --> 00:19:27,200

careful that we don't contaminate mars

486

00:19:31,909 --> 00:19:29,440

with our with anything that came from

487

00:19:34,150 --> 00:19:31,919

earth so we want to protect that

488

00:19:36,950 --> 00:19:34,160

environment as well and when we bring

489

00:19:38,549 --> 00:19:36,960

samples back from some place like venu

490

00:19:41,510 --> 00:19:38,559

we want to make sure that if there's

491

00:19:42,390 --> 00:19:41,520

something there that might make us sick

492

00:19:44,870 --> 00:19:42,400

we want to make sure that we're

493

00:19:47,270 --> 00:19:44,880

protecting against that as well

494

00:19:49,669 --> 00:19:47,280

but i'll say that on bennu we really

495

00:19:51,350 --> 00:19:49,679

don't expect there to be anything there

496

00:19:53,590 --> 00:19:51,360

that could be harmful

497

00:19:56,150 --> 00:19:53,600

so the planetary protection requirements

498

00:19:58,789 --> 00:19:56,160

for an asteroid sample return

499

00:20:00,870 --> 00:19:58,799

um are pretty minimal uh the asteroid's

500

00:20:02,950 --> 00:20:00,880

been out there

501
00:20:04,630 --> 00:20:02,960
in the solar system rotating around

502
00:20:07,110 --> 00:20:04,640
orbiting around the sun for four and a

503
00:20:09,350 --> 00:20:07,120
half billion years subject to all the

504
00:20:12,230 --> 00:20:09,360
radiation from the sun and the solar

505
00:20:15,350 --> 00:20:12,240
wind and and if there were anything

506
00:20:17,110 --> 00:20:15,360
these organic molecules are there um are

507
00:20:18,470 --> 00:20:17,120
are not actually life they're just

508
00:20:20,390 --> 00:20:18,480
building blocks they're just the key

509
00:20:21,350 --> 00:20:20,400
elements that might but we don't expect

510
00:20:23,669 --> 00:20:21,360
there would be anything that could

511
00:20:25,430 --> 00:20:23,679
actually live in that environment

512
00:20:27,669 --> 00:20:25,440
so it's really important to this answer

513
00:20:29,909 --> 00:20:27,679

and of course you're applying it we did

514

00:20:32,230 --> 00:20:29,919

think of this already

515

00:20:34,710 --> 00:20:32,240

and we based on everything we know from

516

00:20:36,789 --> 00:20:34,720

science we made a decision and what we

517

00:20:39,510 --> 00:20:36,799

need to do and in this case there's

518

00:20:42,549 --> 00:20:39,520

really very little no no danger of any

519

00:20:44,390 --> 00:20:42,559

type that uh and from that perspective

520

00:20:46,070 --> 00:20:44,400

yeah and i mentioned that

521

00:20:48,470 --> 00:20:46,080

you know we get uh

522

00:20:51,590 --> 00:20:48,480

bits of asteroids coming onto earth

523

00:20:52,950 --> 00:20:51,600

every day uh through uh meteorites that

524

00:20:54,950 --> 00:20:52,960

come through the atmosphere and they

525

00:20:57,830 --> 00:20:54,960

also contain similar types of these

526
00:21:00,310 --> 00:20:57,840
organic molecules and uh and they aren't

527
00:21:02,230 --> 00:21:00,320
dangerous either they have been with us

528
00:21:03,350 --> 00:21:02,240
and our parents and grandparents and so

529
00:21:05,909 --> 00:21:03,360
forth

530
00:21:07,350 --> 00:21:05,919
where in the solar system glory is the

531
00:21:09,750 --> 00:21:07,360
asteroid

532
00:21:12,789 --> 00:21:09,760
so that's a really good question

533
00:21:14,470 --> 00:21:12,799
uh most of the asteroids in that we

534
00:21:16,950 --> 00:21:14,480
think about in our solar system are in

535
00:21:19,590 --> 00:21:16,960
what we call the main belt of asteroids

536
00:21:22,230 --> 00:21:19,600
which is between mars and jupiter but

537
00:21:24,149 --> 00:21:22,240
blue is interesting because it's in kind

538
00:21:25,029 --> 00:21:24,159

of an unusual orbit

539

00:21:27,430 --> 00:21:25,039

that

540

