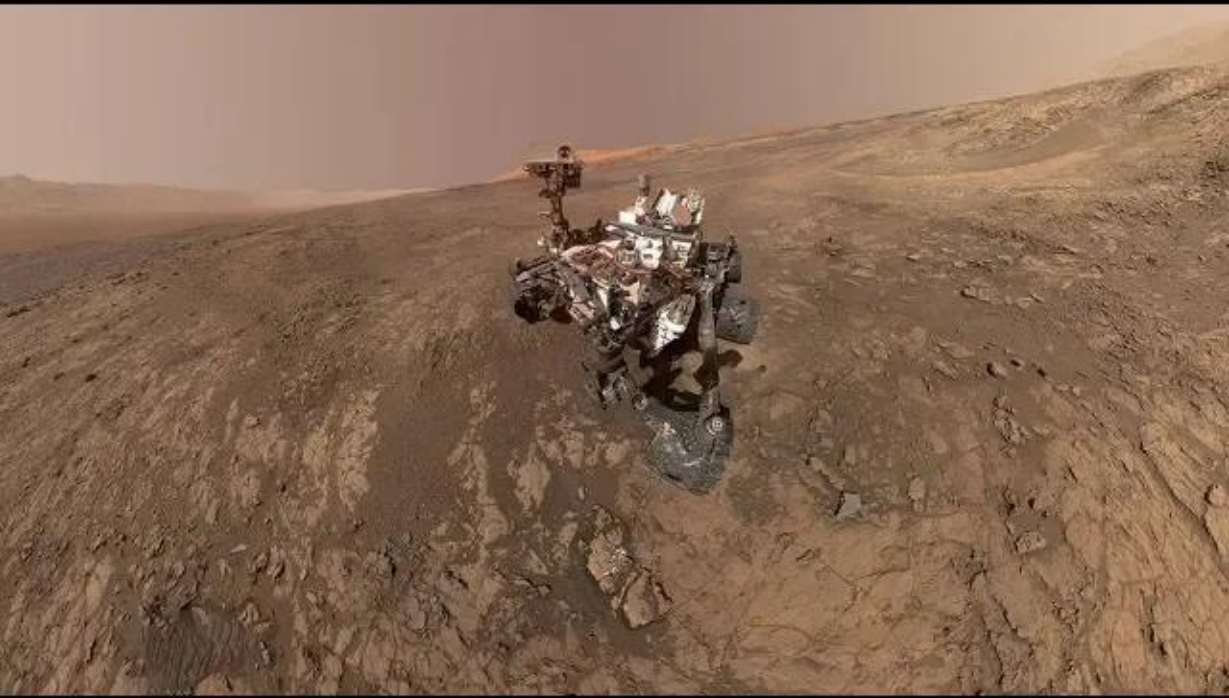

1
00:00:03,260 --> 00:00:01,640
was actually our director of the solar

2
00:00:05,269 --> 00:00:03,270
system exploration division and he's

3
00:00:06,530 --> 00:00:05,279
also the principal investigator for the

4
00:00:08,360 --> 00:00:06,540
Sam instrument which are being talking a

5
00:00:10,070 --> 00:00:08,370
lot today and I also have Jennifer eigen

6
00:00:11,600 --> 00:00:10,080
Brody who has one of the coolest titles

7
00:00:13,820 --> 00:00:11,610
I know of at NASA which is actually an

8
00:00:15,650 --> 00:00:13,830
astrobiologist and we're also here at

9
00:00:16,910 --> 00:00:15,660
another location today as well NASA's

10
00:00:20,300 --> 00:00:16,920
Jet Propulsion Laboratory in California

11
00:00:21,950 --> 00:00:20,310
and here we have dr. Chris Webster who

12
00:00:24,380 --> 00:00:21,960
is a senior research scientist at JPL

13
00:00:25,730 --> 00:00:24,390

and we also have Ashwin Vasavada who is

14
00:00:28,009 --> 00:00:25,740
the project scientist for the Mars

15
00:00:29,779 --> 00:00:28,019
Science Laboratory my name is Michelle

16
00:00:31,429 --> 00:00:29,789
thaller I'm an astronomer here at NASA

17
00:00:32,810 --> 00:00:31,439
and one of the things I'm gonna say

18
00:00:34,549 --> 00:00:32,820
right off the bat today is that none of

19
00:00:36,470 --> 00:00:34,559
us live in a vacuum we all have our own

20
00:00:37,580 --> 00:00:36,480
social media accounts and we're sort of

21
00:00:39,020 --> 00:00:37,590
aware of the interest that this is

22
00:00:41,119 --> 00:00:39,030
generated so I'm going to tell you right

23
00:00:43,190 --> 00:00:41,129
now but we're not announcing today is

24
00:00:44,720 --> 00:00:43,200
the detection of life we're not going to

25
00:00:46,850 --> 00:00:44,730
be talking about that what we are

26
00:00:48,709 --> 00:00:46,860
talking about are some really exciting

27
00:00:51,410 --> 00:00:48,719
new results that have to do with organic

28
00:00:52,880 --> 00:00:51,420
molecules now organic molecules are what

29
00:00:54,740 --> 00:00:52,890
we understand it is the building blocks

30
00:00:56,810 --> 00:00:54,750
of life and even if we're not announcing

31
00:00:58,160 --> 00:00:56,820
the detection of life today I think that

32
00:01:00,200 --> 00:00:58,170
the discoveries we're gonna be talking

33
00:01:02,029 --> 00:01:00,210
about are a really important next step

34
00:01:03,529 --> 00:01:02,039
into finding out whether Mars was once

35
00:01:05,539 --> 00:01:03,539
habitable or might even still be

36
00:01:07,490 --> 00:01:05,549
habitable so what I'm gonna do now is

37
00:01:08,929 --> 00:01:07,500
actually lead it off with Paul Mahaffey

38
00:01:10,520 --> 00:01:08,939

who's gonna talk to us a bit about what

39
00:01:11,000 --> 00:01:10,530
we know and what we don't know about

40
00:01:14,440 --> 00:01:11,010
Mars

41
00:01:17,840 --> 00:01:14,450
so Paul straight up what do we found

42
00:01:21,109 --> 00:01:17,850
really exciting times I'll reinforce

43
00:01:23,630 --> 00:01:21,119
what you said I mean life organic

44
00:01:25,880 --> 00:01:23,640
compounds on earth just so much bear the

45
00:01:28,850 --> 00:01:25,890
imprint of life that it's very natural

46
00:01:31,039 --> 00:01:28,860
for us to equate or finding organics on

47
00:01:33,230 --> 00:01:31,049
Mars with finding life but that's not

48
00:01:34,999 --> 00:01:33,240
the you know that's not the bottom line

49
00:01:36,590 --> 00:01:35,009
of what we're trying to get out here the

50
00:01:39,080 --> 00:01:36,600
bottom line is is that we greatly

51
00:01:40,730 --> 00:01:39,090
expanded our search for organic

52
00:01:43,639 --> 00:01:40,740
compounds which ultimately are

53
00:01:45,080 --> 00:01:43,649
fundamental to our search for life and

54
00:01:47,560 --> 00:01:45,090
it's really interesting kind of two

55
00:01:50,060 --> 00:01:47,570
complementary results one result is

56
00:01:51,710 --> 00:01:50,070
organics from billion-year-old rocks

57
00:01:54,200 --> 00:01:51,720
that got trapped in the rocks in an

58
00:01:57,050 --> 00:01:54,210
ancient lake billions of years ago and

59
00:01:59,030 --> 00:01:57,060
the second really is the simplest

60
00:02:01,429 --> 00:01:59,040
organic methane in the atmosphere and

61
00:02:02,899 --> 00:02:01,439
those two results I can broad and Chris

62
00:02:05,630 --> 00:02:02,909
Webster the lead author on these papers

63
00:02:07,700 --> 00:02:05,640

are going to talk about but let me just

64
00:02:11,240 --> 00:02:07,710
set a little bit of the context it was

65
00:02:13,400 --> 00:02:11,250
kind of August 2012 more than five years

66
00:02:15,440 --> 00:02:13,410
ago we came barreling into Mars

67
00:02:17,600 --> 00:02:15,450
and there was that exciting seven

68
00:02:19,340 --> 00:02:17,610
minutes of Terror and we landed safely

69
00:02:23,450 --> 00:02:19,350
on the service surface thanks to the

70
00:02:26,510 --> 00:02:23,460
great engineering team at JPL that got

71
00:02:29,150 --> 00:02:26,520
us there but the objective of the

72
00:02:32,720 --> 00:02:29,160
mission really was to explore a

73
00:02:34,700 --> 00:02:32,730
habitable environment on Mars and right

74
00:02:36,530 --> 00:02:34,710
off the bat we just found incredible

75
00:02:37,310 --> 00:02:36,540
things we found clays that were formed

76
00:02:40,430 --> 00:02:37,320
by water

77
00:02:42,440 --> 00:02:40,440
the rover Curiosity is just extremely

78
00:02:44,390 --> 00:02:42,450
capable take stereo pictures and

79
00:02:46,670 --> 00:02:44,400
measures the elemental composition of

80
00:02:48,830 --> 00:02:46,680
the rocks it does some mineralogy and

81
00:02:50,390 --> 00:02:48,840
what we've always done even though we

82
00:02:51,710 --> 00:02:50,400
found many things with the experiment

83
00:02:53,480 --> 00:02:51,720
we're going to talk about today which is

84
00:02:59,300 --> 00:02:53,490
Sam the sample analysis at Mars

85
00:03:00,710 --> 00:02:59,310
experiment we essentially found out very

86
00:03:02,420 --> 00:03:00,720
early that this was a habitable

87
00:03:04,820 --> 00:03:02,430
environment water had been there for a

88
00:03:06,590 --> 00:03:04,830

very very long time with our Sam

89
00:03:09,170 --> 00:03:06,600
experiment we found some interesting

90
00:03:11,000 --> 00:03:09,180
things for example how old the rocks

91
00:03:13,700 --> 00:03:11,010
were how long they have been exposed to

92
00:03:15,980 --> 00:03:13,710
cosmic radiation measurements of light

93
