1
00:00:12,830 --> 00:00:10,730
well good afternoon my name is Dwayne

2
00:00:15,829 --> 00:00:12,840
brown with the office of communications

3
00:00:18,950 --> 00:00:15,839
here at NASA headquarters today you will

4
00:00:22,400 --> 00:00:18,960
hear first-hand new discoveries and a

5
00:00:25,340 --> 00:00:22,410
few surprises of planet Mercury revealed

6
00:00:27,950 --> 00:00:25,350
by NASA's messenger spacecraft and on

7
00:00:31,640 --> 00:00:27,960
March 18th of this year it became the

8
00:00:34,160 --> 00:00:31,650
first spacecraft ever to achieve orbit

9
00:00:36,650 --> 00:00:34,170
around this mysterious celestial body

10
00:00:40,670 --> 00:00:36,660
will have brief presentations from our

11
00:00:46,490 --> 00:00:40,680
participants a little surprise before we

12
00:00:49,130 --> 00:00:46,500
open up the Q&A and then we will go to

13
00:00:54,650 --> 00:00:49,140

the website where you can look at the

14
00:00:57,770 --> 00:00:54,660
various images and findings at wwc gov /

15
00:01:03,889 --> 00:00:57,780
messenger let me introduce you to

16
00:01:07,250 --> 00:01:03,899
today's participants first up Brett w de

17
00:01:09,520 --> 00:01:07,260
Neffe scientists Johns Hopkins

18
00:01:12,050 --> 00:01:09,530
University Applied Physics Laboratory

19
00:01:17,420 --> 00:01:12,060
otherwise known as a PL and lower

20
00:01:19,210 --> 00:01:17,430
Maryland Larry are knit ler scientists

21
00:01:23,740 --> 00:01:19,220
Department of terrestrial magnetism

22
00:01:30,740 --> 00:01:27,350
Chauncey Solomon messenger principal

23
00:01:36,010 --> 00:01:30,750
investigator from the Carnegie

24
00:01:39,260 --> 00:01:36,020
Institution also and Ralph L mcnutt jr.