00:21:29,350 --> 00:21:27,440

comes out and then comes in close to

541

00:21:32,149 --> 00:21:29,360

earth it's what we call a near-earth

542

00:21:34,230 --> 00:21:32,159

object and so it's in kind of an unusual

543

00:21:36,950 --> 00:21:34,240

orbit it's going around the sun

544

00:21:38,870 --> 00:21:36,960

but it's not trapped in that that space

545

00:21:40,870 --> 00:21:38,880

between mars and jupiter it periodically

546

00:21:43,350 --> 00:21:40,880

comes in that's why we worry about

547

00:21:45,510 --> 00:21:43,360

potentially coming near earth sometime

548

00:21:46,310 --> 00:21:45,520

it's a near-earth object so

549

00:21:49,830 --> 00:21:46,320

that's

550

00:21:51,909 --> 00:21:49,840

now uh it's it's pretty far away so

551
00:21:53,669 --> 00:21:51,919
where uh where we are one side of the

552
00:21:55,190 --> 00:21:53,679
sun it's almost all the way around on

553
00:21:56,870 --> 00:21:55,200
the other side of the sun

554
00:21:57,990 --> 00:21:56,880
that's right so it's it's really from

555
00:21:59,669 --> 00:21:58,000
our away

556
00:22:01,909 --> 00:21:59,679
most of the time

557
00:22:06,470 --> 00:22:01,919
bandung is actually less than 18 and a

558
00:22:08,149 --> 00:22:06,480
half right minutes away from earth

559
00:22:10,230 --> 00:22:08,159
you know because it's closer but right

560
00:22:12,390 --> 00:22:10,240
now it's really pretty much on the other

561
00:22:15,669 --> 00:22:12,400
side there so so that's great so i'm

562
00:22:19,510 --> 00:22:15,679
going to combine two questions into one

563
00:22:22,390 --> 00:22:19,520

and that is how fast does osiris-rex

564

00:22:24,549 --> 00:22:22,400

touch down and or what is the maximum

565

00:22:27,990 --> 00:22:24,559

amount of time allotted for the

566

00:22:30,630 --> 00:22:28,000

spacecraft to remain active

567

00:22:32,390 --> 00:22:30,640

okay so how fast is it going when it

568

00:22:34,789 --> 00:22:32,400

touches down and we were just talking

569

00:22:37,350 --> 00:22:34,799

about this with the team earlier today

570

00:22:40,310 --> 00:22:37,360

and the spacecraft actually is moving

571

00:22:41,990 --> 00:22:40,320

very very slowly and when they they've

572

00:22:44,230 --> 00:22:42,000

got a couple of maneuvers they have to

573

00:22:45,830 --> 00:22:44,240

make to set it up so they can come down

574

00:22:48,070 --> 00:22:45,840

and take the sample

575

00:22:50,870 --> 00:22:48,080

and those are very very microscopic

576

00:22:51,990 --> 00:22:50,880

changing the uh the velocity of just

577

00:22:54,470 --> 00:22:52,000

really by

578

00:22:56,870 --> 00:22:54,480

a fraction of a centimeter per second

579

00:22:58,390 --> 00:22:56,880

and as the spacecraft comes down to take

580

00:23:00,390 --> 00:22:58,400

the sample it's going to be moving on

581

00:23:02,390 --> 00:23:00,400

the order of about 10 centimeters per

582

00:23:04,630 --> 00:23:02,400

second as it comes in

583

00:23:06,549 --> 00:23:04,640

very very slowly it's going to touch the

584

00:23:08,230 --> 00:23:06,559

surface for a couple of seconds and then

585

00:23:09,590 --> 00:23:08,240

it's going to start backing away again

586

00:23:11,270 --> 00:23:09,600

slowly

587

00:23:13,190 --> 00:23:11,280

and that's the trick reolder and once we

588

00:23:15,830 --> 00:23:13,200

learn how to drive cars if you want to

589

00:23:16,710 --> 00:23:15,840

park into a tight stop you go slowly

590

00:23:19,669 --> 00:23:16,720

right

591

00:23:22,470 --> 00:23:19,679

so we're trying to do that here as well

592

00:23:25,510 --> 00:23:22,480

very short time there but really the

593

00:23:27,510 --> 00:23:25,520

roll up to it is hours literally of

594

00:23:29,430 --> 00:23:27,520

activity to make sure that everything