00:03:17,930 --> 00:03:15,990
versus heavy elements told us about how

94
00:03:20,000 --> 00:03:17,940
the atmosphere had escaped over billions

95
00:03:21,560 --> 00:03:20,010
of years but we've kept going on this

96
00:03:23,870 --> 00:03:21,570
search for organics and we had found

97
00:03:26,720 --> 00:03:23,880
some nothing before we had found some

98
00:03:28,280 --> 00:03:26,730
simple organic molecules before but we

99
00:03:33,500 --> 00:03:28,290
greatly expanded the search with the

100
00:03:34,760 --> 00:03:33,510
results so Paul's just mentioned some of

101
00:03:35,690 --> 00:03:34,770
the results we're talking about today

102
00:03:37,190 --> 00:03:35,700
and one of the things that's really

103
00:03:39,200 --> 00:03:37,200
important is you can be involved in our

104
00:03:40,430 --> 00:03:39,210
discussion so throughout the the

105
00:03:41,810 --> 00:03:40,440
broadcast today you'll see me looking

106
00:03:43,880 --> 00:03:41,820
down at my iPad we're taking live

107
00:03:46,850 --> 00:03:43,890
questions so if you're on social media

108
00:03:48,320 --> 00:03:46,860
you can use hashtag ask NASA or if

109
00:03:49,730 --> 00:03:48,330
you're joining us on Facebook just put

110
00:03:50,600 --> 00:03:49,740
your questions in the Facebook comments

111
00:03:52,430 --> 00:03:50,610
and we'll get to as many of them as we

112
00:03:54,140 --> 00:03:52,440
possibly can and we're also going to be

113
00:03:56,600 --> 00:03:54,150

taking questions live from the media a

114
00:03:58,400 --> 00:03:56,610
little bit later in the show so I'll G

115
00:03:59,600 --> 00:03:58,410
be here live looking at your questions

116
00:04:01,250 --> 00:03:59,610
and I can give them to whatever science

117
00:04:03,620 --> 00:04:01,260
this is probably the most appropriate so

118
00:04:05,240 --> 00:04:03,630
now we're gonna go to Jen so Jennifer

119
00:04:06,860 --> 00:04:05,250
tell us a bit about you know why is it

120
00:04:09,890 --> 00:04:06,870
significant that we found organics on

121
00:04:11,510 --> 00:04:09,900
Mars we found organic molecules in rocks

122
00:04:13,790 --> 00:04:11,520
from an ancient lake bed

123
00:04:15,860 --> 00:04:13,800
those were organic molecules could have

124
00:04:19,280 --> 00:04:15,870
come from life we don't know that there

125
00:04:21,200 --> 00:04:19,290
was ever life on Mars there is the

126
00:04:23,690 --> 00:04:21,210
organic molecules that we found are not

127
00:04:26,420 --> 00:04:23,700
specifically evidence of life because

128
00:04:26,930 --> 00:04:26,430
there are other sources of of making

129
00:04:29,990 --> 00:04:26,940
those model

130
00:04:32,900 --> 00:04:30,000
including things that are non biological

131
00:04:35,240 --> 00:04:32,910
in nature things like meteorites or even

132
00:04:37,160 --> 00:04:35,250
rock processes we can attribute geology

133
00:04:38,840 --> 00:04:37,170
all by itself without life to making

134
00:04:40,970 --> 00:04:38,850
organic molecules and the information

135
00:04:44,260 --> 00:04:40,980
that we have doesn't tell us which

136
00:04:47,480 --> 00:04:44,270
source is responsible for what we have

137
00:04:49,160 --> 00:04:47,490
well thank you so another one of the

138
00:04:50,870 --> 00:04:49,170

major detection and discoveries we're

139
00:04:52,610 --> 00:04:50,880
talking about today involves methane on

140
00:04:54,470 --> 00:04:52,620
Mars and methane is something that we

141
00:04:56,930 --> 00:04:54,480
think of as natural gas a simple organic

142
00:04:59,450 --> 00:04:56,940
molecule and I'm gonna talk to a Chris

143
00:05:00,950 --> 00:04:59,460
Webster at JPL right now so Chris was

144
00:05:03,770 --> 00:05:00,960
actually instrumental in the discovery

145
00:05:05,360 --> 00:05:03,780
before of methane spikes the level of

146
00:05:07,550 --> 00:05:05,370
methane went up very dramatically on

147
00:05:09,350 --> 00:05:07,560
Mars so Chris you've reported before on

148
00:05:10,850 --> 00:05:09,360
these methane spikes can you tell us a

149
00:05:12,760 --> 00:05:10,860
bit about well what today is different

150
00:05:15,620 --> 00:05:12,770
and noteworthy about methane on Mars

151
00:05:18,260 --> 00:05:15,630
well Michelle as you know every chapter

152
00:05:21,590 --> 00:05:18,270
in the story of methane on Mars has been

153
00:05:24,170 --> 00:05:21,600
a surprise from some time ago the

154
00:05:27,080 --> 00:05:24,180
reports of plumes in the atmosphere of

155
00:05:28,820 --> 00:05:27,090
methane there were reports of patches

156
00:05:30,530 --> 00:05:28,830
when orbiters looked at it in spikes

157
00:05:32,780 --> 00:05:30,540
that we reported as you just mentioned

158
00:05:35,480 --> 00:05:32,790
every one of them a surprise but

159
00:05:37,700 --> 00:05:35,490
problematic in the sense frustrating

160
00:05:40,280 --> 00:05:37,710
because none of them were repeatable in

161
00:05:42,980 --> 00:05:40,290
time of space they seem to show that

162
00:05:46,700 --> 00:05:42,990
methane was misbehaving it was sporadic

163
00:05:48,770 --> 00:05:46,710

or almost random pulses and and patches

164
00:05:52,180 --> 00:05:48,780
were showing up so today we're

165
00:05:54,800 --> 00:05:52,190
announcing a discovery of a repeatable

166
00:05:57,290 --> 00:05:54,810
identifiable seasonal pattern in the

167
00:05:59,390 --> 00:05:57,300
methane measurements and we can look

168
00:06:01,400 --> 00:05:59,400
here at the graphic and we can see that

169
00:06:03,080 --> 00:06:01,410
it's in the lower background level

170
00:06:05,240 --> 00:06:03,090
because most of the time are not looking

171
00:06:07,909 --> 00:06:05,250
at spikes and we see this low background

172
00:06:10,310 --> 00:06:07,919
level you can see from the winter to the

173
00:06:12,500 --> 00:06:10,320
summer this growth and the big surprise

174
00:06:15,050 --> 00:06:12,510
too is not only have we got this

175
00:06:17,120 --> 00:06:15,060
wonderful repeatability but their

176
00:06:19,900 --> 00:06:17,130
seasonal cycle changes by a factor of

177
00:06:22,610 --> 00:06:19,910
three that's a huge change completely

178
00:06:25,370 --> 00:06:22,620
unexpected and what it does it gives us

179
00:06:27,800 --> 00:06:25,380
a key to unlocking the mysteries

180
00:06:30,560 --> 00:06:27,810
associated with Mars methane because now

181
00:06:32,900 --> 00:06:30,570
we have something but to test our models

182
00:06:35,710 --> 00:06:32,910
and our understanding against and we'll

183
00:06:37,580 --> 00:06:35,720
hear a little more about that later so