25
00:01:42,410 --> 00:01:39,270
messenger project scientists also from

26
00:01:43,940 --> 00:01:42,420
APL before we start with the official

27
00:01:45,889 --> 00:01:43,950
presentations it's my honor and

28
00:01:48,770 --> 00:01:45,899
privilege to turn it over to Shawn for

29
00:01:51,260 --> 00:01:48,780
some opening remarks so on thank you

30
00:01:53,870 --> 00:01:51,270
doing we're delighted to be here today

31
00:01:56,060 --> 00:01:53,880
to share some of the findings from the

32
00:01:59,480 --> 00:01:56,070
first twenty five percent of our

33
00:02:00,620 --> 00:01:59,490
year-long mission messenger in orbit

34
00:02:02,959 --> 00:02:00,630
around one of our nearest planetary

35
00:02:05,240 --> 00:02:02,969
neighbors yet a planet that has never

36
00:02:07,880 --> 00:02:05,250
had an orbiting spacecraft before

37
00:02:09,639 --> 00:02:07,890
messenger I wanted to begin by telling

38
00:02:12,350 --> 00:02:09,649

you that we passed some substantial

39
00:02:13,040 --> 00:02:12,360
milestones just earlier this week in our

40
00:02:16,520 --> 00:02:13,050
mission

41
00:02:20,050 --> 00:02:16,530
on Sunday we had the first perihelion

42
00:02:24,040 --> 00:02:20,060
passage closest approach to the Sun

43
00:02:27,790 --> 00:02:24,050
since we've been in orbit on Monday we

44
00:02:30,410 --> 00:02:27,800
logged in one mercury year in orbit on

45
00:02:33,470 --> 00:02:30,420
Tuesday we came out of a solar

46
00:02:35,600 --> 00:02:33,480
conjunction when the Sun was in between

47
00:02:37,610 --> 00:02:35,610
Earth and the spacecraft allowing us to

48
00:02:40,070 --> 00:02:37,620
communicate again after being blocked

49
00:02:43,730 --> 00:02:40,080
and just yesterday we had the first

50
00:02:46,730 --> 00:02:43,740
orbit correction maneuver in orbit that

51
00:02:49,190 --> 00:02:46,740
lowered our closest approach to the

52
00:02:53,360 --> 00:02:49,200
planet back down to 200 kilometers or

53
00:02:56,540 --> 00:02:53,370
120 miles on most days since we've been

54
00:03:00,790 --> 00:02:56,550
in orbit we have received new data about

55
00:03:04,910 --> 00:03:00,800
this planetary neighbor of ours almost a

56
00:03:09,380 --> 00:03:04,920
non-stop new images new data from all of

57
00:03:12,920 --> 00:03:09,390
our seven instruments we had many ideas

58
00:03:17,060 --> 00:03:12,930
about mercury that were incomplete ill

59
00:03:19,130 --> 00:03:17,070
form that came out of the few flybys the

60
00:03:21,500 --> 00:03:19,140
three flybys by messenger and the three

61
00:03:23,740 --> 00:03:21,510
flybys in the 1970s by the first

62
00:03:27,470 --> 00:03:23,750
spacecraft to visit mercury mariner 10

63
00:03:30,170 --> 00:03:27,480

many of those ideas are now having to be

64
00:03:31,940 --> 00:03:30,180
cast aside as we as we see orbital data

65
00:03:35,180 --> 00:03:31,950
for the first time we are confirming a

66
00:03:38,449 --> 00:03:35,190
few of the theories that have preceded

67
00:03:40,880 --> 00:03:38,459
us but many of those theories are now

68
00:03:46,490 --> 00:03:40,890
being cast into the dustbin of science

69
00:03:48,320 --> 00:03:46,500
as they are shown to be very incomplete

70
00:03:50,240 --> 00:03:48,330
or incorrect description of the

71
00:03:52,690 --> 00:03:50,250
innermost planet you'll hear examples of

72
00:03:55,699 --> 00:03:52,700
those from each of the presenters today

73
00:03:57,830 --> 00:03:55,709
one of our instruments on the spacecraft

74
00:04:00,979 --> 00:03:57,840
is of course our imaging system we've

75
00:04:04,370 --> 00:04:00,989
taken more than 20,000 images of mercury

76
00:04:06,440 --> 00:04:04,380
to date and I'd like to turn the

77
00:04:07,910 --> 00:04:06,450
microphone over to my colleague Benton

78
00:04:09,229 --> 00:04:07,920
every who will describe some of the

79
00:04:12,290 --> 00:04:09,239
things we're learning from those images

80
00:04:14,479 --> 00:04:12,300
but Thank You Sean well it's my

81
00:04:16,729 --> 00:04:14,489
privilege today to share some of our

82
00:04:19,280 --> 00:04:16,739
early science results from the orbital

83
00:04:24,290 --> 00:04:19,290
imaging campaign if we can pull up the

84
00:04:26,750 --> 00:04:24,300
first image this is a view of mercury

85
00:04:28,580 --> 00:04:26,760
looking down on the North Pole

86
00:04:30,680 --> 00:04:28,590
and this is an area that we didn't

87
00:04:33,710 --> 00:04:30,690
really have great coverage of before due

88
00:04:36,050 --> 00:04:33,720

to the nature of flybys so you can see

89
00:04:39,110 --> 00:04:36,060
on the left half there it's mostly all

90
00:04:40,790 --> 00:04:39,120
of our new orbital coverage where we

91
00:04:43,010 --> 00:04:40,800
filled in pretty much all of the gaps

92
00:04:44,390 --> 00:04:43,020
consistently on the right hand side we

93
00:04:46,850 --> 00:04:44,400
haven't yet marched all the way around

94
00:04:49,370 --> 00:04:46,860
the planet to fill that in so it's still

95
00:04:50,920 --> 00:04:49,380
showing some of our flyby coverage but

96
00:04:54,830 --> 00:04:50,930
what you can see there in yellow

97
00:04:57,890 --> 00:04:54,840
outlined is the approximate extent of a

98
00:05:00,380 --> 00:04:57,900
really large unit of smooth Plains and

99
00:05:03,770 --> 00:05:00,390
these planes are thought to be volcanic

100
00:05:05,840 --> 00:05:03,780
in origin and we had some hints from the

101
00:05:09,410 --> 00:05:05,850
flybys mariner 10 actually got the best

102
00:05:11,030 --> 00:05:09,420
look of these planes but now we're

103
00:05:14,780 --> 00:05:11,040
seeing for the first time their full

104
00:05:17,720 --> 00:05:14,790
extent which is around 4 million square

105
00:05:23,420 --> 00:05:17,730
kilometers surround half the size of the

106
00:05:26,150 --> 00:05:23,430
continental US and if we can go to the

107
00:05:28,340 --> 00:05:26,160
next graphic you can see this is just an

108
00:05:31,220 --> 00:05:28,350
example of how we actually did see some

109
00:05:32,870 --> 00:05:31,230
of these planes during the flybys but

110
00:05:35,360 --> 00:05:32,880
because we're flying by close to the

111
00:05:37,280 --> 00:05:35,370
equator looking up at high latitudes is

112
00:05:39,470 --> 00:05:37,290
really a difficult challenge and so

113
00:05:44,030 --> 00:05:39,480

orbit is perfect for that if you can add

114
00:05:46,850 --> 00:05:44,040
the overlay there you'll see this is the

115
00:05:48,320 --> 00:05:46,860
same area as seen from our flyby images

116
00:05:51,980 --> 00:05:48,330
where we can look straight down on the

117
00:05:54,140 --> 00:05:51,990
surface and so from our more detailed

118
00:05:56,120 --> 00:05:54,150
look at this beautiful large unit of

119
00:05:58,430 --> 00:05:56,130
smooth Plains we're seeing all kinds of

120
00:06:01,220 --> 00:05:58,440
evidence for volcanism the tectonic

121
00:06:02,960 --> 00:06:01,230
deformation of these planes in this

122
00:06:04,700 --> 00:06:02,970
image toward the center and on the right

123
00:06:07,010 --> 00:06:04,710
side they're actually you can see ghosts

124
00:06:09,770 --> 00:06:07,020
craters which are pre-existing impact

125
00:06:12,740 --> 00:06:09,780
craters that were later covered over by

126
00:06:15,890 --> 00:06:12,750
lava and you can just see their rims

127
00:06:18,710 --> 00:06:15,900
affecting the structures there if you

128
00:06:21,710 --> 00:06:18,720
can bring up the next image please we're

129
00:06:24,260 --> 00:06:21,720
also orbiting in our orbital coverage

130
00:06:26,840 --> 00:06:24,270
we're collecting color images through

131
00:06:29,330 --> 00:06:26,850
eight color filters of the whole planet

132
00:06:32,300 --> 00:06:29,340
with a resolution of around a kilometer

133
00:06:35,300 --> 00:06:32,310
per pixel and so the reason we image

134
00:06:36,830 --> 00:06:35,310
mercury in color is so that we can try

135
00:06:38,540 --> 00:06:36,840
to understand it's composition the

136
00:06:39,460 --> 00:06:38,550
colors of the surfaces are related to

137
00:06:43,870 --> 00:06:39,470
the

138
00:06:45,760 --> 00:06:43,880

surface and so this image is also

139
00:06:48,880 --> 00:06:45,770
showing the smooth Plains there the less

140
00:06:52,240 --> 00:06:48,890
cratered area that shows up as kind of

141
00:06:54,820 --> 00:06:52,250
an orange or red in this color scheme if

142
00:06:58,660 --> 00:06:54,830
you bring up the next image the last

143
00:07:02,050 --> 00:06:58,670
image sorry was in an image where the

144
00:07:03,640 --> 00:07:02,060
infra red red and blue filters were in

145
00:07:06,520 --> 00:07:03,650
the red green and blue channels this

146
00:07:09,730 --> 00:07:06,530
image is an enhanced color look at the

147
00:07:12,670 --> 00:07:09,740
same region that just shows these smooth

148
00:07:14,080 --> 00:07:12,680
Plains are compositionally distinct from

149
00:07:15,790 --> 00:07:14,090
their surroundings and while we don't

150
00:07:18,790 --> 00:07:15,800
yet know their composition that's

151
00:07:20,610 --> 00:07:18,800
something we're working on but we're

152
00:07:23,380 --> 00:07:20,620
really excited to keep studying this

153
00:07:26,980 --> 00:07:23,390
huge volcanic deposit near the North

154
00:07:29,220 --> 00:07:26,990
Pole its implications for the evolution

155
00:07:34,720 --> 00:07:29,230
of Mercury's crust and how it formed

156
00:07:37,810 --> 00:07:34,730
next slide please this is just showing

157
00:07:41,500 --> 00:07:37,820
our coverage so far that we've obtained

158
00:07:44,950 --> 00:07:41,510
from orbit in our monochrome mapping

159
00:07:46,510 --> 00:07:44,960
campaign so you can see in just around

160
00:07:48,460 --> 00:07:46,520
three months less than three months

161
00:07:50,560 --> 00:07:48,470
we've filled in a great deal of the

162
00:07:54,400 --> 00:07:50,570
planet already at least for this

163
00:07:56,200 --> 00:07:54,410

hemisphere if you can start the movie

164
00:07:57,940 --> 00:07:56,210
when you zoom in here you can see if

165
00:08:00,760 --> 00:07:57,950
this images are collected at an average

166
00:08:03,280 --> 00:08:00,770
resolution of around 250 meters per

167
00:08:05,530 --> 00:08:03,290
pixel and when you zoom into the full

168
00:08:06,880 --> 00:08:05,540
resolution you can start to see this is

169
00:08:11,320 --> 00:08:06,890
just one of the many spectacular

170
00:08:14,590 --> 00:08:11,330
features on Mercury this is a 13

171
00:08:17,770 --> 00:08:14,600
kilometer impact crater and that dark

172
00:08:20,320 --> 00:08:17,780
region that you see to the south is

173
00:08:23,350 --> 00:08:20,330
impact melt which flowed from the crater

174
00:08:26,170 --> 00:08:23,360
impact mount forms when the impact

175
00:08:28,630 --> 00:08:26,180
occurs the temperatures and pressures

176
00:08:31,750 --> 00:08:28,640
are very high they melt the rock on the

177
00:08:35,610 --> 00:08:31,760
surface and it can flow in this case

178
00:08:39,100 --> 00:08:35,620
away from the crater and this particular

179
00:08:41,620 --> 00:08:39,110
view here shows the impact melt is very

180
00:08:43,540 --> 00:08:41,630
dark the color imaging and also the

181
00:08:45,610 --> 00:08:43,550
reflectance spectrometer on messenger

182
00:08:47,740 --> 00:08:45,620
hint that this may be a unique

183
00:08:49,690 --> 00:08:47,750
composition distinct from its

184
00:08:51,820 --> 00:08:49,700
surroundings and definitely different

185
00:08:52,960 --> 00:08:51,830
from most of the typical impact mounts

186
00:08:58,019 --> 00:08:52,970
that we see on

187
00:09:02,610 --> 00:08:58,029
hurry next please in addition to our

188
00:09:05,829 --> 00:09:02,620

standard color and monochrome mapping

189
00:09:08,499 --> 00:09:05,839
imaging campaigns we also are able to

190
00:09:11,439 --> 00:09:08,509
collect high-resolution targeted images

191
00:09:13,210 --> 00:09:11,449
for regions that are of high scientific

192
00:09:15,360 --> 00:09:13,220
interest things that we saw during the

193
00:09:18,220 --> 00:09:15,370
flybys and wanted to get a better look

194
00:09:20,470 --> 00:09:18,230
this is showing the cratered agha which

195
00:09:23,679 --> 00:09:20,480
is around 50 kilometers in diameter on

196
00:09:27,400 --> 00:09:23,689
the left-hand side you'll see that was

197
00:09:29,980 --> 00:09:27,410
the coverage from Mariner 10 and so our

198
00:09:33,939 --> 00:09:29,990
targeted images and color here are

199
00:09:36,009 --> 00:09:33,949
acquiring a great new level of detail

200
00:09:38,499 --> 00:09:36,019
you can see on this crater there's

201
00:09:40,869 --> 00:09:38,509
impact mount that covers the floor it

202
00:09:43,179 --> 00:09:40,879
has these fractures that formed as the

203
00:09:45,910 --> 00:09:43,189
impact melt cooled and solidified and

204
00:09:48,009 --> 00:09:45,920
cracked and then the beautiful bright

205
00:09:52,740 --> 00:09:48,019
area in the center is the central peak

206
00:09:55,269 --> 00:09:52,750
complex there in the next slide please

207
00:09:58,179 --> 00:09:55,279
we're also able to acquire targeted

208
00:09:59,799 --> 00:09:58,189
monochrome images and this is a great

209
00:10:02,619 --> 00:09:59,809
example of the importance of these

210
00:10:05,199 --> 00:10:02,629
high-resolution images messenger can

211
00:10:08,470 --> 00:10:05,209
acquire images at up to 10 meters per

212
00:10:12,100 --> 00:10:08,480
pixel this one here is 21 meters per

213
00:10:15,240 --> 00:10:12,110

pixel and it shows a region that we saw

214
00:10:18,759 --> 00:10:15,250
these areas during the flybys that had

215
00:10:21,759 --> 00:10:18,769
patchy bright material on crater floors

216
00:10:23,889 --> 00:10:21,769
sometimes in peak rings of craters and

217
00:10:25,809 --> 00:10:23,899
we simply didn't have the ability to

218
00:10:27,549 --> 00:10:25,819
determine what they were because we

219
00:10:30,490 --> 00:10:27,559
couldn't see it at any higher resolution

220
00:10:34,119 --> 00:10:30,500
we look at these targeted images we can

221
00:10:36,850 --> 00:10:34,129
see that these patchy bright regions are

222
00:10:39,699 --> 00:10:36,860