595

00:23:31,590 --> 00:23:29,440

goes exactly the right way

596

00:23:33,909 --> 00:23:31,600

so here's a question for you

597

00:23:36,070 --> 00:23:33,919

are there any instruments or experiments

598

00:23:39,750 --> 00:23:36,080

that the team tried to fit in this

599

00:23:42,789 --> 00:23:39,760

project that ultimately had to drop

600

00:23:44,950 --> 00:23:42,799

oh this is looking back um i'm sure that

601
00:23:47,909 --> 00:23:44,960
that is true because doing a mission of

602
00:23:49,909 --> 00:23:47,919
this size is really really challenging

603
00:23:52,470 --> 00:23:49,919
and it's it's critically important for

604
00:23:54,789 --> 00:23:52,480
the team to to focus in on the science

605
00:23:56,230 --> 00:23:54,799
we would love to send every instrument

606
00:23:58,710 --> 00:23:56,240
we could think of

607
00:24:00,549 --> 00:23:58,720
on a mission like this um

608
00:24:02,310 --> 00:24:00,559
but we do have to focus and that

609
00:24:04,310 --> 00:24:02,320
generally means that that something's

610
00:24:05,909 --> 00:24:04,320
not going to go

611
00:24:08,470 --> 00:24:05,919
and i seem to recall there was something

612
00:24:10,870 --> 00:24:08,480
that got uh jumped that that had to be

613
00:24:12,710 --> 00:24:10,880

taken off of the mission uh as it was

614

00:24:13,830 --> 00:24:12,720

going through its original part of its

615

00:24:15,430 --> 00:24:13,840

uh

616

00:24:17,269 --> 00:24:15,440

competitive face when it was being

617

00:24:19,029 --> 00:24:17,279

proposed i don't remember exactly what

618

00:24:20,630 --> 00:24:19,039

instrument it was but i know there was

619

00:24:23,190 --> 00:24:20,640

one that came off as it was getting

620

00:24:24,789 --> 00:24:23,200

ready to go into its final selection so

621

00:24:26,950 --> 00:24:24,799

that's the story for you

622

00:24:29,110 --> 00:24:26,960

i've never told you that that you know

623

00:24:30,710 --> 00:24:29,120

mike drake was the first principal

624

00:24:32,390 --> 00:24:30,720

investigator and unfortunately he's no

625

00:24:33,669 --> 00:24:32,400

longer with us

626
00:24:37,110 --> 00:24:33,679
and he

627
00:24:40,230 --> 00:24:37,120
actually told me how he struggled to get

628
00:24:42,149 --> 00:24:40,240
all that science we had a drink together

629
00:24:44,310 --> 00:24:42,159
after i meet and he told me how hard it

630
00:24:46,549 --> 00:24:44,320
all fit the answer to that question is

631
00:24:48,710 --> 00:24:46,559
always yes yeah it's just the way it

632
00:24:50,470 --> 00:24:48,720
works but of course the answer to my

633
00:24:52,710 --> 00:24:50,480
question is always as we try to get the

634
00:24:54,549 --> 00:24:52,720
absolutely most important instrument

635
00:24:55,909 --> 00:24:54,559
there will always be more instruments if

636
00:24:58,870 --> 00:24:55,919
we desire

637
00:25:01,350 --> 00:24:58,880
to do so so i'm going to go to my scenes

638
00:25:03,750 --> 00:25:01,360

a question on twitter who asked do you

639

00:25:07,590 --> 00:25:03,760

think bennu and ryoko

640

00:25:10,230 --> 00:25:07,600

are of the same uh parent body if so why

641

00:25:12,149 --> 00:25:10,240

is it possible to find out when the

642

00:25:13,590 --> 00:25:12,159

parent body broke up and what the

643

00:25:15,669 --> 00:25:13,600

material how the material would have

644

00:25:17,510 --> 00:25:15,679

chemically evolved that's a really

645

00:25:20,470 --> 00:25:17,520

interesting question because

646

00:25:22,789 --> 00:25:20,480

when you look at ryugu and bennu if you

647

00:25:25,430 --> 00:25:22,799

didn't know the difference they actually

648

00:25:27,510 --> 00:25:25,440

look really really similar they both

649

00:25:30,230 --> 00:25:27,520

have the same kind of shape they both