184
00:06:39,409 --> 00:06:37,590
one of the things you're hearing a lot

185
00:06:40,820 --> 00:06:39,419
about today is the term organic and this

186
00:06:42,860 --> 00:06:40,830
is something that a lot of people are

187
00:06:44,360 --> 00:06:42,870
in many different ways so I'm gonna talk

188
00:06:46,339 --> 00:06:44,370

to you Jennifer eigen Road so so

189
00:06:48,320 --> 00:06:46,349
Jennifer tell us a bit about what do we

190
00:06:49,730 --> 00:06:48,330
mean by organic and tell us about you

191
00:06:51,469 --> 00:06:49,740
know what is so significant about

192
00:06:53,749 --> 00:06:51,479
finding organics on Mars right so

193
00:06:55,730 --> 00:06:53,759
organic molecules to a chemist are

194
00:06:57,499 --> 00:06:55,740
simply molecules forms of carbon and

195
00:06:59,390 --> 00:06:57,509
hydrogen sometimes there's other things

196
00:07:02,450 --> 00:06:59,400
that go in that such as sulfur nitrogen

197
00:07:04,369 --> 00:07:02,460
oxygen phosphorus however that's your

198
00:07:06,170 --> 00:07:04,379
chemist is just that type of a structure

199
00:07:07,790 --> 00:07:06,180
what we're not talking about is

200
00:07:09,559 --> 00:07:07,800
molecules that specifically come from

201
00:07:11,450 --> 00:07:09,569
life and we're really not referring to

202
00:07:13,309 --> 00:07:11,460
the organic stuff that you find at the

203
00:07:15,680 --> 00:07:13,319
grocery store which is that pesticide

204
00:07:19,100 --> 00:07:15,690
free produce that we get they're very

205
00:07:20,240 --> 00:07:19,110
different things so it seems to be kind

206
00:07:22,279 --> 00:07:20,250
of amazing I mean this is one of the

207
00:07:24,170 --> 00:07:22,289
engineering feats of the Mars Curiosity

208
00:07:25,760 --> 00:07:24,180
rover is that we're finding molecules we

209
00:07:27,589 --> 00:07:25,770
have a chemical laboratory on another

210
00:07:29,149 --> 00:07:27,599
planet he talked to us about how we

211
00:07:30,200 --> 00:07:29,159
identify these molecules on another

212
00:07:33,320 --> 00:07:30,210
planet all the way on Mars

213
00:07:35,510 --> 00:07:33,330

sure so the Curiosity rover drills into

214
00:07:37,760 --> 00:07:35,520
rock layers and when it does it produces

215
00:07:39,860 --> 00:07:37,770
a rock powder and that rock powder gets

216
00:07:42,260 --> 00:07:39,870
put into the Sam oven and heated and

217
00:07:43,820 --> 00:07:42,270
when it's heated it produces gases they

218
00:07:45,920 --> 00:07:43,830
get whisked off into the mass

219
00:07:47,420 --> 00:07:45,930
spectrometer here you can see the gases

220
00:07:50,659 --> 00:07:47,430
coming through some tubes and they enter

221
00:07:54,379 --> 00:07:50,669
into this chamber where electrons ionize

222
00:07:56,300 --> 00:07:54,389
that material as a result if you have

223
00:07:58,969 --> 00:07:56,310
molecules that are split into tiny

224
00:08:01,490 --> 00:07:58,979
little pieces and the mass spectrometer

225
00:08:02,779 --> 00:08:01,500
can then identify what those different

226
00:08:04,430 --> 00:08:02,789
pieces are and we can put them back

227
00:08:06,860 --> 00:08:04,440
together to understand what the original

228
00:08:08,899 --> 00:08:06,870
molecule was now there's another feature

229
00:08:11,379 --> 00:08:08,909
of Sam that is it has a gas

230
00:08:14,779 --> 00:08:11,389
chromatograph and a gas chromatograph

231
00:08:17,869 --> 00:08:14,789
looks a little bit like this it's a

232
00:08:19,399 --> 00:08:17,879
really really long tube and it has in a

233
00:08:20,119 --> 00:08:19,409
hole in it that's about the width of a

234
00:08:23,480 --> 00:08:20,129
human hair

235
00:08:25,459 --> 00:08:23,490
now that the column allows molecules to

236
00:08:26,930 --> 00:08:25,469
go through it and they go down this long

237
00:08:28,850 --> 00:08:26,940
long tube and when they come out the

238
00:08:31,700 --> 00:08:28,860

other side they come out one by one

239
00:08:33,620 --> 00:08:31,710
they're separated and when that happens

240
00:08:36,230 --> 00:08:33,630
they go into the mass spectrometer and

241
00:08:39,079 --> 00:08:36,240
we can identify individual molecules now

242
00:08:40,550 --> 00:08:39,089
the GCS on Sam were built by our French

243
00:08:44,029 --> 00:08:40,560
colleagues from the French National

244
00:08:46,009 --> 00:08:44,039
Center for scientific research and it's

245
00:08:48,050 --> 00:08:46,019
because of these GCS that we were able

246
00:08:50,720 --> 00:08:48,060
to identify certain molecules that we

247
00:08:51,650 --> 00:08:50,730
are reporting on today and in fact

248
00:08:53,150 --> 00:08:51,660
actually we have one of our first

249
00:08:54,590 --> 00:08:53,160
questions from social media this is from

250
00:08:55,970 --> 00:08:54,600
John Vandal art we were talking

251
00:08:58,160 --> 00:08:55,980
about drilling into the surface of Mars

252
00:09:00,050 --> 00:08:58,170
but the arm of Sam how far in do we go

253
00:09:01,819 --> 00:09:00,060
how are you deep into the surface five

254
00:09:05,090 --> 00:09:01,829
centimetres that's about as far as you

255
00:09:06,410 --> 00:09:05,100
can go yeah five centimetres we'll talk

256
00:09:07,819 --> 00:09:06,420
a little bit more John about why that's

257
00:09:10,009 --> 00:09:07,829
significant there may be even more

258
00:09:11,780 --> 00:09:10,019
interesting things farther down so the

259
00:09:13,340 --> 00:09:11,790
thing that really amazes me and I

260
00:09:14,689 --> 00:09:13,350
remember very well the landing of the

261
00:09:16,790 --> 00:09:14,699
Curiosity rover as one of the best

262
00:09:17,990 --> 00:09:16,800
nights early mornings of my life when

263
00:09:20,090 --> 00:09:18,000

you showed me that tiny gas

264
00:09:22,280 --> 00:09:20,100
chromatograph coil you know that had to

265
00:09:23,480 --> 00:09:22,290
actually land on Mars at one point going

266
00:09:25,400 --> 00:09:23,490
through the atmosphere there was a big

267
00:09:27,439 --> 00:09:25,410
snap of g-forces like up to ten times

268
00:09:29,689 --> 00:09:27,449
the force of gravity we actually land

269
00:09:32,420 --> 00:09:29,699
these incredibly sensitive sophisticated

270
00:09:33,439 --> 00:09:32,430
instruments on Mars and I want to talk a

271
00:09:34,189 --> 00:09:33,449
little bit more about that so we're

272
00:09:37,100 --> 00:09:34,199
gonna go our friend

273
00:09:38,600 --> 00:09:37,110
Ashwin at JPL so tell us where you are

274
00:09:41,660 --> 00:09:38,610
and tell us a bit about the the

275