actually a train that appears to be

223
00:10:42,999 --> 00:10:39,709
etched there are clusters of small

224
00:10:45,780 --> 00:10:43,009
rimless depressions a few hundred metres

225
00:10:51,460 --> 00:10:45,790
to a kilometre they often have diffuse

226
00:10:53,199 --> 00:10:51,470
bright halos around them the line on the

227
00:10:55,449 --> 00:10:53,209
bottom image where you can see kind of a

228
00:10:57,910 --> 00:10:55,459
line of these little pits and etch

229
00:11:02,410 --> 00:10:57,920
terrain that's actually the peak ring of

230
00:11:04,329 --> 00:11:02,420
an impact crater and so we still aren't

231
00:11:05,350 --> 00:11:04,339
sure how these are formed how these

232
00:11:07,870 --> 00:11:05,360
formed

233
00:11:11,110 --> 00:11:07,880
there are a couple ideas when you see

234
00:11:13,990 --> 00:11:11,120
rimless depressions like this in other

235
00:11:16,690 --> 00:11:14,000
places they're often due to an explosive

236
00:11:19,269 --> 00:11:16,700
volcanic eruption where you have a gas

237
00:11:22,630 --> 00:11:19,279
that when it gets near the surface in

238
00:11:26,319 --> 00:11:22,640

the magma expands explodes like mount

239
00:11:28,949 --> 00:11:26,329
st. helens for example but these

240
00:11:32,530 --> 00:11:28,959
features do appear quite different from

241
00:11:34,630 --> 00:11:32,540
the typical vents that we see on the

242
00:11:38,620 --> 00:11:34,640
moon or on Mercury they're really unlike

243
00:11:41,170 --> 00:11:38,630
anything we've seen before so another

244
00:11:43,870 --> 00:11:41,180
idea is that they contain some kind of

245
00:11:46,000 --> 00:11:43,880
material or compound that is not stable

246
00:11:50,009 --> 00:11:46,010
when it's exposed near the surface of

247
00:11:53,019 --> 00:11:50,019
mercury so a volatile material that

248
00:11:55,360 --> 00:11:53,029
evaporates or sublimes when exposed at

249
00:11:57,400 --> 00:11:55,370
the surface so we're really excited to

250
00:12:00,610 --> 00:11:57,410
keep studying these features try and

251
00:12:01,990 --> 00:12:00,620
understand their origin apply data from

252
00:12:05,139 --> 00:12:02,000
all of the other instruments on

253
00:12:08,949 --> 00:12:05,149
messenger and with that I'll pass to

254
00:12:10,930 --> 00:12:08,959
Larry Thank You Bret I'm very happy to

255
00:12:13,090 --> 00:12:10,940
be here today I'm going to talk about

256
00:12:14,710 --> 00:12:13,100
results we've gotten from to specific

257
00:12:16,240 --> 00:12:14,720
instruments on messenger the x-ray

258
00:12:18,040 --> 00:12:16,250
spectrometer and the gamma-ray and

259
00:12:21,400 --> 00:12:18,050
neutron spectrometer these instruments

260
00:12:22,960 --> 00:12:21,410
are designed to measure the abundances

261
00:12:25,210 --> 00:12:22,970
of the chemical elements at the surface

262
00:12:27,519 --> 00:12:25,220
of mercury now the abundances of

263
00:12:29,110 --> 00:12:27,529

elements on planets depends on the what

264
00:12:30,699 --> 00:12:29,120
the planets were originally made out of

265
00:12:33,639 --> 00:12:30,709
their entire geological history so

266
00:12:38,019 --> 00:12:33,649
they're very diagnostic of important

267
00:12:39,819 --> 00:12:38,029
processes over the years many ideas and

268
00:12:41,439 --> 00:12:39,829
models have been put forward about what

269
00:12:43,600 --> 00:12:41,449
the composition of mercury might be

270
00:12:46,689 --> 00:12:43,610
based on various formation models and

271
00:12:49,300 --> 00:12:46,699
evolution models and but it was only

272
00:12:50,740 --> 00:12:49,310
until now that messenger is in orbit

273
00:12:52,900 --> 00:12:50,750
around the planet that we can actually

274
00:12:55,630 --> 00:12:52,910
start testing these models in detail and

275
00:12:59,199 --> 00:12:55,640
really see if any of them are right and

276
00:13:01,750 --> 00:12:59,209
what we were finding is Sean indicated

277
00:13:03,250 --> 00:13:01,760
is that in many cases a lot of the

278
00:13:05,230 --> 00:13:03,260
original ideas about mercury are just

279
00:13:07,360 --> 00:13:05,240
plain wrong and so we're finding some

280
00:13:09,370 --> 00:13:07,370
surprises and we're getting very

281
00:13:12,069 --> 00:13:09,380
interesting results as I'll show you so

282
00:13:14,740 --> 00:13:12,079
this first animation is an illustration

283
00:13:17,590 --> 00:13:14,750
of how one of these instruments works

284
00:13:19,240 --> 00:13:17,600
the x-ray spectrometer now we use this

285
00:13:21,430 --> 00:13:19,250
instrument basically x-rays

286
00:13:22,810 --> 00:13:21,440
from the Sun are emitted by high

287
00:13:24,940 --> 00:13:22,820
temperature plasma and the outer

288
00:13:28,090 --> 00:13:24,950

atmosphere of the Sun these x-rays hit

289
00:13:29,800 --> 00:13:28,100
the planet and they can be cause rhea

290
00:13:31,750 --> 00:13:29,810
mission of fluorescent x-rays this is

291
00:13:34,420 --> 00:13:31,760
very much like a blacklight poster

292
00:13:36,430 --> 00:13:34,430
glowing under a UV lamp so it's a

293
00:13:38,020 --> 00:13:36,440
fluorescent process these x-rays can be

294
00:13:40,780 --> 00:13:38,030
detected by the instrument onboard the

295
00:13:42,730 --> 00:13:40,790
spacecraft and used to determine what

296
00:13:46,570 --> 00:13:42,740
elements are present and in what

297
00:13:48,700 --> 00:13:46,580
abundance so this technique depends as I

298
00:13:50,740 --> 00:13:48,710
said on the x rays from the Sun the

299
00:13:53,830 --> 00:13:50,750
solar x-ray emission varies with time

300
00:13:55,330 --> 00:13:53,840
wildly and gets especially high during

301
00:13:56,770 --> 00:13:55,340
large solar flares well we've been

302
00:13:58,450 --> 00:13:56,780
fortunate that the Sun has been

303
00:14:00,880 --> 00:13:58,460
relatively active since we went into

304
00:14:03,460 --> 00:14:00,890
orbit three months ago so we've gotten

305
00:14:04,870 --> 00:14:03,470
some very good fluorescent to x-ray data

306
00:14:06,520 --> 00:14:04,880
from the surface so we're getting good

307
00:14:08,890 --> 00:14:06,530
measurements right now of the average

308
00:14:11,110 --> 00:14:08,900
composition of key elements like

309
00:14:13,060 --> 00:14:11,120
magnesium aluminum silicon sulfur

310
00:14:15,340 --> 00:14:13,070
calcium titanium and iron with this

311
00:14:19,390 --> 00:14:15,350
instrument so as an example may have the

312
00:14:21,550 --> 00:14:19,400
next slide please this shows the a graph

313
00:14:23,770 --> 00:14:21,560

of the magnesium to silicon ratio

314
00:14:25,720 --> 00:14:23,780
plotted against the aluminum to silicon

315
00:14:27,579 --> 00:14:25,730
ratio for different types of rocks on

316
00:14:30,250 --> 00:14:27,589
the earth and on the moon and on Mars

317
00:14:31,720 --> 00:14:30,260
now you can see is that these different

318
00:14:33,640 --> 00:14:31,730
types of rocks and planets have

319
00:14:35,650 --> 00:14:33,650
different lie in different places on

320
00:14:36,910 --> 00:14:35,660
this plot and so it's a good

321
00:14:38,860 --> 00:14:36,920
discriminant of pot of different

322
00:14:40,450 --> 00:14:38,870
processes for example at the bottom

323
00:14:42,520 --> 00:14:40,460
right you can see that rocks from the

324
00:14:44,770 --> 00:14:42,530
interior of the earth are relatively

325
00:14:47,680 --> 00:14:44,780
enriched in magnesium and depleted in

326
00:14:49,329 --> 00:14:47,690
aluminum compared to typical rocks on

327
00:14:51,040 --> 00:14:49,339
the surface of the earth like basalts

328
00:14:52,870 --> 00:14:51,050
that can be seen at the sort of middle

329
00:14:55,930 --> 00:14:52,880
left with higher aluminum and lower

330
00:14:57,460 --> 00:14:55,940
magnesium many many rocks on the surface

331
00:15:00,130 --> 00:14:57,470
of the Moon are even more enriched in

332
00:15:01,480 --> 00:15:00,140
aluminum than typical earth rocks so

333
00:15:05,230 --> 00:15:01,490
there are up in the upper left portion

334
00:15:07,930 --> 00:15:05,240
of this diagram and that reflects a very

335
00:15:10,600 --> 00:15:07,940
high abundance of minerals feldspar

336
00:15:12,130 --> 00:15:10,610
minerals so if we end on this graph we

337
00:15:13,750 --> 00:15:12,140
can also see that Mars occupies an

338
00:15:15,460 --> 00:15:13,760

entirely different region on this plot

339
00:15:17,800 --> 00:15:15,470
so different planets lie in different

340
00:15:19,870 --> 00:15:17,810
regions and where there's mercury lie

341
00:15:22,090 --> 00:15:19,880
well if I have the next slide this shows

342
00:15:24,520 --> 00:15:22,100
our data that we're determining from the

343
00:15:26,530 --> 00:15:24,530
x-ray spectrometer the lighter symbols

344
00:15:28,120 --> 00:15:26,540
indicate measurements over very large

345
00:15:30,970 --> 00:15:28,130
area sort of one to two thousand

346
00:15:32,620 --> 00:15:30,980
kilometer footprint size whereas the

347
00:15:33,220 --> 00:15:32,630
darker symbols are slightly better

348
00:15:35,080 --> 00:15:33,230
resolved

349
00:15:37,240 --> 00:15:35,090
measurements down to a few hundred

350
00:15:39,370 --> 00:15:37,250
kilometers and what's clear here is the

351
00:15:41,260 --> 00:15:39,380
mercury is not the moon and it's not the

352
00:15:43,600 --> 00:15:41,270
earth the surface of mercury occupies a

353
00:15:45,630 --> 00:15:43,610
fairly unique location on this diagram

354
00:15:48,610 --> 00:15:45,640
for the surfaces of terrestrial planets

355
00:15:50,830 --> 00:15:48,620
it's got lower aluminum and more

356
00:15:53,290 --> 00:15:50,840
magnesium relative to silicon so it has

357
00:15:55,390 --> 00:15:53,300
a lower abundance of feldspar and it

358
00:15:58,210 --> 00:15:55,400
clearly is undergone a unique geological

359
00:16:00,400 --> 00:15:58,220
history in addition to these data the

360
00:16:03,070 --> 00:16:00,410
x-ray spectrometers made two additional

361
00:16:05,110 --> 00:16:03,080
very interesting observations first we

362
00:16:07,690 --> 00:16:05,120
have found that the surface of mercury

363
00:16:10,720 --> 00:16:07,700

Israel has relatively low abundances of

364
00:16:12,220 --> 00:16:10,730
iron and titanium now it's been known

365
00:16:15,580 --> 00:16:12,230
for many years from ground-based

366
00:16:17,290 --> 00:16:15,590
spectral observations of mercury that

367
00:16:19,080 --> 00:16:17,300
the silicate minerals at the surface of

368
00:16:22,600 --> 00:16:19,090
the planet are low in iron and titanium

369
00:16:25,900 --> 00:16:22,610
but data from the flybys of messenger of

370
00:16:27,970 --> 00:16:25,910
mercury suggested that there in fact

371
00:16:29,620 --> 00:16:27,980
could be much higher abundances of iron

372
00:16:31,030 --> 00:16:29,630
and titanium at the surface that just

373
00:16:33,640 --> 00:16:31,040
were not in silicates we're in other

374
00:16:35,140 --> 00:16:33,650
phases well the x-ray data clearly

375
00:16:36,850 --> 00:16:35,150
showed this is not the case that the

376
00:16:39,460 --> 00:16:36,860
rocky part of the planet is low in iron

377
00:16:41,200 --> 00:16:39,470
and titanium so it shows it helps show

378
00:16:42,850 --> 00:16:41,210
the power of orbital missions versus

379
00:16:45,910 --> 00:16:42,860
flybys that even when you get excellent

380
00:16:47,950 --> 00:16:45,920
data on flybys it's not always easy to

381
00:16:49,720 --> 00:16:47,960
unambiguously interpret it so here in

382
00:16:51,580 --> 00:16:49,730
the orbit we're getting this and again

383
00:16:53,170 --> 00:16:51,590
it shows that mercury is different from

384
00:16:54,610 --> 00:16:53,180
the other planets which have much more

385
00:16:56,890 --> 00:16:54,620
iron and titanium in their rocky

386
00:16:59,110 --> 00:16:56,900
portions the other very interesting

387
00:17:00,730 --> 00:16:59,120
observation that we've found is that the

388
00:17:03,040 --> 00:17:00,740

data revealed that the surface of

389
00:17:05,110 --> 00:17:03,050
mercury has a very high relatively high

390
00:17:07,150 --> 00:17:05,120
sulphur abundance on the order of a few

391
00:17:09,310 --> 00:17:07,160
percent by weight of the surface of

392
00:17:10,720 --> 00:17:09,320
mercury appears to be sulfur which is at

393
00:17:13,810 --> 00:17:10,730
least a factor of ten times higher than

394
00:17:15,610 --> 00:17:13,820
the crust of the earth or the moon we do

395
00:17:17,680 --> 00:17:15,620
not fully understand this yet but it

396
00:17:19,630 --> 00:17:17,690
almost certainly relates to the origin

397
00:17:21,580 --> 00:17:19,640
of mercury that mercury most likely

398
00:17:23,170 --> 00:17:21,590
formed from building blocks that were

399
00:17:24,370 --> 00:17:23,180
fundamentally chemically different from

400
00:17:27,550 --> 00:17:24,380
those that form the Earth and Moon

401
00:17:29,110 --> 00:17:27,560
originally it also has important

402
00:17:30,670 --> 00:17:29,120
implications for understanding volcanism

403
00:17:32,200 --> 00:17:30,680
as bread was talking about we have

404
00:17:36,400 --> 00:17:32,210
evidence for explosive volcanism

405
00:17:39,190 --> 00:17:36,410
possibly driven by its volatile gases

406
00:17:41,440 --> 00:17:39,200
and on the earth these are and this is

407
00:17:43,180 --> 00:17:41,450
often driven by sulfur bearing volatile

408
00:17:45,580 --> 00:17:43,190
gases and so the presence of sulfur

409
00:17:47,070 --> 00:17:45,590
should tell us new things about the

410
00:17:50,170 --> 00:17:47,080
nature of volcanism on mark

411
00:17:52,840 --> 00:17:50,180
so shifting gears have the next

412
00:17:54,340 --> 00:17:52,850
animation please so this is an

413
00:17:56,140 --> 00:17:54,350

illustration of the other instrument the

414
00:17:58,390 --> 00:17:56,150
gamma ray and neutron spectrometer which

415
00:18:00,610 --> 00:17:58,400
which probes material to depths of a few

416
00:18:03,520 --> 00:18:00,620
hundred or few tens of centimeters of

417
00:18:04,810 --> 00:18:03,530
few feet and basically this instrument

418
00:18:06,790 --> 00:18:04,820
works when galactic cosmic rays

419
00:18:08,590 --> 00:18:06,800