650

00:25:31,029 --> 00:25:30,240

got really blocky surfaces

651
00:25:33,750 --> 00:25:31,039
um

652
00:25:35,909 --> 00:25:33,760
but in fact they are compositionally

653
00:25:39,350 --> 00:25:35,919
they're very different

654
00:25:41,909 --> 00:25:39,360
when we look at bennu and we see

655
00:25:44,070 --> 00:25:41,919
rocks on the surface that have minerals

656
00:25:46,149 --> 00:25:44,080
that contain water we know that there's

657
00:25:48,149 --> 00:25:46,159
water trapped in some of those minerals

658
00:25:50,789 --> 00:25:48,159
and we see these uh

659
00:25:52,470 --> 00:25:50,799
the carbon compounds there at ryugu what

660
00:25:54,230 --> 00:25:52,480
we think we saw is actually something

661
00:25:56,470 --> 00:25:54,240
that was much drier that didn't

662
00:25:59,190 --> 00:25:56,480
necessarily have those water-based as

663
00:26:01,029 --> 00:25:59,200

many of those water-based minerals so

664

00:26:02,549 --> 00:26:01,039

they seem compositionally somewhat

665

00:26:04,149 --> 00:26:02,559

different

666

00:26:05,590 --> 00:26:04,159

in this particular case we don't think

667

00:26:07,430 --> 00:26:05,600

that they're

668

00:26:09,430 --> 00:26:07,440

genetically related

669

00:26:11,510 --> 00:26:09,440

but we do look for those kinds of things

670

00:26:13,590 --> 00:26:11,520

uh for lots of asteroids there are you

671

00:26:15,430 --> 00:26:13,600

can tell that when they break up they

672

00:26:16,789 --> 00:26:15,440

travel together they continue moving

673

00:26:18,950 --> 00:26:16,799

together and we can tell that they're

674

00:26:21,029 --> 00:26:18,960

from the same kind of family kind of

675

00:26:22,870 --> 00:26:21,039

asteroids that maybe of a parent that

676
00:26:24,789 --> 00:26:22,880
broke up but we don't think we're

677
00:26:26,630 --> 00:26:24,799
and

678
00:26:28,390 --> 00:26:26,640
so before i ask you the last question i

679
00:26:30,710 --> 00:26:28,400
just want to remind everybody that they

680
00:26:32,710 --> 00:26:30,720
could continue in the discussion

681
00:26:36,390 --> 00:26:32,720
that has that to pendulum and back of

682
00:26:39,830 --> 00:26:36,400
course the time is at 6 00 12 eastern

683
00:26:43,029 --> 00:26:39,840
tomorrow and the nasa tv uh starts the

684
00:26:44,789 --> 00:26:43,039
program at five o'clock eastern to 6 30

685
00:26:46,870 --> 00:26:44,799
and i was so excited for that and here's

686
00:26:48,549 --> 00:26:46,880
the last question which is how long will

687
00:26:51,029 --> 00:26:48,559
it take for the samples to come back to

688
00:26:52,470 --> 00:26:51,039

earth that's a great question

689

00:26:53,830 --> 00:26:52,480

the big deal is tomorrow we're going to

690

00:26:55,510 --> 00:26:53,840

collect the sample but then what's

691

00:26:57,510 --> 00:26:55,520

really important is when do we get to

692

00:26:59,590 --> 00:26:57,520

actually look at the samples they are

693

00:27:03,669 --> 00:26:59,600

actually going to return to earth in

694

00:27:05,190 --> 00:27:03,679

september of 2023 so about three years a

695

00:27:06,950 --> 00:27:05,200

little less than three years they'll be

696

00:27:08,710 --> 00:27:06,960

back on the surface of the earth and

697

00:27:10,390 --> 00:27:08,720

we'll be able to open up that capsule

698

00:27:12,549 --> 00:27:10,400

and start the analysis

699

00:27:14,470 --> 00:27:12,559

we look forward to that and of course to

700

00:27:16,789 --> 00:27:14,480

tomorrow thank you so much all of you

701

00:27:18,870 --> 00:27:16,799

for the questions and continue

702

00:27:21,029 --> 00:27:18,880

interacting with us listen to this

703

00:27:23,590 --> 00:27:21,039

amazing broadcast

704

00:27:26,230 --> 00:27:23,600

in various subways and as especially