00:09:43,519 --> 00:09:41,670
Curiosity rover the larger rover hi

276
00:09:45,110 --> 00:09:43,529
there yeah you know probably wondering

277
00:09:47,749 --> 00:09:45,120
what's behind me and what you see behind

278
00:09:49,519 --> 00:09:47,759
me is actually the test model of the

279
00:09:51,199 --> 00:09:49,529
Curiosity rover it's a twin basically

280
00:09:53,749 --> 00:09:51,209
that we use for testing here on earth

281
00:09:56,360 --> 00:09:53,759
the one on Mars is in a place called

282
00:09:58,910 --> 00:09:56,370
Gale Crater we sent it there it's about

283
00:10:01,340 --> 00:09:58,920
a hundred mile diameter hole in the

284
00:10:02,720 --> 00:10:01,350
ground that formed when a giant impact

285
00:10:04,550 --> 00:10:02,730
occurred on Mars about four billion

286
00:10:06,170 --> 00:10:04,560
years ago but what drew us to this

287
00:10:08,179 --> 00:10:06,180
crater is the mountain that you see in

288
00:10:10,160 --> 00:10:08,189

the middle of it this mountain wasn't

289
00:10:12,319 --> 00:10:10,170
there when the crater formed in fact it

290
00:10:14,809 --> 00:10:12,329
formed as sediment was carried in by

291
00:10:16,999 --> 00:10:14,819
rivers and streams and then deposited

292
00:10:19,970 --> 00:10:17,009
into this giant lake that filled the

293
00:10:21,559 --> 00:10:19,980
crater and as that sediment settled out

294
00:10:23,420 --> 00:10:21,569
from the water it builds up the layers

295
00:10:25,429 --> 00:10:23,430
that then made up the mountain each

296
00:10:27,559 --> 00:10:25,439
layer of this mountain is younger than

297
00:10:29,480 --> 00:10:27,569
the one below it so by climbing this

298
00:10:31,790 --> 00:10:29,490
mountain with the rover we can read the

299
00:10:33,379 --> 00:10:31,800
ancient history of Mars and climbing is

300
00:10:35,420 --> 00:10:33,389
exactly what we've been doing throughout

301
00:10:37,429 --> 00:10:35,430
most of curiosity's mission we're now a

302
00:10:38,840 --> 00:10:37,439
thousand feet above the crater floor

303
00:10:41,480 --> 00:10:38,850
that's as high as some of the

304
00:10:45,259 --> 00:10:41,490
skyscrapers in downtown Los Angeles and

305
00:10:46,939 --> 00:10:45,269
we get this amazing view and so the the

306
00:10:48,710 --> 00:10:46,949
progress has just been to continually

307
00:10:50,509 --> 00:10:48,720
drill each layer of this mountain and

308
00:10:51,949 --> 00:10:50,519
the samples that Jen described were

309
00:10:54,410 --> 00:10:51,959
taken from the lowest part of the

310
00:10:57,710 --> 00:10:54,420
mountain about a few years ago in 2015

311
00:10:59,540 --> 00:10:57,720
and it's taken us a few years to get an

312
00:11:01,790 --> 00:10:59,550
understanding of these results so that

313
00:11:03,259 --> 00:11:01,800

we can describe them to you today and an

314
00:11:04,639 --> 00:11:03,269
Ashwin there was a reason that Gale

315
00:11:06,379 --> 00:11:04,649
Crater was selected there was something

316
00:11:07,670 --> 00:11:06,389
really fascinating about the rocks some

317
00:11:08,569 --> 00:11:07,680
evidence of water can you tell us a bit

318
00:11:11,210 --> 00:11:08,579
about why this site was

319
00:11:14,479 --> 00:11:11,220
selected sure I mean we had some hints

320
00:11:17,179 --> 00:11:14,489
that water was involved in interacting

321
00:11:19,189 --> 00:11:17,189
with these rocks because of the orbiters

322
00:11:20,359 --> 00:11:19,199
that have been at Mars before us so for

323
00:11:22,850 --> 00:11:20,369
example there's the Mars Reconnaissance

324
00:11:25,039 --> 00:11:22,860
Orbiter and there's Mars Express and

325
00:11:27,139 --> 00:11:25,049
both of those instruments had in both of

326
00:11:28,819 --> 00:11:27,149
those orbiters had instruments capable

327
00:11:30,710 --> 00:11:28,829
of detecting clay minerals at the site

328
00:11:32,090 --> 00:11:30,720
so we know that some of the layers in

329
00:11:33,739 --> 00:11:32,100
the mountain are made of clay minerals

330
00:11:35,929 --> 00:11:33,749
which means that water had interacted

331
00:11:38,229 --> 00:11:35,939
with them we weren't sure though if

332
00:11:40,789 --> 00:11:38,239
rivers and lakes actually existed and

333
00:11:42,769 --> 00:11:40,799
curiosity has now shown that Lakes is

334
00:11:44,329 --> 00:11:42,779
listed for a long time probably hundreds

335
00:11:46,189 --> 00:11:44,339
of thousands if not millions of years

336
00:11:48,139 --> 00:11:46,199
and actually I have a question from

337
00:11:49,970 --> 00:11:48,149
social media so Jean pack up John

338
00:11:51,439 --> 00:11:49,980

Pascale from facebook says tell us more

339
00:11:52,639 --> 00:11:51,449
about the tweak in the repairs made to

340
00:11:54,559 --> 00:11:52,649
the arm there was some trouble recently

341
00:11:56,600 --> 00:11:54,569
with the drilling arm and it I mean it's

342
00:11:58,609 --> 00:11:56,610
space is hard you're all the way on Mars

343
00:12:01,489 --> 00:11:58,619
tell us how you actually fix this from

344
00:12:02,960 --> 00:12:01,499
millions of miles away you know this is

345
00:12:04,549 --> 00:12:02,970
really worth the press conference of its

346
00:12:05,780 --> 00:12:04,559
own you know it's just sort of

347
00:12:07,400 --> 00:12:05,790
coincidence that we have this amazing

348
00:12:09,350 --> 00:12:07,410
week to tell you not only about the

349
00:12:10,999 --> 00:12:09,360
success of the drill but about these

350
00:12:13,579 --> 00:12:11,009
wonderful results from the last few

351
00:12:15,769 --> 00:12:13,589
years of exploration as well in late

352
00:12:17,299 --> 00:12:15,779
2016 we realized that one of the main

353
00:12:19,369 --> 00:12:17,309
motors of the drill was no longer

354
00:12:21,319 --> 00:12:19,379
functioning reliably this basically

355
00:12:22,909 --> 00:12:21,329
meant the drill was dead and a big part

356
00:12:25,489 --> 00:12:22,919
of what we could accomplish on Mars we'd

357
00:12:26,840 --> 00:12:25,499
no longer be able to do it's not just

358
00:12:28,400 --> 00:12:26,850
that we fixed something or tweaked

359
00:12:30,829 --> 00:12:28,410
something we had to invent a whole new

360
00:12:32,960 --> 00:12:30,839
way of drilling and that's just a

361
00:12:34,429 --> 00:12:32,970
remarkable story that really I have to

362
00:12:36,590 --> 00:12:34,439
give all the credit to the engineers at

363
00:12:38,419 --> 00:12:36,600

JPL who did that work so for about a

364
00:12:40,699 --> 00:12:38,429
year and a half they tried to fix the

365
00:12:42,319 --> 00:12:40,709