streaming through space interact with

420
00:18:10,690 --> 00:18:08,600
the surface they make neutrons they can

421
00:18:12,040 --> 00:18:10,700
be fast high energy or slow and then

422
00:18:14,440 --> 00:18:12,050
they can get slowed down to be thermal

423
00:18:17,170 --> 00:18:14,450
neutrons these neutrons can interact

424
00:18:18,910 --> 00:18:17,180
with materials at the surface to produce

425
00:18:21,100 --> 00:18:18,920
gamma rays that are have energies

426
00:18:22,540 --> 00:18:21,110
characteristic of the elements and in

427
00:18:24,130 --> 00:18:22,550
addition if you have naturally

428
00:18:26,850 --> 00:18:24,140
radioactive elements like potassium

429
00:18:29,740 --> 00:18:26,860
thorium and uranium they can decay

430
00:18:31,180 --> 00:18:29,750
naturally and release gamma rays and all

431
00:18:32,830 --> 00:18:31,190
of these neutrons and gamma rays can be

432
00:18:34,480 --> 00:18:32,840
detected by the instrument onboard the

433
00:18:36,940 --> 00:18:34,490
spacecraft and used to determine the

434
00:18:38,680 --> 00:18:36,950
composition of the planet I'm going to

435
00:18:40,000 --> 00:18:38,690
focus today on the results for potassium

436
00:18:42,040 --> 00:18:40,010
and thorium both of which have

437
00:18:43,900 --> 00:18:42,050
radioactive isotopes so we can detect

438
00:18:48,760 --> 00:18:43,910

their abundances may have the next slide

439
00:18:52,270 --> 00:18:48,770
please so the ratio of potassium to

440
00:18:54,370 --> 00:18:52,280
thorium has long been understood to be a

441
00:18:56,530 --> 00:18:54,380
very useful probe in planetary science

442
00:18:59,530 --> 00:18:56,540
and the reason for this is potassium is

443
00:19:00,970 --> 00:18:59,540
a rather volatile element so it

444
00:19:05,350 --> 00:19:00,980
evaporates at relatively low temperature

445
00:19:07,360 --> 00:19:05,360
and thorium does not so the ratio of

446
00:19:09,100 --> 00:19:07,370
these two elements can provide great a

447
00:19:10,930 --> 00:19:09,110
great deal of information about thermal

448
00:19:12,490 --> 00:19:10,940
heating processes that occurred in the

449
00:19:15,160 --> 00:19:12,500
early solar system when these planets

450
00:19:18,490 --> 00:19:15,170
were coming together so this plot shows

451
00:19:20,680 --> 00:19:18,500
the potassium to thorium for Venus the

452
00:19:22,270 --> 00:19:20,690
Earth and Moon system and Mars and a

453
00:19:24,340 --> 00:19:22,280
striking thing on here is that the moon

454
00:19:25,840 --> 00:19:24,350
has a much lower ratio of potassium to

455
00:19:27,760 --> 00:19:25,850
thorium than the other planets and this

456
00:19:29,050 --> 00:19:27,770
is a direct reflection of the very very

457
00:19:31,450 --> 00:19:29,060
high temperatures that the moon

458
00:19:33,550 --> 00:19:31,460
experienced when it formed by a giant

459
00:19:35,620 --> 00:19:33,560
impact of a mars-sized impactor on the

460
00:19:37,720 --> 00:19:35,630
earth and it got so hot that they've

461
00:19:40,540 --> 00:19:37,730
potassium and other volatile elements

462
00:19:42,610 --> 00:19:40,550
like it essentially evaporated away well

463
00:19:44,950 --> 00:19:42,620

prior to messenger many ideas about

464
00:19:46,870 --> 00:19:44,960
mercury suggested that it should also

465
00:19:49,090 --> 00:19:46,880
have a low potassium to thorium ratio

466
00:19:50,980 --> 00:19:49,100
mercury formed very close to the Sun in

467
00:19:53,740 --> 00:19:50,990
the early solar system was thought that

468
00:19:55,750 --> 00:19:53,750
the nebula from which the the disk from

469
00:19:58,630 --> 00:19:55,760
which the solar system formed the

470
00:20:00,760 --> 00:19:58,640
planets formed a was hot there and very

471
00:20:02,350 --> 00:20:00,770
light there are many formation

472
00:20:04,390 --> 00:20:02,360
models for mercury that suggested this

473
00:20:06,220 --> 00:20:04,400
ratio should be low but in fact the

474
00:20:08,620 --> 00:20:06,230
gamma ray results show the opposite may

475
00:20:10,510 --> 00:20:08,630
have the next slide please they've been

476
00:20:13,090 --> 00:20:10,520
able to measure this ratio on mercury

477
00:20:14,710 --> 00:20:13,100
and surprisingly it's not low it's in

478
00:20:16,480 --> 00:20:14,720
fact as high or higher than that of the

479
00:20:18,670 --> 00:20:16,490
other terrestrial planets so this tells

480
00:20:20,590 --> 00:20:18,680
us right away that mercury is not highly

481
00:20:22,600 --> 00:20:20,600
depleted in these kinds of volatile

482
00:20:24,700 --> 00:20:22,610
elements unlike previous ideas it rules

483
00:20:25,720 --> 00:20:24,710
out some formation models and it's

484
00:20:27,430 --> 00:20:25,730
completely consistent with other

485
00:20:29,230 --> 00:20:27,440
observations like the high abundance of

486
00:20:31,570 --> 00:20:29,240
sulfur which is also a relatively

487
00:20:33,250 --> 00:20:31,580
volatile element and the presence of

488
00:20:36,430 --> 00:20:33,260

sodium which has been observed over the

489
00:20:38,530 --> 00:20:36,440
years in the exosphere around mercury

490
00:20:40,330 --> 00:20:38,540
and has clearly been coming from the

491
00:20:42,880 --> 00:20:40,340
surface so there are there seem to be a

492
00:20:46,780 --> 00:20:42,890
large amount of volatile elements in the

493
00:20:49,210 --> 00:20:46,790
planet and all taken altogether these

494
00:20:51,280 --> 00:20:49,220
elements are changing our view of the

495
00:20:52,930 --> 00:20:51,290
origin of mercury it indicates the

496
00:20:55,540 --> 00:20:52,940
mercury is not the earth that is not the

497
00:20:56,770 --> 00:20:55,550
moon and we're going to use these data

498
00:20:58,510 --> 00:20:56,780
in conjunction with all the other

499
00:21:00,220 --> 00:20:58,520
observations to truly try and better

500
00:21:01,660 --> 00:21:00,230
understand how the planet formed what it

501
00:21:03,460 --> 00:21:01,670
formed from and what has happened to it

502
00:21:07,180 --> 00:21:03,470
in the immediate four-and-a-half billion

503
00:21:09,610 --> 00:21:07,190
years and with that I will pass it on to

504
00:21:11,920 --> 00:21:09,620
shot Thank You Larry I'd like to share

505
00:21:13,810 --> 00:21:11,930
some of our recent findings from two

506
00:21:16,750 --> 00:21:13,820
different investigations from the

507
00:21:19,150 --> 00:21:16,760
messenger mission the measurement of the

508
00:21:21,250 --> 00:21:19,160
topography of the surface of mercury and

509
00:21:23,590 --> 00:21:21,260
the measurement of Mercury's internal

510
00:21:26,050 --> 00:21:23,600
magnetic field if we could go to the

511
00:21:27,850 --> 00:21:26,060
first animation you'll see a very

512
00:21:30,640 --> 00:21:27,860
schematic depiction of the operation of

513
00:21:33,340 --> 00:21:30,650

Mercury's messenger laser mercury laser

514
00:21:35,650 --> 00:21:33,350
altimeter that sends eight times the

515
00:21:39,190 --> 00:21:35,660
second a short pulse from a powerful

516
00:21:41,740 --> 00:21:39,200
laser and it records the reflection of

517
00:21:43,450 --> 00:21:41,750
that laser pulse off the surface and

518
00:21:46,420 --> 00:21:43,460
from the time of flight of the laser

519
00:21:48,220 --> 00:21:46,430
signal and from precise knowledge of the

520
00:21:50,650 --> 00:21:48,230
position of the spacecraft it determines

521
00:21:52,450 --> 00:21:50,660
a topographic profile underneath the

522
00:21:54,520 --> 00:21:52,460
path of the spacecraft while we're

523
00:21:56,950 --> 00:21:54,530
switching to the next animation let me

524
00:21:59,230 --> 00:21:56,960
say that that laser altimeter has

525
00:22:02,350 --> 00:21:59,240
operated more than two million times

526
00:22:06,570 --> 00:22:02,360
from orbit so far and what do you see

527
00:22:09,630 --> 00:22:06,580
playing out on this animation our tracks

528
00:22:11,860 --> 00:22:09,640
color-coded by elevation of the

529
00:22:14,020 --> 00:22:11,870
topography of the northern hemisphere of

530
00:22:14,560 --> 00:22:14,030
mercury we're seeing the broad shape of

531
00:22:16,480 --> 00:22:14,570
the planet

532
00:22:19,210 --> 00:22:16,490
for the first time we're seeing detailed

533
00:22:23,740 --> 00:22:19,220
profiles of geological features impact

534
00:22:26,430 --> 00:22:23,750
craters and basins fault scarps volcanic

535
00:22:29,409 --> 00:22:26,440
terrain you're seeing that the northern

536
00:22:31,840 --> 00:22:29,419
region of the planet is surprisingly low

537
00:22:34,149 --> 00:22:31,850
the area of the of the Northern Plains

538
00:22:36,580 --> 00:22:34,159

that Bret talked about has some quite

539
00:22:38,560 --> 00:22:36,590
low but variable elevations several

540
00:22:41,590 --> 00:22:38,570
kilometres below that for the average of

541
00:22:45,279 --> 00:22:41,600
the planet the total range in elevation

542
00:22:48,009 --> 00:22:45,289
is as much as 9 kilometers on the basis

543
00:22:50,139 --> 00:22:48,019
of observations to date one of the

544
00:22:52,930 --> 00:22:50,149
investigations that we're using alt

545
00:22:55,960 --> 00:22:52,940
imagery to pursue is a 20-year old

546
00:22:58,690 --> 00:22:55,970
mystery that was set by earth-based

547
00:23:03,369 --> 00:22:58,700
radar observations in the next graphic

548
00:23:05,049 --> 00:23:03,379
shows a modern radar image of a portion

549
00:23:07,299 --> 00:23:05,059
of the north polar region of mercury

550
00:23:10,060 --> 00:23:07,309
obtained at the Arecibo Observatory in

551
00:23:12,820 --> 00:23:10,070
Puerto Rico what you see are bright

552
00:23:14,440 --> 00:23:12,830
deposits that radar wavelengths that are

553
00:23:15,519 --> 00:23:14,450
thought on the basis of the radar

554
00:23:18,180 --> 00:23:15,529
characteristics this is a

555
00:23:21,509 --> 00:23:18,190
twenty-year-old proposal to be water ice

556
00:23:24,909 --> 00:23:21,519
this on the planet closest to the Sun

557
00:23:26,980 --> 00:23:24,919
now yep planet gets very hot at the

558
00:23:29,950 --> 00:23:26,990
equator in the daytime so how can there

559
00:23:32,200 --> 00:23:29,960
be water ice at the poles of mercury the

560
00:23:34,899 --> 00:23:32,210
hypothesis now going back 20 years is

561
00:23:37,450 --> 00:23:34,909
that that water ice resides and on the

562
00:23:39,730 --> 00:23:37,460
floors of impact craters that are in

563
00:23:41,649 --> 00:23:39,740

permanent shadow that never see sunlight

564
00:23:44,110 --> 00:23:41,659
and therefore are extraordinarily cold

565
00:23:47,019 --> 00:23:44,120
and remain cold for millions or billions

566
00:23:50,049 --> 00:23:47,029
of years well we are testing that idea

567
00:23:53,169 --> 00:23:50,059
with several of our investigations but

568
00:23:55,060 --> 00:23:53,179
today let me tell you that the first

569
00:23:57,190 --> 00:23:55,070
test has been with altimetry the next

570
00:24:01,990 --> 00:23:57,200
slide shows an example of one of these

571
00:24:07,230 --> 00:24:02,000
craters on one of our global mosaics the

572
00:24:09,879 --> 00:24:07,240
one in circles in red is our host a

573
00:24:13,389 --> 00:24:09,889
polar deposits on its floors you see the

574
00:24:16,419 --> 00:24:13,399
radar map superimposed on the global

575
00:24:19,090 --> 00:24:16,429
mosaic for a messenger NRL temperature

576
00:24:22,060 --> 00:24:19,100
made several passes over this particular

577
00:24:25,149 --> 00:24:22,070
crater 25 kilometers in diameter 15

578
00:24:26,560 --> 00:24:25,159
miles across early in the orbital phase

579
00:24:27,919 --> 00:24:26,570
of our mission and the next slide shows

580
00:24:30,259 --> 00:24:27,929
a contour map

581
00:24:32,359 --> 00:24:30,269
of that crater built up by the

582
00:24:36,889 --> 00:24:32,369
topographic profiles that we collected

583
00:24:39,769 --> 00:24:36,899
from orbit and this contour map combined

584
00:24:42,320 --> 00:24:39,779
with calculations of where the Sun

585
00:24:45,289 --> 00:24:42,330
shines as a function of time of year and

586
00:24:47,989 --> 00:24:45,299
position on mercury surface allows us to

587
00:24:50,029 --> 00:24:47,999
test what parts of the floor of this

588
00:24:51,739 --> 00:24:50,039

crater and other craters at high

589
00:24:54,619 --> 00:24:51,749
northern latitudes are in permanent

590
00:24:58,129 --> 00:24:54,629
shadow and indeed this crater passes the

591
00:25:01,430 --> 00:24:58,139
test the portion of the floor that is in

592
00:25:03,950 --> 00:25:01,440
permanent shadow a coincides with the

593
00:25:05,720 --> 00:25:03,960
portion of the floor of the crater where

594
00:25:10,039 --> 00:25:05,730
we see the radar bright deposits

595
00:25:12,739 --> 00:25:10,049
hypothesized to be water ice so stay

596
00:25:15,830 --> 00:25:12,749
tuned this is a very exciting hypothesis

597
00:25:18,169 --> 00:25:15,840
is now with us for 20 years that planet

598
00:25:20,600 --> 00:25:18,179
Mercury may have large quantities of

599
00:25:22,570 --> 00:25:20,610
Isis at the North and South Pole the

600
00:25:25,220 --> 00:25:22,580
very first scientific test of that

601
00:25:28,989 --> 00:25:25,230
hypothesis using messenger data from

602
00:25:31,310 --> 00:25:28,999
orbit has passed with flying colors and

603
00:25:33,019 --> 00:25:31,320
we look forward to results particularly

604
00:25:35,239 --> 00:25:33,029
from our geochemical remote-sensing

605
00:25:38,180 --> 00:25:35,249
instruments the neutron spectrometer in

606
00:25:40,369 --> 00:25:38,190
particular given enough time from orbit

607
00:25:43,879 --> 00:25:40,379
and one years we've shown is enough time

608
00:25:46,639 --> 00:25:43,889
so stay tuned we'll demonstrate whether

609
00:25:48,680 --> 00:25:46,649
or not the material at the poles is

610
00:25:51,289 --> 00:25:48,690
likely to be water ice on the basis of

611
00:25:55,789 --> 00:25:51,299
excess hydrogen let me turn now to the

612
00:25:57,649 --> 00:25:55,799
magnetic field of mercury the magnetic

613
00:25:59,570 --> 00:25:57,659

field was discovered by Mariner 10 it's

614
00:26:01,340 --> 00:25:59,580
much smaller than the magnetic field of