motor then invent this entire new way of

366
00:12:44,449 --> 00:12:42,329
drilling that didn't use that motor any

367
00:12:46,539 --> 00:12:44,459
longer and just this week we have

368
00:12:49,699 --> 00:12:46,549
achieved success we've now successfully

369
00:12:52,129 --> 00:12:49,709
drill drilled and analyzed samples with

370
00:12:53,419 --> 00:12:52,139
our laboratories once again so we're

371
00:12:54,949 --> 00:12:53,429
talking about drilling down and

372
00:12:56,359 --> 00:12:54,959
analyzing these samples and for those of

373
00:12:57,409 --> 00:12:56,369
you that are a fan of organic chemistry

374
00:12:58,850 --> 00:12:57,419
we're actually gonna dive into the

375
00:13:01,069 --> 00:12:58,860
details just a little bit right now so

376
00:13:04,309 --> 00:13:01,079
so Jenn tell me the details about what

377
00:13:06,439 --> 00:13:04,319
was detected right so we detected a

378
00:13:08,090 --> 00:13:06,449
variety of molecules including some that

379
00:13:10,429 --> 00:13:08,100
have a carbons linked in a ring

380
00:13:12,499 --> 00:13:10,439
structure such as benzene and others

381
00:13:12,949 --> 00:13:12,509
that include carbon chains and here's an

382
00:13:15,590 --> 00:13:12,959
example

383
00:13:17,960 --> 00:13:15,600
propane now these are just

384
00:13:20,119 --> 00:13:17,970
representative of molecules small little

385
00:13:21,530 --> 00:13:20,129
bits and pieces of molecules but because

386
00:13:23,240 --> 00:13:21,540
we see these coming

387
00:13:25,340 --> 00:13:23,250
from the sample at high temperatures

388
00:13:27,680 --> 00:13:25,350

what they're really telling us is that

389
00:13:30,139 --> 00:13:27,690
they're part of something larger a macro

390
00:13:31,490 --> 00:13:30,149
molecule and this is just an example of

391
00:13:34,460 --> 00:13:31,500
something we find on earth we call it

392
00:13:37,370 --> 00:13:34,470
Carrigan now we find examples of karagin

393
00:13:41,059 --> 00:13:37,380
on earth and things like coal and black

394
00:13:43,730 --> 00:13:41,069
shale these two things rights and we

395
00:13:46,340 --> 00:13:43,740
also find them in meteorites so they're

396
00:13:48,410 --> 00:13:46,350
common this tells us that there is

397
00:13:50,540 --> 00:13:48,420
organic material in the rock in a

398
00:13:52,610 --> 00:13:50,550
different form than what Sam detected

399
00:13:56,170 --> 00:13:52,620
and what it means is that it was in a

400
00:14:00,319 --> 00:13:56,180
robust form this form of organic matter

401
00:14:04,400 --> 00:14:00,329
resistant to changes now the other thing

402
00:14:05,900 --> 00:14:04,410
that we found was a thiophene and this

403
00:14:07,699 --> 00:14:05,910
is an example of some of the data we

404
00:14:09,829 --> 00:14:07,709
would get from Sam we can actually tell

405
00:14:12,920 --> 00:14:09,839
after the molecules go through the GC

406
00:14:15,379 --> 00:14:12,930
column the actual structure we use this

407
00:14:17,540 --> 00:14:15,389
information to figure out this type of

408
00:14:20,840 --> 00:14:17,550
structure so here we have four carbons

409
00:14:25,639 --> 00:14:20,850
and a sulfur now sulfur looks like this

410
00:14:28,160 --> 00:14:25,649
when it's in rock form but in the sample

411
00:14:29,840 --> 00:14:28,170
the sulfur is probably in the organic

412
00:14:33,069 --> 00:14:29,850
molecules themselves and that's

413
00:14:36,319 --> 00:14:33,079

important because sulfur actually is the

414
00:14:37,639 --> 00:14:36,329
is a material that can help bind all the

415
00:14:39,800 --> 00:14:37,649
small pieces of organic molecules

416
00:14:41,949 --> 00:14:39,810
together into something really big like

417
00:14:46,160 --> 00:14:41,959
that large molecule I showed you and

418
00:14:48,079 --> 00:14:46,170
sulfur helps to resist oxidation that's

419
00:14:50,900 --> 00:14:48,089
really important for our discovery

420
00:14:52,400 --> 00:14:50,910
because we are looking at ancient rocks

421
00:14:54,050 --> 00:14:52,410
that are three and a half billion years

422
00:14:57,199 --> 00:14:54,060
old and we found organic materials

423
00:14:59,480 --> 00:14:57,209
inside them however we drilled in the

424
00:15:02,449 --> 00:14:59,490
top five centimeters and that's hot five

425
00:15:04,689 --> 00:15:02,459
centimeters the surface is exposed to a

426
00:15:07,879 --> 00:15:04,699
lot of ionizing radiation and that

427
00:15:10,730 --> 00:15:07,889
generates free radicals and oxidants and

428
00:15:12,860 --> 00:15:10,740
all of those can be grade organic

429
00:15:14,540 --> 00:15:12,870
materials and so that rock has been

430
00:15:16,610 --> 00:15:14,550
sitting at the surface for an extended

431
00:15:18,650 --> 00:15:16,620
period of time we're talking tens of

432
00:15:21,350 --> 00:15:18,660
thousands to hundreds of thousands of

433
00:15:23,150 --> 00:15:21,360
years and that's a long time for all

434
00:15:24,530 --> 00:15:23,160
these changes that happen there were a

435
00:15:26,300 --> 00:15:24,540
lot of people who thought we weren't

436
00:15:29,569 --> 00:15:26,310
going to find all the organic molecules

437
00:15:32,929 --> 00:15:29,579
that we did for instance Viking started

438
00:15:35,480 --> 00:15:32,939

this quest back in 1976 looking for

439
00:15:37,670 --> 00:15:35,490
organic molecules we at Curie

440
00:15:39,800 --> 00:15:37,680
he has continued that quest and now we

441
00:15:42,050 --> 00:15:39,810
have a diverse set of molecules that we

442
00:15:43,670 --> 00:15:42,060
can now start to understand a little bit

443
00:15:46,100 --> 00:15:43,680
more about how this material is

444
00:15:48,350 --> 00:15:46,110
preserved and where else we might look

445
00:15:50,090 --> 00:15:48,360
to get more this is a pretty amazing

446
00:15:51,650 --> 00:15:50,100
thing I mean you know working on Mars is

447
00:15:53,300 --> 00:15:51,660
very hard I mean a lot of people know

448
00:15:54,560 --> 00:15:53,310
that Mars has almost no atmosphere

449
00:15:56,300 --> 00:15:54,570
compared to the earth about one percent

450
00:15:58,010 --> 00:15:56,310
the atmospheric pressure of the earth it

451
00:15:59,389 --> 00:15:58,020
has very high radiation levels because

452
00:16:01,579 --> 00:15:59,399
Mars isn't protected the way the earth

453
00:16:03,110 --> 00:16:01,589
is by an active magnetic field as well

454
00:16:05,120 --> 00:16:03,120
as a thick atmosphere that's right so we

455
00:16:08,360 --> 00:16:05,130
have this laboratory working on Mars and

456
00:16:10,310 --> 00:16:08,370
so the the radiation from the Sun gets

457
00:16:11,780 --> 00:16:10,320
about how far down into the soil it's

458
00:16:13,610 --> 00:16:11,790
coming from the Sun but it's also coming

459
00:16:15,350 --> 00:16:13,620
from the galaxies right and it can

460
00:16:17,060 --> 00:16:15,360
extend about a metre and a half down

461
00:16:19,519 --> 00:16:17,070
maybe a little bit more depends on what

462
00:16:21,230 --> 00:16:19,529
model you use but there are places you

463
00:16:23,090 --> 00:16:21,240

can go deeper down that we might be able

464
00:16:25,519 --> 00:16:23,100
to tap into molecules that aren't

465
00:16:27,740 --> 00:16:25,529
disrupted by the radiation itself and

466
00:16:30,740 --> 00:16:27,750
the ExoMars Rover is a perfect example

467
00:16:33,350 --> 00:16:30,750
it's going to drill two meters deep this

468
00:16:35,810 --> 00:16:33,360
is the European Space Agency's ExoMars

469
00:16:37,850 --> 00:16:35,820
River and it's go JAL two meters deep

470
00:16:40,519 --> 00:16:37,860
and it will have the opportunity to

471
00:16:41,960 --> 00:16:40,529
examine materials at the surface and on

472
00:16:45,019 --> 00:16:41,970
the way down to see if there's

473
00:16:48,079 --> 00:16:45,029
comparisons will learn how important it

474
00:16:50,389 --> 00:16:48,089
is to where where we have to refine our

475
00:16:53,090 --> 00:16:50,399
analyses where we have where what will

476
00:16:54,740 --> 00:16:53,100
understand the preservation issue and

477
00:16:56,590 --> 00:16:54,750
how it affects things at the surface as

478
00:16:59,870 --> 00:16:56,600
a compared to things further down but

479
00:17:02,300 --> 00:16:59,880
most importantly if there are bio

480
00:17:04,880 --> 00:17:02,310
signatures inside that organic material

481
00:17:06,110 --> 00:17:04,890
or associated with it we're going to

482
00:17:08,390 --> 00:17:06,120
have a better chance of understanding

483
00:17:10,280 --> 00:17:08,400
that if we get to materials that are not

484
00:17:11,419 --> 00:17:10,290
exposed to all this radiation that's one

485
00:17:13,100 --> 00:17:11,429
of the things today we're finding some

486
00:17:14,660 --> 00:17:13,110
very interesting chemistry right up on

487
00:17:15,679 --> 00:17:14,670
the surface of Mars and then it's a

488
00:17:17,540 --> 00:17:15,689

promise it even more interesting

489
00:17:19,970 --> 00:17:17,550
chemistry to come if we can get a little

490
00:17:21,679 --> 00:17:19,980
bit deeper down underneath that so you

491
00:17:24,679 --> 00:17:21,689
know we're looking at Gale Crater and

492
00:17:26,120 --> 00:17:24,689
and yeah what's so how do these organics

493
00:17:27,799 --> 00:17:26,130
get here we're finding these organic

494
00:17:29,600 --> 00:17:27,809
molecules now on um on the floor of Gale

495
00:17:30,890 --> 00:17:29,610
Crater how'd they get there so what

496
00:17:32,900 --> 00:17:30,900
we're looking at here are a lot of

497
00:17:35,750 --> 00:17:32,910
layers that were put down in an ancient

498
00:17:37,400 --> 00:17:35,760
lake and as previously we discussed that

499
00:17:39,530 --> 00:17:37,410
Lake had been there for a long period of

500
00:17:41,299 --> 00:17:39,540
time hundreds of thousands maybe even

501
00:17:43,790 --> 00:17:41,309
millions of years we're not sure but

502
00:17:46,820 --> 00:17:43,800
those lake sediments are for a gigantic

503
00:17:48,710 --> 00:17:46,830
lake organic materials can come into

504
00:17:51,470 --> 00:17:48,720
that lake through rivers

505
00:17:54,590 --> 00:17:51,480
they could be windblown in or they can

506
00:17:56,990 --> 00:17:54,600
be formed in the actual lake itself by

507
00:17:58,960 --> 00:17:57,000
things like biology now there's three

508
00:18:01,970 --> 00:17:58,970
different sources of organic materials -

509
00:18:03,740 --> 00:18:01,980
one of them's the biology one of them

510
00:18:05,899 --> 00:18:03,750
could be meteorites that are in falling

511
00:18:08,149 --> 00:18:05,909
into the surface and being directly

512
00:18:10,100 --> 00:18:08,159
deposited and the other one is a rock

513
00:18:12,200 --> 00:18:10,110

forming processes that might generate

514
00:18:13,909 --> 00:18:12,210
organic matter are all on their own and

515
00:18:16,370 --> 00:18:13,919
they might be the ones that are being

516
00:18:18,620 --> 00:18:16,380
brought in by rivers we don't have

517
00:18:20,450 --> 00:18:18,630
enough information from the observations

518
00:18:23,090 --> 00:18:20,460
we've made to tell what the source is

519
00:18:24,620 --> 00:18:23,100
and how it got in there so we found this

520
00:18:26,419 --> 00:18:24,630
really locate a really good location to

521
00:18:28,220 --> 00:18:26,429
look for organics on Mars and we're also

522
00:18:30,140 --> 00:18:28,230
going to talk now about the seasonal

523
00:18:31,700 --> 00:18:30,150
methane so I mean it is are your

524
00:18:33,320 --> 00:18:31,710
discoveries about the sorts of organics

525
00:18:34,789 --> 00:18:33,330
and the site is that all related to

526
00:18:38,930 --> 00:18:34,799
Chris's stuff about the cities now leave

527
00:18:40,779 --> 00:18:38,940
nothing yes and no if you take the

528
00:18:43,700 --> 00:18:40,789
organic detection in the ancient rocks

529
00:18:45,950 --> 00:18:43,710
and you just generalize it we have found

530
00:18:48,110 --> 00:18:45,960
organic material in the subsurface and

531
00:18:50,870 --> 00:18:48,120
that might be representative of organic

532
00:18:53,779 --> 00:18:50,880
material throughout a grander area and

533
00:18:56,060 --> 00:18:53,789
that is carbon that could go through

534
00:18:59,480 --> 00:18:56,070
various processes and make its way to

535
00:19:01,100 --> 00:18:59,490
the surface and and and form it turned

536
00:19:02,000 --> 00:19:01,110
into things like methane and then seep

537
00:19:04,159 --> 00:19:02,010
into the atmosphere

538
00:19:05,870 --> 00:19:04,169

now the detection that Chris has going

539
00:19:08,539 --> 00:19:05,880
to talk about is about modern day

540
00:19:10,880 --> 00:19:08,549
nothing as opposed to ancient signals

541
00:19:12,320 --> 00:19:10,890
well I discovered in the rocks all right

542
00:19:15,380 --> 00:19:12,330
so we're gonna go over to Chris Webster

543
00:19:17,299 --> 00:19:15,390
back at JPL and so so Chris did tell me

544
00:19:18,980 --> 00:19:17,309
a bit about the seasonality of methane

545
00:19:21,950 --> 00:19:18,990
you tell me to give us some detail about

546
00:19:25,039 --> 00:19:21,960
this new discovery well I thought I'd