615
00:26:03,739 --> 00:26:01,350
the earth you probably know that Venus

616
00:26:05,779 --> 00:26:03,749
and Mars do not have a magnetic field so

617
00:26:07,519 --> 00:26:05,789
the mercury is the only other earth-like

618
00:26:10,190 --> 00:26:07,529
planet to have one and what we thought

619
00:26:12,470 --> 00:26:10,200
on the basis of the flybys was that

620
00:26:15,019 --> 00:26:12,480
mercury was a miniature version of

621
00:26:17,359 --> 00:26:15,029
Earth's magnetic field produced by

622
00:26:20,149 --> 00:26:17,369
similar processes and with broadly

623
00:26:21,710 --> 00:26:20,159
similar geometry now that we're in orbit

624
00:26:24,470 --> 00:26:21,720
we can measure that magnetic field every

625
00:26:26,649 --> 00:26:24,480
day and what we're seeing is that it is

626
00:26:29,389 --> 00:26:26,659
not a minister of the Earth's field

627
00:26:30,649 --> 00:26:29,399
before you start the animation let me

628
00:26:32,090 --> 00:26:30,659
say what you're going to see we're

629
00:26:35,359 --> 00:26:32,100
looking down on the North Pole of

630
00:26:37,999 --> 00:26:35,369
mercury every orbit we determine the

631
00:26:39,440 --> 00:26:38,009
position of the magnetic equator the

632
00:26:41,750 --> 00:26:39,450
part of the orbit where we cross

633
00:26:44,480 --> 00:26:41,760
Mercury's magnetic equator to find

634
00:26:47,060 --> 00:26:44,490
the point at which the internal magnetic

635
00:26:49,220 --> 00:26:47,070
field is parallel to the spin axis of

636
00:26:51,230 --> 00:26:49,230
the planet and those red dots of the

637
00:26:52,880 --> 00:26:51,240
location of the magnetic equator looking

638
00:26:54,110 --> 00:26:52,890

down from the North Pole so all looks

639
00:26:56,150 --> 00:26:54,120
well but now if we can start the

640
00:26:59,390 --> 00:26:56,160
animation you'll see where that magnetic

641
00:27:01,940 --> 00:26:59,400
equator loss it is not at the geographic

642
00:27:05,420 --> 00:27:01,950
equator of the planet which is that gray

643
00:27:07,730 --> 00:27:05,430
line it is north of systematically north

644
00:27:10,010 --> 00:27:07,740
on every orbit north of the geographic

645
00:27:13,130 --> 00:27:10,020
equator by two-tenths of a planet radius

646
00:27:15,470 --> 00:27:13,140
what that means is that the magnetic

647
00:27:18,200 --> 00:27:15,480
field and the northern hemisphere is

648
00:27:19,400 --> 00:27:18,210
stronger and differs from that in the

649
00:27:21,440 --> 00:27:19,410
southern hemisphere and it means that

650
00:27:23,330 --> 00:27:21,450
the process that creates the magnetic

651
00:27:25,580 --> 00:27:23,340
field which we think is somewhat similar

652
00:27:27,470 --> 00:27:25,590
to that in earth that it arises from

653
00:27:30,080 --> 00:27:27,480
Dynamo processes in the planets core

654
00:27:31,670 --> 00:27:30,090
must be capable of producing this

655
00:27:34,880 --> 00:27:31,680
asymmetry between the North and the

656
00:27:37,250 --> 00:27:34,890
South now there are some consequences of

657
00:27:38,840 --> 00:27:37,260
having this strongly asymmetric fields

658
00:27:42,440 --> 00:27:38,850
and one of them is depicted on the next

659
00:27:45,050 --> 00:27:42,450
slide if if you map the magnetic field

660
00:27:47,330 --> 00:27:45,060
lines at the north and south polar

661
00:27:51,290 --> 00:27:47,340
regions of mercury those magnetic field

662
00:27:53,870 --> 00:27:51,300
lines look pretty complicated but focus

663
00:27:55,790 --> 00:27:53,880

on what is different between the North

664
00:27:56,900 --> 00:27:55,800
and the South the north on the left and

665
00:27:59,030 --> 00:27:56,910
the south on the right and what is

666
00:28:01,880 --> 00:27:59,040
different is the area around the pole

667
00:28:05,450 --> 00:28:01,890
itself the areas were the letters n and

668
00:28:08,150 --> 00:28:05,460
s and the next slide shows those in more

669
00:28:10,550 --> 00:28:08,160
detail those areas are called polar caps

670
00:28:12,770 --> 00:28:10,560
for students of the magnetosphere and

671
00:28:16,370 --> 00:28:12,780
their areas were the field lines don't

672
00:28:18,860 --> 00:28:16,380
close around the planet but are open to

673
00:28:21,530 --> 00:28:18,870
interplanetary space why is that

674
00:28:23,540 --> 00:28:21,540
important it is important because open

675
00:28:25,670 --> 00:28:23,550
field lines are like interstate highways

676
00:28:27,740 --> 00:28:25,680
for charged particles from the inter

677
00:28:29,660 --> 00:28:27,750
planetary environment and those charged

678
00:28:31,550 --> 00:28:29,670
particles come roaring in and hit the

679
00:28:33,170 --> 00:28:31,560
surface of mercury what happens when

680
00:28:35,450 --> 00:28:33,180
they do one of the things is that

681
00:28:37,400 --> 00:28:35,460
material is kicked off the surface and

682
00:28:39,800 --> 00:28:37,410
contributes to Mercury's very tenuous

683
00:28:42,080 --> 00:28:39,810
atmosphere calls an exosphere and

684
00:28:44,180 --> 00:28:42,090
another is that the impacts of these

685
00:28:46,640 --> 00:28:44,190
charged particles changed slowly over

686
00:28:48,800 --> 00:28:46,650
time that the chemistry and the color

687
00:28:51,410 --> 00:28:48,810
and the reflective properties of the

688
00:28:53,930 --> 00:28:51,420

surface by a set of processes known as

689
00:28:55,379 --> 00:28:53,940
space weathering so a prediction of this

690
00:28:57,869 --> 00:28:55,389
new model for

691
00:28:59,819 --> 00:28:57,879
mercury's magnetic field is that the

692
00:29:03,359 --> 00:28:59,829
processes of generation of the exosphere

693
00:29:05,639 --> 00:29:03,369
and the processes of changing the color

694
00:29:07,589 --> 00:29:05,649
and reflectance of mercury service

695
00:29:09,119 --> 00:29:07,599
should be very different near the North

696
00:29:11,759 --> 00:29:09,129
Pole and near the South Pole and we'll

697
00:29:15,419 --> 00:29:11,769
be testing these ideas as we go forward

698
00:29:17,879 --> 00:29:15,429
but Mercury's magnetic field environment

699
00:29:20,190 --> 00:29:17,889
Mercury's magnetosphere is different in

700
00:29:22,319 --> 00:29:20,200
some other ways as well and I will turn

701
00:29:24,209 --> 00:29:22,329
the podium now to my colleague Ralph

702
00:29:26,819 --> 00:29:24,219
mcnutt to describe some other new

703
00:29:29,159 --> 00:29:26,829
results Thank You Sean what I'd like to

704
00:29:31,079 --> 00:29:29,169
do is to amplify on some of the things

705
00:29:33,359 --> 00:29:31,089
that Sean is talking about about the

706
00:29:35,909 --> 00:29:33,369
magnetosphere and also talk a little bit

707
00:29:38,459 --> 00:29:35,919
about rather serendipitous discovery

708
00:29:41,279 --> 00:29:38,469
that was made with the instruments that

709
00:29:43,769 --> 00:29:41,289
Larry was talking about for for doing

710
00:29:45,829 --> 00:29:43,779
our geochemistry observations and if I

711
00:29:48,839 --> 00:29:45,839
could have the first graphic please

712
00:29:50,819 --> 00:29:48,849
larry was talking about using our gamma

713
00:29:52,560 --> 00:29:50,829

ray spectrometer to look for gamma rays

714
00:29:54,180 --> 00:29:52,570
from the surface of the planet and this

715
00:29:56,129 --> 00:29:54,190
is actually what the gamma ray

716
00:29:58,409 --> 00:29:56,139
spectrometer on messenger looks like in

717
00:30:00,209 --> 00:29:58,419
schematic the yellow part at the top

718
00:30:01,919 --> 00:30:00,219
actually points back toward the surface

719
00:30:04,109 --> 00:30:01,929
of the planet that's nominally where the

720
00:30:08,369 --> 00:30:04,119
gamma rays come in through through and

721
00:30:11,699 --> 00:30:08,379
the blow-up shows the working piece of

722
00:30:13,849 --> 00:30:11,709
this the red area is actually a single

723
00:30:16,319 --> 00:30:13,859
polished crystal of germanium

724
00:30:18,239 --> 00:30:16,329
semiconductor about two and a half

725
00:30:19,859 --> 00:30:18,249
inches by two and a half inches and

726
00:30:22,349 --> 00:30:19,869
that's what we use for actually looking

727
00:30:25,619 --> 00:30:22,359
at the looking at the gamma rays but it

728
00:30:27,690 --> 00:30:25,629
turns out that at energies that are

729
00:30:29,190 --> 00:30:27,700
lower than what we use for looking at

730
00:30:31,589 --> 00:30:29,200
the gamma rays there is still some

731
00:30:35,099 --> 00:30:31,599
response of the instrument to what is

732
00:30:37,289 --> 00:30:35,109
also going or going on nearby to the

733
00:30:40,649 --> 00:30:37,299
spacecraft and if I could have the next

734
00:30:43,019 --> 00:30:40,659
graphic please round the spacecraft in

735
00:30:46,680 --> 00:30:43,029
the magnetosphere we know that there are

736
00:30:48,209 --> 00:30:46,690
charged particles the plasma one of the

737
00:30:50,849 --> 00:30:48,219
things that of course has been a big

738
00:30:53,509 --> 00:30:50,859

mystery is that at the time of the

739
00:30:56,940 --> 00:30:53,519
mariner 10 fly by the first one back in

740
00:30:58,469 --> 00:30:56,950
1974 not only was the magnetic field of

741
00:31:00,119 --> 00:30:58,479
the magnetosphere discovered but there

742
00:31:03,659 --> 00:31:00,129
were also these bursts of energetic

743
00:31:05,940 --> 00:31:03,669
electrons and this is something that we

744
00:31:07,889 --> 00:31:05,950
haven't seen on any of the flybys that

745
00:31:09,180 --> 00:31:07,899
we've had with messenger going by going

746
00:31:11,730 --> 00:31:09,190
by the planet and we've

747
00:31:13,560 --> 00:31:11,740
have we have a detector that's on board

748
00:31:15,660 --> 00:31:13,570
the energetic particle spectrometer

749
00:31:18,480 --> 00:31:15,670
specifically for looking for events like

750
00:31:22,170 --> 00:31:18,490
that and it's been quite silent during

751
00:31:24,330 --> 00:31:22,180
all the flybys we we had but then

752
00:31:26,400 --> 00:31:24,340
something interesting happened once that

753
00:31:28,200 --> 00:31:26,410
we finally got into orbit and this just

754
00:31:30,390 --> 00:31:28,210
illustrates one of the things that can

755
00:31:32,040 --> 00:31:30,400
happen in particular with the gamma ray

756
00:31:34,740 --> 00:31:32,050
spectrometers it's got a very large

757
00:31:37,080 --> 00:31:34,750
active area that allows you to see

758
00:31:39,150 --> 00:31:37,090
things that you can't necessarily see

759
00:31:41,580 --> 00:31:39,160
with the other instruments we of course

760
00:31:44,100 --> 00:31:41,590
got there's a possibility of having

761
00:31:45,810 --> 00:31:44,110
electrons near the near the spacecraft

762
00:31:47,820 --> 00:31:45,820
those are indicated on the left and

763
00:31:50,520 --> 00:31:47,830

those can come in and actually hit the

764
00:31:52,800 --> 00:31:50,530
outer case of the instrument if I could

765
00:31:54,870 --> 00:31:52,810
go to the next graphic they're not

766
00:31:56,940 --> 00:31:54,880
energetic enough necessarily to go

767
00:31:59,910 --> 00:31:56,950
through that case but what does happen

768
00:32:02,490 --> 00:31:59,920
and what can happen is I can actually

769
00:32:04,470 --> 00:32:02,500
make x-rays internal to the instrument

770
00:32:07,410 --> 00:32:04,480
itself and it's exactly the same

771
00:32:10,050 --> 00:32:07,420
physical process that's used in medical

772
00:32:12,690 --> 00:32:10,060
x-ray imaging equipment it's exactly the

773
00:32:14,400 --> 00:32:12,700
same process that happens in the upper

774
00:32:17,790 --> 00:32:14,410
atmosphere of the corona of the Sun

775
00:32:20,580 --> 00:32:17,800
where that hard x-ray fluxes are

776
00:32:22,950 --> 00:32:20,590
emanated from such as have happened here

777
00:32:24,810 --> 00:32:22,960
in the last couple of weeks and so one

778
00:32:26,640 --> 00:32:24,820
of the possibilities we actually have

779
00:32:28,500 --> 00:32:26,650
with this instrument is not only in

780
00:32:31,410 --> 00:32:28,510
looking at the gamma rays coming back

781
00:32:34,140 --> 00:32:31,420
from the surface but actually being able

782
00:32:35,850 --> 00:32:34,150
to see gamma rays that are being that

783
00:32:39,090 --> 00:32:35,860
are being produced within the instrument

784
00:32:41,910 --> 00:32:39,100
housing itself if there are enough

785
00:32:44,220 --> 00:32:41,920
electrons in the region of space that

786
00:32:46,140 --> 00:32:44,230
we're flying through certainly the kind

787
00:32:48,810 --> 00:32:46,150
of usage of this instrument that it was

788
00:32:50,970 --> 00:32:48,820

not designed for but again it gets back

789
00:32:52,890 --> 00:32:50,980
to serendipity having a having a happy

790
00:32:55,380 --> 00:32:52,900
discovery based upon something one

791
00:32:58,110 --> 00:32:55,390
wasn't expecting if I could go to the

792
00:32:59,550 --> 00:32:58,120
next graphic please and let me just let

793
00:33:01,590 --> 00:32:59,560
me just explain this for a minute this

794
00:33:04,260 --> 00:33:01,600
is very similar to what Sean was just

795
00:33:07,560 --> 00:33:04,270
showing you with the wear that the the

796
00:33:10,050 --> 00:33:07,570
magnetic equator lines up on the planet

797
00:33:11,960 --> 00:33:10,060
in this case again we're looking down on

798
00:33:14,430 --> 00:33:11,970
mercury from the top from the North Pole

799
00:33:16,920 --> 00:33:14,440
but in this case what we're looking at

800
00:33:20,190 --> 00:33:16,930
the the greens and the arrow regions are

801
00:33:22,010 --> 00:33:20,200
the pieces of the orbits that are the

802
00:33:24,440 --> 00:33:22,020
basically we've painted

803
00:33:27,560 --> 00:33:24,450
with the areas where we've seen these

804
00:33:29,540 --> 00:33:27,570
energetic electrons and it's not a

805
00:33:31,490 --> 00:33:29,550
question of just simply flying through

806
00:33:34,580 --> 00:33:31,500
the area and having the electron flux

807
00:33:36,710 --> 00:33:34,590
come up we see this as burst sometimes

808
00:33:38,870 --> 00:33:36,720
they're only there are only tens of

809
00:33:42,080 --> 00:33:38,880
seconds long sometimes they last for

810
00:33:44,630 --> 00:33:42,090
several minutes they're sporadic but

811
00:33:47,000 --> 00:33:44,640
they happen like clockwork almost on

812
00:33:48,320 --> 00:33:47,010
every orbit a lot of variations and the

813
00:33:50,330 --> 00:33:48,330

other thing it's important to notice

814
00:33:52,160 --> 00:33:50,340
note from this graphic as I look down on

815
00:33:56,360 --> 00:33:52,170
this this is Anna coordinate system

816
00:34:00,170 --> 00:33:56,370
where that the Sun is off to thee is off

817
00:34:02,900 --> 00:34:00,180
on the the the right hand side and where

818
00:34:04,640 --> 00:34:02,910
we're seeing these are located all

819
00:34:08,000 --> 00:34:04,650
around the planet and if we could go

820
00:34:09,740 --> 00:34:08,010
ahead and roll this as a film clip this

821
00:34:11,630 --> 00:34:09,750
shows why that we didn't see them bring

822
00:34:14,060 --> 00:34:11,640
the flybys they're all in the northern

823
00:34:16,730 --> 00:34:14,070
hemisphere sort of the darkish gray

824
00:34:19,159 --> 00:34:16,740
areas or the lightest grey areas on here

825
00:34:21,350 --> 00:34:19,169
are pieces of the orbits that the

826
00:34:22,639 --> 00:34:21,360
messenger was in as has been in since

827
00:34:25,340 --> 00:34:22,649
we've gotten into orbit around the

828
00:34:27,320 --> 00:34:25,350
planet and you can see the distribution

829
00:34:30,380 --> 00:34:27,330
of these things tends to be at mid

830
00:34:32,480 --> 00:34:30,390
northern latitudes the blue ones which

831
00:34:34,700 --> 00:34:32,490
tend to be more symmetric about the

832
00:34:37,280 --> 00:34:34,710
planet or at higher energies from the

833
00:34:38,810 --> 00:34:37,290
from the the gamma ray detector the

834
00:34:41,240 --> 00:34:38,820
lower energy ones are from similar

835
00:34:43,010 --> 00:34:41,250
physical processes that we're seeing in

836
00:34:44,990 --> 00:34:43,020
the x-ray detector again that's the same

837
00:34:47,720 --> 00:34:45,000
two instruments that Larry was talking

838
00:34:50,360 --> 00:34:47,730

about in a region of the measurement

839
00:34:51,830 --> 00:34:50,370
Shane where that there's no interference

840
00:34:54,260 --> 00:34:51,840
with what we're looking for with the

841
00:34:56,600 --> 00:34:54,270
geochemistry and nonetheless that we're

842
00:34:59,120 --> 00:34:56,610
able to get an idea of what's going on

843
00:35:00,620 --> 00:34:59,130
around the planet and it turns out of

844
00:35:02,750 --> 00:35:00,630
course that with the three messenger

845
00:35:05,030 --> 00:35:02,760
flybys those were all near the

846
00:35:07,940 --> 00:35:05,040
equatorial plane where we don't see any

847
00:35:11,450 --> 00:35:07,950
of these events the mariner 10 flyby

848
00:35:13,940 --> 00:35:11,460
back in 1974 was at high northern

849
00:35:16,430 --> 00:35:13,950
latitudes and again these events for all

850
00:35:18,320 --> 00:35:16,440
the world look exactly like what was

851
00:35:19,910 --> 00:35:18,330
seen on Mariner 10 so the reason we

852
00:35:22,040 --> 00:35:19,920
didn't see them on messenger is simply

853
00:35:24,650 --> 00:35:22,050
because we were going through the wrong

854
00:35:27,230 --> 00:35:24,660
part of the planets magnetosphere and if

855
00:35:28,820 --> 00:35:27,240
I could go to the last graphic this is

856
00:35:31,880 --> 00:35:28,830
an attempt to sort of put all of this in

857
00:35:33,800 --> 00:35:31,890
context again the Sun is sitting off on

858
00:35:35,930 --> 00:35:33,810
the off on the right-hand side and this

859
00:35:37,880 --> 00:35:35,940
is a schematic that's showing

860
00:35:40,910 --> 00:35:37,890
selection of some of the magnetic field

861
00:35:42,440 --> 00:35:40,920
lines the solar wind blows outward from

862
00:35:44,690 --> 00:35:42,450
the Sun intends to compress the

863
00:35:46,390 --> 00:35:44,700

magnetosphere on on the sunward side of

864
00:35:48,650 --> 00:35:46,400
the planet and there's a so-called

865
00:35:50,900 --> 00:35:48,660
magnetotail where the field lines are

866
00:35:52,460 --> 00:35:50,910
drawn out on the other side you can see

867
00:35:54,760 --> 00:35:52,470
the magnetic equator here in this

868
00:35:57,470 --> 00:35:54,770
schematic we've displaced it northward

869
00:35:59,089 --> 00:35:57,480
again this gets back to what Sean was

870
00:36:00,500 --> 00:35:59,099
illustrating about the difference in

871
00:36:03,740 --> 00:36:00,510
this magnetic field from that of the

872
00:36:06,109 --> 00:36:03,750
earth and and the again the green areas

873
00:36:08,300 --> 00:36:06,119
are where we've seen the x-ray where the

874
00:36:11,599 --> 00:36:08,310
x-ray detector has lit up with lower

875
00:36:13,490 --> 00:36:11,609
energy emissions from electrons that

876
00:36:15,970 --> 00:36:13,500
have characteristic energies of maybe

877
00:36:18,770 --> 00:36:15,980
five to ten kilo electron volts and the

878
00:36:21,280 --> 00:36:18,780
blue regions are aware that the the

879
00:36:24,170 --> 00:36:21,290
gamma ray spectrometer has lit up with

880
00:36:26,390 --> 00:36:24,180
electrons due to electrons that are that

881
00:36:29,569 --> 00:36:26,400
are at higher energies one of the

882
00:36:31,280 --> 00:36:29,579
original ideas was that if indeed there

883
00:36:34,099 --> 00:36:31,290
were energetic particles that they would

884
00:36:36,740 --> 00:36:34,109
tend to be concentrated in the night

885
00:36:38,359 --> 00:36:36,750
side of the planets magnetosphere but

886
00:36:39,950 --> 00:36:38,369
that's not what we're seeing we really

887
00:36:43,010 --> 00:36:39,960
are seeing them all around the planet

888
00:36:45,079 --> 00:36:43,020

and this is really different again from

889
00:36:46,250 --> 00:36:45,089
the sorts of things that we've typically

890
00:36:48,800 --> 00:36:46,260
seen in the earth and the Earth's

891
00:36:51,950 --> 00:36:48,810
magnetosphere there was a lot of of work

892
00:36:55,190 --> 00:36:51,960
back after them the mariner 10 flybys

893
00:36:56,809 --> 00:36:55,200
speculation on how that mercury and the

894
00:36:59,510 --> 00:36:56,819
Earth's magnetosphere might be similar

895
00:37:01,309 --> 00:36:59,520
but once again as with some of these

896
00:37:03,140 --> 00:37:01,319
other observations such as with the

897
00:37:06,079 --> 00:37:03,150
geochemistry the planet we're finding

898
00:37:09,819 --> 00:37:06,089
out that mercury really is a world in

899
00:37:12,260 --> 00:37:09,829
and of its own and we're finding that

900
00:37:15,140 --> 00:37:12,270
just like the earth it's got its own

901
00:37:17,569 --> 00:37:15,150
personality mercury is one of the

902
00:37:20,120 --> 00:37:17,579
terrestrial planets and therefore

903
00:37:21,829 --> 00:37:20,130
provide some context for what was going

904
00:37:24,079 --> 00:37:21,839
on in the inner part of the solar system

905
00:37:26,690 --> 00:37:24,089
back when that the planets were

906
00:37:29,210 --> 00:37:26,700
condensing from the solar nebula but as

907
00:37:31,220 --> 00:37:29,220
we look and as we continue to look with

908
00:37:33,920 --> 00:37:31,230
messenger at mercury looking close up

909
00:37:36,050 --> 00:37:33,930
with targeted observations using all of

910
00:37:37,280 --> 00:37:36,060
the various instrumentation such as

911
00:37:39,800 --> 00:37:37,290
things that were simply not available

912
00:37:43,040 --> 00:37:39,810
with the technology at the time of

913
00:37:46,069 --> 00:37:43,050

Mariner 10 we're managing to really

914
00:37:49,040 --> 00:37:46,079
explore a new world for the first time

915
00:37:49,550 --> 00:37:49,050
we are out there on the edge we're doing

916
00:37:51,500 --> 00:37:49,560
things

917
00:37:53,960 --> 00:37:51,510
with technology that had to be developed

918
00:37:57,560 --> 00:37:53,970
for this mission and we're learning

919
00:38:01,630 --> 00:37:57,570
things by being in a place that no human

920
00:38:05,090 --> 00:38:01,640
being has ever by proxy gone before and

921
00:38:07,130 --> 00:38:05,100
that's what science and exploration and

922
00:38:08,750 --> 00:38:07,140
the sorts of things that come out of the

923
00:38:11,690 --> 00:38:08,760
science Mission Directorate at NASA are

924
00:38:16,940 --> 00:38:11,700
all about and I think all of us are very

925
00:38:19,820 --> 00:38:16,950
pleased to be part of messenger as one

926
00:38:22,340 --> 00:38:19,830
of these discovery missions which has

927
00:38:25,250 --> 00:38:22,350
now gone through only one quarter of its

928
00:38:27,650 --> 00:38:25,260
nominal mission at mercury and there's a

929
00:38:30,200 --> 00:38:27,660
lot more to come and all I can say is

930
00:38:33,920 --> 00:38:30,210
keep following us the best is yet to be

931
00:38:36,560 --> 00:38:33,930
and Wayne thank you all congratulations

932
00:38:37,970 --> 00:38:36,570
again just a reminder to our television

933
00:38:39,860 --> 00:38:37,980
audience all the images that were

934
00:38:44,690 --> 00:38:39,870
presented today and much much more is on

935
00:38:47,540 --> 00:38:44,700
www yoga / messenger now I kind of snuck

936
00:38:49,310 --> 00:38:47,550
in in my introductory remarks a little

937
00:38:50,630 --> 00:38:49,320
surprise of our own here you heard about

938
00:38:52,850 --> 00:38:50,640

the surprises of mercury but

939
00:38:54,470 --> 00:38:52,860
headquarters has a surprise so before we

940
00:38:57,950 --> 00:38:54,480
open it up for questions I would like

941
00:38:59,840 --> 00:38:57,960
dr. Jim Green the director of NASA's

942
00:39:09,170 --> 00:38:59,850
planetary science division to come to

943
00:39:13,850 --> 00:39:09,180
the stage thank you doing in Shawn will

944
00:39:17,480 --> 00:39:13,860
you please come here thank you on behalf

945
00:39:20,360 --> 00:39:17,490
of NASA and the US Postal Service is my

946
00:39:22,520 --> 00:39:20,370
great pleasure to give you a commitment

947
00:39:24,890 --> 00:39:22,530
of commemorative first day cover it's

948
00:39:27,980 --> 00:39:24,900
everything mercury that NASA is doing

949
00:39:29,210 --> 00:39:27,990
for 50 years for 50 years and as you

950
00:39:31,160 --> 00:39:29,220
know with the stamps that have been

951
00:39:33,260 --> 00:39:31,170
issued its forever they're forever

952
00:39:35,750 --> 00:39:33,270
stamps is forever mercury and Israel

953
00:39:37,970 --> 00:39:35,760
said more great Sciences you have to be

954
00:39:39,770 --> 00:39:37,980
coming with with the rest of the mission

955
00:39:42,050 --> 00:39:39,780
so congratulations to you and the team

956
00:39:44,090 --> 00:39:42,060
occasion like the first that you have

957
00:39:52,569 --> 00:39:44,100
and getting messenger in orbit all right

958
00:39:57,469 --> 00:39:56,329
okay let's see if we have any questions

959
00:39:59,539 --> 00:39:57,479
here we're going to start here now so

960
00:40:04,370 --> 00:39:59,549
headquarters wait for the mic give you a

961
00:40:06,019 --> 00:40:04,380
name and affiliation Randy Shostak

962
00:40:08,420 --> 00:40:06,029
reported with eos newspaper of the

963
00:40:10,009 --> 00:40:08,430

American Geophysical Union this is very

964
00:40:12,979 --> 00:40:10,019
exciting information thank you for the

965
00:40:15,380 --> 00:40:12,989
press conference um I wondered if you

966
00:40:17,509 --> 00:40:15,390
could elaborate particularly on some of

967
00:40:20,359 --> 00:40:17,519
the latter comments by dr. McNutt and if

968
00:40:23,959 --> 00:40:20,369
you can put this in broader context in

969
00:40:25,969 --> 00:40:23,969
for me what does all this add up to what

970
00:40:28,579 --> 00:40:25,979
do all these new images what do all

971
00:40:30,529 --> 00:40:28,589
these new findings add up to and at this

972
00:40:33,529 --> 00:40:30,539
point what are you most pleased about to

973
00:40:35,709 --> 00:40:33,539
date and what what are the the surprises

974
00:40:38,089 --> 00:40:35,719
and and things that puzzle you the most

975
00:40:39,739 --> 00:40:38,099
well I think that certainly the thing

976
00:40:41,269 --> 00:40:39,749
that we're most pleased about is that

977
00:40:43,069 --> 00:40:41,279
we're in orbit we've got a healthy

978
00:40:44,719 --> 00:40:43,079
spacecraft we've gotten through the

979
00:40:47,479 --> 00:40:44,729
hottest part of the orbit and everything

980
00:40:49,609 --> 00:40:47,489
is still working you know I've

981
00:40:52,339 --> 00:40:49,619
personally been involved in a variety of

982
00:40:55,370 --> 00:40:52,349
NASA missions and all I can say is that

983
00:40:58,969 --> 00:40:55,380
I keep being amazed every morning that I

984
00:41:01,539 --> 00:40:58,979
get up how well that messenger is going

985
00:41:04,670 --> 00:41:01,549
it has been it has been a tremendous

986
00:41:07,609 --> 00:41:04,680
partnership between the messenger team

987
00:41:09,829 --> 00:41:07,619
and NASA actually again pulling

988
00:41:13,099 --> 00:41:09,839

something off that no one has ever done

989
00:41:15,349 --> 00:41:13,109
before I think in terms of what we're

990
00:41:17,509 --> 00:41:15,359
learning again one of the things that we

991
00:41:21,259 --> 00:41:17,519
said when we started the mission in the

992
00:41:23,719 --> 00:41:21,269
beginning is that mercury is that end

993
00:41:25,789 --> 00:41:23,729
member planet of the terrestrial planets

994
00:41:28,670 --> 00:41:25,799
it tells us something about the inner

995
00:41:30,709 --> 00:41:28,680
part of the solar nebula it tells us

996
00:41:32,959 --> 00:41:30,719
something about how the terrestrial

997
00:41:35,150 --> 00:41:32,969
planets formed ultimately again the

998
00:41:37,430 --> 00:41:35,160
sorts of results that that Larry was

999
00:41:40,189 --> 00:41:37,440
discussing about how that the potassium

1000
00:41:42,349 --> 00:41:40,199
thorium ratio differs amongst the

1001
00:41:45,199 --> 00:41:42,359
planets and that and that mercury has

1002
00:41:47,209 --> 00:41:45,209
really been a surprise there it's

1003
00:41:49,969 --> 00:41:47,219
certainly clear from that as well as

1004
00:41:52,140 --> 00:41:49,979
from the images that the rut was showing

1005