547
00:19:28,430 --> 00:19:25,049
tell you right away that we've seen the

548
00:19:30,350 --> 00:19:28,440
seasonal variation and we've tried to

549
00:19:32,840 --> 00:19:30,360
look at the data and come up with some

550
00:19:35,510 --> 00:19:32,850
explanations and we've been able to rule

551
00:19:38,180 --> 00:19:35,520
out some of the some of the sources we

552
00:19:41,240 --> 00:19:38,190
don't actually think the meteoritic or

553
00:19:43,279 --> 00:19:41,250
delivery of interplanetary dust that can

554
00:19:45,620 --> 00:19:43,289
produce methane in the atmosphere as Jen

555
00:19:47,180 --> 00:19:45,630
said we don't think that's so important

556
00:19:49,909 --> 00:19:47,190
because we wouldn't expect to see a

557
00:19:52,430 --> 00:19:49,919
large seasonal variation we might see

558
00:19:55,549 --> 00:19:52,440
20% instead we're seeing this massive

559
00:19:57,919 --> 00:19:55,559
change in that in the methane signal and

560
00:20:01,070 --> 00:19:57,929
so what we consider we look at the data

561
00:20:02,150 --> 00:20:01,080
and the idea that best fits our data is

562
00:20:05,600 --> 00:20:02,160
is the

563
00:20:08,180 --> 00:20:05,610

idea of subsurface storage so way under

564
00:20:09,710 --> 00:20:08,190
the ground under Mars this does methane

565
00:20:12,350 --> 00:20:09,720
is trapped it may be trapped as

566
00:20:14,870 --> 00:20:12,360
clathrates or other materials we don't

567
00:20:16,700 --> 00:20:14,880
know if that methane is ancient we don't

568
00:20:19,190 --> 00:20:16,710
know if it's modern it could be either

569
00:20:22,160 --> 00:20:19,200
and we also don't know if that methane

570
00:20:24,800 --> 00:20:22,170
was created from rock water rock

571
00:20:28,490 --> 00:20:24,810
chemistry like serpentinization or it

572
00:20:31,130 --> 00:20:28,500
was created by methanogens microbes we

573
00:20:33,290 --> 00:20:31,140
cannot distinguish that so but the

574
00:20:35,660 --> 00:20:33,300
methane leaks or seeps up to the surface

575
00:20:37,850 --> 00:20:35,670
we believe and finds its way through

576
00:20:40,400 --> 00:20:37,860
cracks and fissures and eventually when

577
00:20:42,380 --> 00:20:40,410
it gets to the surface we're then in a

578
00:20:45,110 --> 00:20:42,390
situation where the surface temperature

579
00:20:47,900 --> 00:20:45,120
can modulate or especially amplify the

580
00:20:50,650 --> 00:20:47,910
release of methane so this is a an

581
00:20:53,840 --> 00:20:50,660
exciting time because we have this

582
00:20:57,080 --> 00:20:53,850
seasonal cycle to constrain some of the

583
00:20:59,660 --> 00:20:57,090
theories and of the sources and sinks of

584
00:21:01,070 --> 00:20:59,670
this important guess now of course I

585
00:21:02,300 --> 00:21:01,080
want to talk to you a bit more about you

586
00:21:03,520 --> 00:21:02,310
trying to distinguish between whether

587
00:21:05,480 --> 00:21:03,530
this is a biological or non-biological

588
00:21:07,670 --> 00:21:05,490

source of the methane but to begin with

589
00:21:09,710 --> 00:21:07,680
tell us about how you actually detected

590
00:21:11,600 --> 00:21:09,720
this so in the case of gems work they

591
00:21:13,610 --> 00:21:11,610
actually brought Martian soil into this

592
00:21:14,960 --> 00:21:13,620
oven and heated it up but how is the

593
00:21:17,840 --> 00:21:14,970
methane variation detected

594
00:21:20,450 --> 00:21:17,850
well it's we're ingesting from the air

595
00:21:22,310 --> 00:21:20,460
and if you look at curiosity around

596
00:21:25,610 --> 00:21:22,320
about waist height there are two inlets

597
00:21:28,220 --> 00:21:25,620
two little valves and these valves allow

598
00:21:31,190 --> 00:21:28,230
the Martian atmosphere into our sample

599
00:21:33,110 --> 00:21:31,200
cell once it gets into Sam and into the

600
00:21:36,380 --> 00:21:33,120
tunable laser spectrometer in particular

601
00:21:39,800 --> 00:21:36,390
we have tiny little infrared laser being

602
00:21:42,440 --> 00:21:39,810
that multi passes it bounces 81 times

603
00:21:44,870 --> 00:21:42,450
between these mirrors and that amplifies

604
00:21:47,360 --> 00:21:44,880
its sensitivity so when you look at the

605
00:21:49,520 --> 00:21:47,370
laser light on a detector you can scan

606
00:21:53,060 --> 00:21:49,530
the laser and look for this the spectrum

607
00:21:55,550 --> 00:21:53,070
of methane and that the resolution a

608
00:21:58,190 --> 00:21:55,560
spectral resolution is so high that we

609
00:22:00,560 --> 00:21:58,200
see individual methane lines and in

610
00:22:03,170 --> 00:22:00,570
particular we see a fingerprint the

611
00:22:05,110 --> 00:22:03,180
three lines together that can only be

612
00:22:07,910 --> 00:22:05,120
from methane so our measurement is

613
00:22:09,700 --> 00:22:07,920

unambiguous the signals we see they come

614
00:22:12,320 --> 00:22:09,710
from methane and nothing else and

615
00:22:14,960 --> 00:22:12,330
secondly we measure them with higher

616
00:22:15,950 --> 00:22:14,970
precision so let's go to the let's go to

617
00:22:17,930 --> 00:22:15,960
the two different scenario

618
00:22:19,700 --> 00:22:17,940
is what be causing the methane I guess

619
00:22:21,830 --> 00:22:19,710
one is that we have a seasonal cycle

620
00:22:23,330 --> 00:22:21,840
because bacteria under the surface of

621
00:22:27,080 --> 00:22:23,340
Mars would be more active in the summer

622
00:22:29,120 --> 00:22:27,090
is that the idea that's a possible idea

623
00:22:34,130 --> 00:22:29,130
but again we cannot distinguish that

624
00:22:36,920 --> 00:22:34,140
from serpentinization the reaction of

625
00:22:39,290 --> 00:22:36,930
water with olivine to produce serpentine

626
00:22:42,320 --> 00:22:39,300
and hydrogen once you get the hydrogen

627
00:22:47,960 --> 00:22:42,330
released in both of both of in that

628
00:22:49,850 --> 00:22:47,970
reaction it can be catalyzed metal

629
00:22:52,760 --> 00:22:49,860
catastro deuce methane let's see a

630
00:22:56,210 --> 00:22:52,770
biological root or it can be catalyzed

631
00:22:58,460 --> 00:22:56,220
through enzymes in the microbes in the

632
00:22:59,990 --> 00:22:58,470
cell potential so just sort of putting

633
00:23:01,400 --> 00:23:00,000
that into slightly simpler terms if you

634
00:23:03,680 --> 00:23:01,410
have water that's interacting with

635
00:23:05,030 --> 00:23:03,690
volcanic minerals like olivine you can

636
00:23:06,500 --> 00:23:05,040
also get in similar methane that's

637
00:23:10,610 --> 00:23:06,510