00:41:54,960 --> 00:41:52,150
is that

1006
00:41:58,019 --> 00:41:54,970
comments to the contrary mercury ain't

1007
00:42:00,420 --> 00:41:58,029
the moon there have been a lot of a lot

1008
00:42:02,039 --> 00:42:00,430
of comments that one would read saying

1009
00:42:04,529 --> 00:42:02,049
how that well it just looks like another

1010
00:42:06,630 --> 00:42:04,539
dead piece of rock like the moon why are

1011
00:42:10,799 --> 00:42:06,640
we doing this and the reason we're doing

1012
00:42:12,690 --> 00:42:10,809
it is because I you learn something by

1013
00:42:15,319 --> 00:42:12,700

going to places that we haven't been

1014
00:42:19,380 --> 00:42:15,329
before in the solar system is our home

1015
00:42:21,120 --> 00:42:19,390
we're here we know that we don't know we

1016
00:42:23,339 --> 00:42:21,130
don't know as much as me we might like

1017
00:42:26,519 --> 00:42:23,349
to about our origins and about kind of

1018
00:42:29,430 --> 00:42:26,529
where how all of this came together and

1019
00:42:31,920 --> 00:42:29,440
by going back and taking a look in

1020
00:42:34,680 --> 00:42:31,930
detail at places like mercury we're able

1021
00:42:37,200 --> 00:42:34,690
to put more of those jigsaw puzzle

1022
00:42:39,960 --> 00:42:37,210
pieces together again sean is talking

1023
00:42:42,000 --> 00:42:39,970
about the fact that we've got this this

1024
00:42:45,420 --> 00:42:42,010
very interesting magnetic field

1025
00:42:46,890 --> 00:42:45,430
configuration the only other place in

1026
00:42:49,529 --> 00:42:46,900
the solar system where that you have

1027
00:42:51,990 --> 00:42:49,539
something like this is the magnetic

1028
00:42:54,150 --> 00:42:52,000
field of Saturn where that the spin axis

1029
00:42:56,910 --> 00:42:54,160
and the dipole axis are aligned and it

1030
00:42:58,980 --> 00:42:56,920
turns out that the magnetic equator of

1031
00:43:02,010 --> 00:42:58,990
Saturn is displaced northward of its

1032
00:43:03,450 --> 00:43:02,020
geographic equator not by as larger

1033
00:43:06,480 --> 00:43:03,460
percentage something like about I think

1034
00:43:08,809 --> 00:43:06,490
six I think it's like point 06 Saturn

1035
00:43:12,180 --> 00:43:08,819
radii is compared to about point to

1036
00:43:15,269 --> 00:43:12,190
mercury radii for mercury and certainly

1037
00:43:18,180 --> 00:43:15,279
the the environment and the chemistry

1038
00:43:21,000 --> 00:43:18,190

and the and the geophysics of mercury

1039
00:43:25,019 --> 00:43:21,010
and and Saturn are quite different and

1040
00:43:27,980 --> 00:43:25,029
yet now we have examples of two active

1041
00:43:31,890 --> 00:43:27,990
planetary dynamos in the solar system

1042
00:43:34,349 --> 00:43:31,900
that shouldn't be there and for a long

1043
00:43:37,260 --> 00:43:34,359
time I know with with the investigators

1044
00:43:40,200 --> 00:43:37,270
that first void for well first really at

1045
00:43:42,630 --> 00:43:40,210
pioneer 11 and then with Voyager and now

1046
00:43:44,760 --> 00:43:42,640
of course with Cassini there's been a

1047
00:43:46,890 --> 00:43:44,770
lot of speculation about whether that

1048
00:43:49,319 --> 00:43:46,900
Saturn was just sort of the odd man out

1049
00:43:50,970 --> 00:43:49,329
well now with these messenger

1050
00:43:53,160 --> 00:43:50,980
observations we've been able to show

1051
00:43:56,339 --> 00:43:53,170
that now it's just it's just an example

1052
00:43:58,019 --> 00:43:56,349
it's one of two I think that I think

1053
00:43:59,789 --> 00:43:58,029
that one of the other really surprising

1054
00:44:03,259 --> 00:43:59,799
things and very interesting things is

1055
00:44:07,699 --> 00:44:03,269
again this this example of how much

1056
00:44:09,919 --> 00:44:07,709
flooded area of pyroclastic flows these

1057
00:44:11,569 --> 00:44:09,929
explosive flows of volcanism early in

1058
00:44:13,519 --> 00:44:11,579
the history the planet there are and of

1059
00:44:16,009 --> 00:44:13,529
course one of the things we've remarked

1060
00:44:18,589 --> 00:44:16,019
upon before or the or the so-called

1061
00:44:22,249 --> 00:44:18,599
lobate scarps where that we see this

1062
00:44:25,159 --> 00:44:22,259
evidence of mercury having shrunk with

1063
00:44:26,959 --> 00:44:25,169

the the crust folding over where of

1064
00:44:30,319 --> 00:44:26,969
course Shawn's been talking about the

1065
00:44:32,839 --> 00:44:30,329
the idea about the the ice and the

1066
00:44:35,929 --> 00:44:32,849
craters and the fact that we have this

1067
00:44:37,849 --> 00:44:35,939
lidar this laser altimeter that's now in

1068
00:44:40,069 --> 00:44:37,859
orbit around mercury where that we can

1069
00:44:42,380 --> 00:44:40,079
make these deductions about the overall

1070
00:44:44,329 --> 00:44:42,390
topography of the planet I mean this is

1071
00:44:47,509 --> 00:44:44,339
just incredible there's again there is

1072
00:44:49,519 --> 00:44:47,519
oh there's a lot more to come so I don't

1073
00:44:52,219 --> 00:44:49,529
think it's so much a question of what is

1074
00:44:54,620 --> 00:44:52,229
the most amazing but really the question

1075
00:44:56,599 --> 00:44:54,630
of what about the mission and the

1076
00:44:59,029 --> 00:44:56,609
results to date have not been amazing

1077
00:45:01,339 --> 00:44:59,039
because this really is the undiscovered

1078
00:45:04,729 --> 00:45:01,349
country and we really are for the first

1079
00:45:06,620 --> 00:45:04,739
time exploring a new world you have a

1080
00:45:08,449 --> 00:45:06,630
question you pass the mic and there a

1081
00:45:10,759 --> 00:45:08,459
name and affiliation please haiyan

1082
00:45:12,079 --> 00:45:10,769
walters with the German press agency um

1083
00:45:13,729 --> 00:45:12,089
you mentioned quite a number of

1084
00:45:16,039 --> 00:45:13,739
observations that you've had that

1085
00:45:17,959 --> 00:45:16,049
weren't what you were expecting to see

1086
00:45:20,539 --> 00:45:17,969
and I was hoping that you could maybe

1087
00:45:23,659 --> 00:45:20,549
say what was the biggest misconception

1088
00:45:27,729 --> 00:45:23,669

that there was about mercury before you

1089
00:45:32,809 --> 00:45:27,739
started this mission the biggest

1090
00:45:35,389 --> 00:45:32,819
misconception the biggest misconception

1091
00:45:37,899 --> 00:45:35,399
was that we would go to a planet orbited

1092
00:45:43,969 --> 00:45:37,909
for the first time and not be surprised

1093
00:45:48,129 --> 00:45:43,979
and and some even in the planetary

1094
00:45:52,549 --> 00:45:48,139
community after the mariner 10 mission

1095
00:45:55,659 --> 00:45:52,559
placed a low priority on returning a

1096
00:45:59,449 --> 00:45:55,669
spacecraft to mercury on the grounds

1097
00:46:01,639 --> 00:45:59,459
that it was very much like the moon we

1098
00:46:04,519 --> 00:46:01,649
had been to the moon it was an example

1099
00:46:07,039 --> 00:46:04,529
to use a phrase coined by a very famous

1100
00:46:12,139 --> 00:46:07,049
space scientist one of the burnt-out

1101
00:46:15,769 --> 00:46:12,149
cinders of the solar system and it is

1102
00:46:16,819 --> 00:46:15,779
anything but that just to elaborate very

1103
00:46:20,029 --> 00:46:16,829
brief them on the

1104
00:46:22,969 --> 00:46:20,039
summary that Ralph gave and give a

1105
00:46:24,910 --> 00:46:22,979
little more context NASA is doing some

1106
00:46:28,609 --> 00:46:24,920
other wonderful missions that are

1107
00:46:30,680 --> 00:46:28,619
expanding at a huge rate our knowledge

1108
00:46:33,440 --> 00:46:30,690
of planets around other stars you know

1109
00:46:36,229 --> 00:46:33,450
Kepler's announced tripled the number of

1110
00:46:37,699 --> 00:46:36,239
extrasolar planets recently in their

1111
00:46:41,569 --> 00:46:37,709
announcements and and many of those

1112
00:46:44,719 --> 00:46:41,579
planets are at distances similar to that

1113
00:46:47,779 --> 00:46:44,729

of mercury from our Sun many are of a

1114
00:46:51,829 --> 00:46:47,789
growing number are of masses that are

1115
00:46:53,809 --> 00:46:51,839
approaching that of Earth and Venus but

1116
00:46:57,579 --> 00:46:53,819
we have in our solar system for

1117
00:47:00,499 --> 00:46:57,589
experiments in how earth-like planets

1118
00:47:02,839 --> 00:47:00,509
evolved once they form under slightly

1119
00:47:05,469 --> 00:47:02,849
different conditions different distance

1120
00:47:09,859 --> 00:47:05,479
from the host star a different mass

1121
00:47:11,359 --> 00:47:09,869
different starting composition what

1122
00:47:13,009 --> 00:47:11,369
we're learning is that each of those

1123
00:47:16,009 --> 00:47:13,019
experiments had an extraordinarily

1124
00:47:19,219 --> 00:47:16,019
different outcome and one of those

1125
00:47:21,499 --> 00:47:19,229
experiments we live on so it really

1126
00:47:24,859 --> 00:47:21,509
behooves us to understand in a very

1127
00:47:29,180 --> 00:47:24,869
general way how earth-like planets form

1128
00:47:32,890 --> 00:47:29,190
and evolve and operate and what mercury

1129
00:47:37,279 --> 00:47:32,900
is telling us is we didn't understand

1130
00:47:41,620 --> 00:47:37,289
incomplete generality how planets of the

1131
00:47:45,650 --> 00:47:41,630
earth like class operate in detail so

1132
00:47:48,589 --> 00:47:45,660
we're learning new things every day okay

1133
00:47:50,539 --> 00:47:48,599
now we will switch over and go down to

1134
00:47:57,319 --> 00:47:50,549
the Kennedy Space Center where I believe

1135
00:47:59,599 --> 00:47:57,329
we have a question Kennedy hello ken

1136
00:48:02,539 --> 00:47:59,609
kremer from space flight magazine for

1137
00:48:04,519 --> 00:48:02,549
anybody please you talked about the the

1138
00:48:06,739 --> 00:48:04,529

water ice at the North Pole I'm

1139
00:48:09,259 --> 00:48:06,749
wondering about how much of the surface

1140
00:48:12,109 --> 00:48:09,269
do you think would would be covered with

1141
00:48:13,969 --> 00:48:12,119
this water ice is the fact that it was

1142
00:48:15,289 --> 00:48:13,979
depressed about nine kilometers I think

1143
00:48:17,900 --> 00:48:15,299
you mentioned does that increase or

1144
00:48:21,559 --> 00:48:17,910
decrease the chances of finding water

1145
00:48:23,089 --> 00:48:21,569
ricin is the LRO data with a similar

1146
00:48:24,709 --> 00:48:23,099
instrument are you comparing results

1147
00:48:27,650 --> 00:48:24,719
there and has that been helpful in

1148
00:48:28,910 --> 00:48:27,660
interpreting your data at all thanks Ken

1149
00:48:30,730 --> 00:48:28,920
let me take that question this is sean

1150
00:48:37,250 --> 00:48:30,740
solomon

1151
00:48:39,050 --> 00:48:37,260
in parts the the area of a polar

1152
00:48:41,720 --> 00:48:39,060
deposits has been well worked out by the

1153
00:48:44,060 --> 00:48:41,730
earth base braids are folks that area is

1154
00:48:45,470 --> 00:48:44,070
quite a bit larger than on the moon we

1155
00:48:46,900 --> 00:48:45,480
don't know the thickness of those

1156
00:48:50,870 --> 00:48:46,910
deposits we know that it's thick enough

1157
00:48:52,700 --> 00:48:50,880
to to have radar bright characteristics

1158
00:48:54,500 --> 00:48:52,710
for radar of different wavelengths which

1159
00:48:57,440 --> 00:48:54,510
means it's at least several red or

1160
00:49:02,150 --> 00:48:57,450
thicknesses in extent and the vertical

1161
00:49:05,090 --> 00:49:02,160
direction meaning meters or more there

1162
00:49:06,860 --> 00:49:05,100
isn't a beautiful laser altimeter on the

1163
00:49:09,710 --> 00:49:06,870

Lunar Reconnaissance Orbiter known as

1164
00:49:13,280 --> 00:49:09,720
Lola and that is producing data at a

1165
00:49:16,400 --> 00:49:13,290
huge rate and the topographic maps that

1166
00:49:19,490 --> 00:49:16,410
the lunar reconnaissance orbiter is is

1167
00:49:22,040 --> 00:49:19,500
send is creating from the Lola data is

1168
00:49:25,730 --> 00:49:22,050
just exquisite in its detail and is

1169
00:49:28,220 --> 00:49:25,740
indeed helping to define as our images

1170
00:49:30,950 --> 00:49:28,230
taken from the same spacecraft areas of

1171
00:49:32,360 --> 00:49:30,960
permanent shadow and as you know nASA

1172
00:49:35,540 --> 00:49:32,370
has flown other missions like the L

1173
00:49:37,640 --> 00:49:35,550
crossed mission that impacted into one

1174
00:49:39,410 --> 00:49:37,650
of the south polar craters thought to

1175
00:49:41,750 --> 00:49:39,420
have water and other volatile and showed

1176
00:49:43,760 --> 00:49:41,760
quite spectacularly in on the basis of

1177
00:49:46,970 --> 00:49:43,770
spectral evidence from the ejecta that

1178
00:49:49,460 --> 00:49:46,980
that there is water there but if water

1179
00:49:51,470 --> 00:49:49,470
is the major constituent of the polar

1180
00:49:53,710 --> 00:49:51,480
deposits on mercury then we have the

1181
00:49:57,470 --> 00:49:53,720
irony that the planet closest to the Sun

1182
00:50:00,430 --> 00:49:57,480
is going to have more ice at its poles

1183
00:50:03,320 --> 00:50:00,440
than even our own moon and so stay tuned

1184
00:50:04,910 --> 00:50:03,330
as this mission evolves will be relying

1185
00:50:06,470 --> 00:50:04,920
more and more on the geochemical

1186
00:50:08,690 --> 00:50:06,480
remote-sensing instruments which take

1187
00:50:10,370 --> 00:50:08,700
time to build up their observations but

1188
00:50:13,370 --> 00:50:10,380

the neutron spectrometer the gamma ray

1189
00:50:15,350 --> 00:50:13,380
spectrometer have the ability to tell us

1190
00:50:17,780 --> 00:50:15,360
what those materials are is it water

1191
00:50:19,790 --> 00:50:17,790
rises it's something else and we expect

1192
00:50:25,550 --> 00:50:19,800
to have that answer before our mission

1193
00:50:28,580 --> 00:50:25,560
is done ok now we can go to the phone

1194
00:50:36,250 --> 00:50:28,590
line and will take first Lisa Grossman

1195
00:50:41,570 --> 00:50:39,380
and that's the data from spectrometers

1196
00:50:43,430 --> 00:50:41,580
is ruling out some models of what

1197
00:50:46,420 --> 00:50:43,440
Mercury's composition can be what models

1198
00:50:48,980 --> 00:50:46,430
are those and what ones are left over

1199
00:50:54,100 --> 00:50:48,990
well so repeat that Lisa could you

1200
00:51:00,950 --> 00:50:58,970
sorry sorry about that um I was

1201
00:51:02,900 --> 00:51:00,960
wondering what the models of Mercury's

1202
00:51:05,990 --> 00:51:02,910
composition and information have been

1203
00:51:06,950 --> 00:51:06,000
ruled out already by the composition

1204
00:51:09,170 --> 00:51:06,960
data you're getting from the

1205
00:51:12,020 --> 00:51:09,180
spectrometers and what possible models

1206
00:51:14,620 --> 00:51:12,030
are still left so this is Larry knit

1207
00:51:16,790 --> 00:51:14,630
lair I'll take that question Lisa

1208
00:51:19,430 --> 00:51:16,800
there's a number of models of the

1209
00:51:21,770 --> 00:51:19,440
formation of mercury that were proposed

1210
00:51:24,380 --> 00:51:21,780
after the Mariner 10 observations in the

1211
00:51:27,110 --> 00:51:24,390
1970s indicated it had an unusually

1212
00:51:31,160 --> 00:51:27,120
large core and one of these models was

1213
00:51:33,140 --> 00:51:31,170

that the planet formed at normally or

1214
00:51:35,210 --> 00:51:33,150
similarly to the earth and had a

1215
00:51:36,800 --> 00:51:35,220
normal-sized core meaning earth-sized

1216
00:51:40,070 --> 00:51:36,810
core relative to the radius of the

1217
00:51:42,530 --> 00:51:40,080
planet and then because the Sun went

1218
00:51:44,650 --> 00:51:42,540
through a phase of extreme high

1219
00:51:47,180 --> 00:51:44,660
intensity in its earliest stages

1220
00:51:50,360 --> 00:51:47,190
essentially mercury was so close to this

1221
00:51:52,850 --> 00:51:50,370
to this hot Sun that the outer layers

1222
00:51:54,470 --> 00:51:52,860
could have evaporated off and in this

1223
00:51:55,940 --> 00:51:54,480
model this would have predicted very

1224
00:51:59,030 --> 00:51:55,950
very low abundances of things like

1225
00:52:01,300 --> 00:51:59,040
potassium and sulfur and sodium so we

1226
00:52:05,120 --> 00:52:01,310
can rule out this this kind of model

1227
00:52:07,550 --> 00:52:05,130
there are other models that proposed

1228
00:52:11,240 --> 00:52:07,560
that mercury formed from a specific kind

1229
00:52:14,210 --> 00:52:11,250
of meteorite called a CB chondrite that

1230
00:52:16,100 --> 00:52:14,220
are very very rich in metal now these

1231
00:52:19,490 --> 00:52:16,110
models make very specific predictions

1232
00:52:21,950 --> 00:52:19,500
for the composition of lavas and rocks

1233
00:52:24,110 --> 00:52:21,960
at the surface of the planet and for the

1234
00:52:25,640 --> 00:52:24,120
most part these are not in detail not in

1235
00:52:27,740 --> 00:52:25,650
agreement with our observations so these

1236
00:52:29,990 --> 00:52:27,750
models in detail can be ruled out but

1237
00:52:34,280 --> 00:52:30,000
possibly variations on them will

1238
00:52:36,830 --> 00:52:34,290

eventually be proven to be right another

1239
00:52:40,300 --> 00:52:36,840
model is that it formed mercury formed

1240
00:52:42,920 --> 00:52:40,310
larger and similarly to the earth and

1241
00:52:45,590 --> 00:52:42,930
after it had formed a earth or moon like

1242
00:52:47,870 --> 00:52:45,600
crust a another planet hit it and

1243
00:52:48,410 --> 00:52:47,880
smashed off the outer crust and part of

1244
00:52:50,180 --> 00:52:48,420
the mental

1245
00:52:52,370 --> 00:52:50,190
leaving a residual mantle that could

1246
00:52:54,320 --> 00:52:52,380
have then produced a new crust at this

1247
00:52:56,450 --> 00:52:54,330
stage we cannot rule out this model the

1248
00:52:59,330 --> 00:52:56,460
data some of our compositional data are

1249
00:53:01,580 --> 00:52:59,340
certainly consistent with this this idea

1250
00:53:04,100 --> 00:53:01,590
in broad outlines whether the high

1251
00:53:06,620 --> 00:53:04,110
sulphur abundance is consistent with

1252
00:53:08,420 --> 00:53:06,630
this we have not yet figured out but

1253
00:53:11,330 --> 00:53:08,430
this is a model that's still still in

1254
00:53:13,760 --> 00:53:11,340
the running and they're probably going

1255
00:53:15,470 --> 00:53:13,770
to be many more models devised before we

1256
00:53:18,580 --> 00:53:15,480
have an answer on this as we continue to

1257
00:53:21,410 --> 00:53:18,590
get interesting data but thank you all

1258
00:53:25,100 --> 00:53:21,420
next question will be from Peter spot oh

1259
00:53:26,960 --> 00:53:25,110
thank you thanks Lisa next question will

1260
00:53:28,550 --> 00:53:26,970
be Peter spots on the christian science

1261
00:53:30,470 --> 00:53:28,560
monitor with the christian science

1262
00:53:32,780 --> 00:53:30,480
monitor and actually good that pretty

1263
00:53:35,260 --> 00:53:32,790

much was like can you hear me so great

1264
00:53:39,740 --> 00:53:35,270
great Pete am I getting through yes I

1265
00:53:41,030 --> 00:53:39,750
guess so okay yeah that that actually

1266
00:53:43,430 --> 00:53:41,040
answered most of my question but let me

1267
00:53:47,720 --> 00:53:43,440
just throw one one other one related to

1268
00:53:50,720 --> 00:53:47,730
that and is is there any possibility for

1269
00:53:53,240 --> 00:53:50,730
a migration of mercury from forming in a

1270
00:53:58,340 --> 00:53:53,250
bit more distant location in the solar

1271
00:54:01,910 --> 00:53:58,350
nebula and somehow migrating in I can

1272
00:54:04,250 --> 00:54:01,920
take that Pete this is Sean Solomon the

1273
00:54:06,290 --> 00:54:04,260
process I think you know or you would

1274
00:54:10,490 --> 00:54:06,300
have asked this question of building up

1275
00:54:13,190 --> 00:54:10,500
the inner planets is a is is one with a

1276
00:54:16,580 --> 00:54:13,200
lot of chance encounters we would call

1277
00:54:20,840 --> 00:54:16,590
it stochastic that the interaction of

1278
00:54:25,910 --> 00:54:20,850
growing objects that start out many and

1279
00:54:29,150 --> 00:54:25,920
become few is not fully predictable and

1280
00:54:32,180 --> 00:54:29,160
depends on particular encounters that

1281
00:54:34,760 --> 00:54:32,190
that can result in in growth of a larger

1282
00:54:37,010 --> 00:54:34,770
object or disruption of an object and

1283
00:54:38,960 --> 00:54:37,020
some of those simulations that have been

1284
00:54:42,920 --> 00:54:38,970
done of the growth of the inner planets

1285
00:54:46,010 --> 00:54:42,930
do include the possibility that mercury

1286
00:54:49,310 --> 00:54:46,020
started to form at a different place in

1287
00:54:52,780 --> 00:54:49,320
the the in solar distance then it ended

1288
00:54:55,370 --> 00:54:52,790

up my late colleague George wetherill

1289
00:55:01,170 --> 00:54:55,380
did some of the pioneering calculations

1290
00:55:05,250 --> 00:55:01,180
of that sort that said

1291
00:55:09,650 --> 00:55:05,260
uh there are also interesting studies of

1292
00:55:12,750 --> 00:55:09,660
the migration of planets once formed and

1293
00:55:14,549 --> 00:55:12,760
this was this work was really stimulated

1294
00:55:16,680 --> 00:55:14,559
by the discovery of extrasolar planets

1295
00:55:19,020 --> 00:55:16,690
near their host stars and a lot of the

1296
00:55:21,480 --> 00:55:19,030
attention has been directed at the major

1297
00:55:23,670 --> 00:55:21,490
planets whose migrations may have had a

1298
00:55:26,190 --> 00:55:23,680
big influence on the history of small

1299
00:55:28,020 --> 00:55:26,200
objects in the solar system but there's

1300
00:55:30,900 --> 00:55:28,030
a very interesting study by a French

1301
00:55:34,650 --> 00:55:30,910
dynamicists of the long term evolution

1302
00:55:37,170 --> 00:55:34,660
of planet Mercury and their simulations

1303
00:55:39,480 --> 00:55:37,180
have shown that some of the orbital

1304
00:55:42,569 --> 00:55:39,490
characteristics of mercury like the

1305
00:55:45,150 --> 00:55:42,579
large eccentricity of the orbit like the

1306
00:55:47,099 --> 00:55:45,160
large inclination that Mercury's orbit

1307
00:55:50,370 --> 00:55:47,109
makes with the orbits of most of the

1308
00:55:52,950 --> 00:55:50,380
other planets are not fixed in time but

1309
00:55:54,299 --> 00:55:52,960
evolve and they made a very interesting

1310
00:55:56,940 --> 00:55:54,309
prediction and a paper in Nature a

1311
00:55:58,890 --> 00:55:56,950
couple years ago that three and a half

1312
00:56:00,299 --> 00:55:58,900
billion years from now it's not

1313
00:56:04,109 --> 00:56:00,309

something we have to worry about next

1314
00:56:06,359 --> 00:56:04,119
week that there's a possibility that the

1315
00:56:09,630 --> 00:56:06,369
orbit of mercury will substantially

1316
00:56:14,160 --> 00:56:09,640
disrupt the orbit of one of the other

1317
00:56:16,020 --> 00:56:14,170
inner planets and so it's something that

1318
00:56:18,240 --> 00:56:16,030
our great-great-great great-great-great

1319
00:56:20,700 --> 00:56:18,250
grandchildren might devote some time

1320
00:56:22,950 --> 00:56:20,710
thinking about that that mercury and its

1321
00:56:24,990 --> 00:56:22,960
orbital evolution may have major

1322
00:56:28,829 --> 00:56:25,000
consequences for the orbit of our own

1323
00:56:32,069 --> 00:56:28,839
planet but that's a prediction that may

1324
00:56:34,079 --> 00:56:32,079
or may not be borne out according to an

1325
00:56:37,530 --> 00:56:34,089
article in nature but I can send you

1326
00:56:40,770 --> 00:56:37,540
that link if you're interested p okay

1327
00:56:43,470 --> 00:56:40,780
next up this Kelly BTW sky and telescope

1328
00:56:46,920 --> 00:56:43,480
magazine Kelly is it is it possible oh

1329
00:56:48,420 --> 00:56:46,930
go ahead go ahead yeah yeah people will

1330
00:56:49,890 --> 00:56:48,430
give you an opportunity to follow us

1331
00:56:52,349 --> 00:56:49,900
because we're approaching the top of the

1332
00:56:59,520 --> 00:56:52,359
hour so let's go ahead and go to Kelly

1333
00:57:01,079 --> 00:56:59,530
BTW at sky and telescope magazine thanks

1334
00:57:03,390 --> 00:57:01,089
very much i came in a little bit late so

1335
00:57:04,980 --> 00:57:03,400
Sean if you covered the possible

1336
00:57:06,839 --> 00:57:04,990
interior structure of the planet i

1337
00:57:08,700 --> 00:57:06,849
missed it but if you didn't if i didn't

1338
00:57:09,839 --> 00:57:08,710

can you say anything about the interior

1339
00:57:12,660 --> 00:57:09,849
structure of the planet and in

1340
00:57:14,700 --> 00:57:12,670
particular what an offset magnetic field

1341
00:57:20,310 --> 00:57:14,710
says about the state of the

1342
00:57:21,990 --> 00:57:20,320
okay Kelly you didn't miss much on

1343
00:57:26,250 --> 00:57:22,000
that topic and we didn't cover it a

1344
00:57:28,740 --> 00:57:26,260
great length we know on the basis of

1345
00:57:32,190 --> 00:57:28,750
measurements made with her earth-based

1346
00:57:34,050 --> 00:57:32,200
radar that the core the outer core of

1347
00:57:38,880 --> 00:57:34,060
mercury is molten like the outer core of

1348
00:57:40,770 --> 00:57:38,890
the earth molten metallic iron rich we

1349
00:57:42,180 --> 00:57:40,780
also know the approximate radius of the

1350
00:57:43,620 --> 00:57:42,190
core on that just on the basis of the

1351
00:57:46,890 --> 00:57:43,630
mean density the planet that's been

1352
00:57:48,510 --> 00:57:46,900
known for 50 60 years and it's a at

1353
00:57:52,490 --> 00:57:48,520
least three-quarters of the radius of

1354
00:57:55,050 --> 00:57:52,500
mercury what the asymmetry the

1355
00:57:59,070 --> 00:57:55,060
equatorial are the asymmetry about the

1356
00:58:01,140 --> 00:57:59,080
equator of the magnetic field means as

1357
00:58:06,599 --> 00:58:01,150
still to be sorted out by the theorists

1358
00:58:08,910 --> 00:58:06,609
but one possibility is that the field

1359
00:58:11,310 --> 00:58:08,920
generating region of the outer core or

1360
00:58:14,040 --> 00:58:11,320
the in particular the boundary between

1361
00:58:16,560 --> 00:58:14,050
the outer core and the mantle may be

1362
00:58:17,760 --> 00:58:16,570
strongly different in the Northern

1363
00:58:20,099 --> 00:58:17,770

Hemisphere and the southern hemisphere

1364
00:58:22,560 --> 00:58:20,109
this idea has been put forward as an

1365
00:58:26,220 --> 00:58:22,570
explanation for an early magnetic field

1366
00:58:27,750 --> 00:58:26,230
on Mars that hat is much stronger in the

1367
00:58:29,790 --> 00:58:27,760
southern hemisphere of Mars than in the

1368
00:58:31,950 --> 00:58:29,800
northern hemisphere to explain the

1369
00:58:35,160 --> 00:58:31,960
strong magnetic anomalies recorded in

1370
00:58:36,930 --> 00:58:35,170
crustal rocks on Mars and their

1371
00:58:39,480 --> 00:58:36,940
locations which are dominantly in the

1372
00:58:42,859 --> 00:58:39,490
southern hemisphere so I have no doubt

1373
00:58:45,750 --> 00:58:42,869
that our new results on Mercury's

1374
00:58:48,740 --> 00:58:45,760
magnetic field geometry is going to

1375
00:58:50,940 --> 00:58:48,750
stimulate a variety of new ideas for how

1376
00:58:53,670 --> 00:58:50,950
Mercury's magnetic field has generated

1377
00:58:55,890 --> 00:58:53,680
how that field might vary with time how

1378
00:58:58,470 --> 00:58:55,900
it varies with position and I look

1379
00:59:02,339 --> 00:58:58,480
forward to those models and to our

1380
00:59:04,440 --> 00:59:02,349
ability to test them okay folks are we

1381
00:59:06,000 --> 00:59:04,450
are going to have to wrap up here at the

1382
00:59:07,950 --> 00:59:06,010
top of the hour for the media who are

1383
00:59:10,470 --> 00:59:07,960
still on the line please get in touch

1384
00:59:13,740 --> 00:59:10,480
with my office or apo public affairs to

1385
00:59:15,900 --> 00:59:13,750
get some follow-up questions and

1386
00:59:17,910 --> 00:59:15,910
interview set up for later in the day I

1387
00:59:19,980 --> 00:59:17,920
want to thank you all for showing up in

1388
00:59:23,310 --> 00:59:19,990

joining us today congratulations to the

1389
00:59:26,400 --> 00:59:23,320
messenger team again go to ww any say

1390
00:59:27,970 --> 00:59:26,410
gioves last messenger science never