trapped in the soil and preferentially

638
00:23:12,520 --> 00:23:10,620

comes up in the summer yes yes that's

639
00:23:15,050 --> 00:23:12,530
exactly right

640
00:23:17,450 --> 00:23:15,060
but we are we're hoping that we'll see

641
00:23:19,880 --> 00:23:17,460
more we'll get more results in the

642
00:23:23,390 --> 00:23:19,890
future on this especially from other

643
00:23:27,470 --> 00:23:23,400
missions and as far as testing for the

644
00:23:29,720 --> 00:23:27,480
biological source or not there are

645
00:23:32,030 --> 00:23:29,730
several more steps that can be made we

646
00:23:34,790 --> 00:23:32,040
can look at the carbon 13 isotope ratio

647
00:23:37,310 --> 00:23:34,800
for example that could be suggestive of

648
00:23:40,340 --> 00:23:37,320
biological activity and we can look at

649
00:23:43,910 --> 00:23:40,350
the accompaniment of other gases so we

650
00:23:46,250 --> 00:23:43,920
have and we can sit on the surface in

651
00:23:48,200 --> 00:23:46,260
curiosity and maybe one day we'll see a

652
00:23:50,300 --> 00:23:48,210
plume that's large enough where we can

653
00:23:52,540 --> 00:23:50,310
measure that carbon 13 ratio or

654
00:23:56,000 --> 00:23:52,550
ourselves so there's lots of exciting

655
00:23:59,210 --> 00:23:56,010
ways forward but at this at this moment

656
00:23:59,750 --> 00:23:59,220
again the biological option is is being

657
00:24:03,350 --> 00:23:59,760
held

658
00:24:04,910 --> 00:24:03,360
it hasn't been rolled out so really

659
00:24:07,250 --> 00:24:04,920
exciting results about the methane and a

660
00:24:08,540 --> 00:24:07,260
seasonal variation of it on Mars I want

661
00:24:09,800 --> 00:24:08,550
to take a moment just to say it burning

662
00:24:11,510 --> 00:24:09,810
base has been joining us where we're

663
00:24:12,920 --> 00:24:11,520

live at NASA we're at the Goddard Space

664
00:24:14,510 --> 00:24:12,930
Flight Center and we're also at NASA's

665
00:24:16,640 --> 00:24:14,520
Jet Propulsion Laboratory and we'll be

666
00:24:18,430 --> 00:24:16,650
taking your questions soon live so if

667
00:24:21,410 --> 00:24:18,440
you're on social media use the hashtag

668
00:24:22,940 --> 00:24:21,420
hashtag ask NASA and if you're joining

669
00:24:24,500 --> 00:24:22,950
us on Facebook to put your questions in

670
00:24:26,750 --> 00:24:24,510
the comments and we'll get to as many of

671
00:24:28,940 --> 00:24:26,760
those as we possibly can okay so we've

672
00:24:29,870 --> 00:24:28,950
talked a bit about the the latest

673
00:24:31,669 --> 00:24:29,880
results

674
00:24:32,750 --> 00:24:31,679
the Mars Curiosity rover one of the

675
00:24:34,310 --> 00:24:32,760
things that I just want to mention very

676
00:24:36,500 --> 00:24:34,320
briefly is that we have a mission to

677
00:24:37,789 --> 00:24:36,510
Mars on the way right now they fit that

678
00:24:39,560 --> 00:24:37,799
this year we launched the insight

679
00:24:42,740 --> 00:24:39,570
mission and it will arrive at Mars

680
00:24:44,150 --> 00:24:42,750
November 26 of this coming year and the

681
00:24:45,350 --> 00:24:44,160
exciting thing about the insight mission

682
00:24:46,850 --> 00:24:45,360
is that it's looking about it's looking

683
00:24:48,320 --> 00:24:46,860
at a different sort of definition of the

684
00:24:50,930 --> 00:24:48,330
word life it's looking to see whether

685
00:24:52,909 --> 00:24:50,940
the planet Mars is still geologically

686
00:24:54,680 --> 00:24:52,919
alive and by that we mean are there

687
00:24:56,659 --> 00:24:54,690
things like Mars quakes is there any

688
00:24:58,549 --> 00:24:56,669

activity below the surface how quickly

689
00:25:01,010 --> 00:24:58,559
is the interior of Mars losing heat

690
00:25:02,870 --> 00:25:01,020
through geological processes so look for

691
00:25:05,000 --> 00:25:02,880
that good coming this fall we'll have

692
00:25:06,110 --> 00:25:05,010
another landing on Mars a geological

693
00:25:08,480 --> 00:25:06,120
mission to actually see what the

694
00:25:10,940 --> 00:25:08,490
activity geologically is underneath the

695
00:25:12,440 --> 00:25:10,950
surface of Mars okay well before we go

696
00:25:14,210 --> 00:25:12,450
on I do want to make one more trip back

697
00:25:15,649 --> 00:25:14,220
to the UM of the uh the Mars Curiosity

698
00:25:17,810 --> 00:25:15,659
rover into Ashwin

699
00:25:19,460 --> 00:25:17,820
so Ashwin the amazing thing about this

700
00:25:21,380 --> 00:25:19,470
seasonal variation of methane that we

701
00:25:23,630 --> 00:25:21,390
were just talking about is you need to

702
00:25:25,549 --> 00:25:23,640
be there for many seasons so so tell us

703
00:25:27,080 --> 00:25:25,559
about the lifetime of the the Curiosity

704
00:25:28,340 --> 00:25:27,090
rover and you just give us a sense of

705
00:25:31,399 --> 00:25:28,350
what an amazing accomplishment that's

706
00:25:34,010 --> 00:25:31,409
been sure yeah you know this is really

707
00:25:36,770 --> 00:25:34,020
wonderful to have this discovery that

708
00:25:38,350 --> 00:25:36,780
took so many years to not only take the

709
00:25:40,460 --> 00:25:38,360
measurements but then to analyze as well

710
00:25:41,630 --> 00:25:40,470
the measurements that Chris described

711
00:25:43,370 --> 00:25:41,640
come from an instrument called the

712
00:25:45,500 --> 00:25:43,380
tunable laser spectrometer within the

713
00:25:47,990 --> 00:25:45,510

Sam instrument suite on Mars and we've

714
00:25:49,970 --> 00:25:48,000
taken about thirty measurements with

715
00:25:51,590 --> 00:25:49,980
this instrument over the course of the

716
00:25:55,279 --> 00:25:51,600
mission in fact we're planning one on

717
00:25:58,610 --> 00:25:55,289
Mars today so without having the rover

718
00:26:00,289 --> 00:25:58,620
survived for six earth years three Mars

719
00:26:02,090 --> 00:26:00,299
years which is three times longer than

720
00:26:03,770 --> 00:26:02,100
its original mission we would have never

721
00:26:05,510 --> 00:26:03,780
been able to discover these amazing

722
00:26:08,510 --> 00:26:05,520
seasonal patterns that are the heart of

723
00:26:12,020 --> 00:26:08,520
what Chris described and finally I just

724
00:26:16,130 --> 00:26:12,030
wanted to add a few more words to to

725
00:26:18,770 --> 00:26:16,140
Jen's discoveries one of the things that

726
00:26:21,110 --> 00:26:18,780
makes that so special as the role how it

727
00:26:22,520 --> 00:26:21,120
fulfills the role that curiosity has has

728
00:26:26,630 --> 00:26:22,530
played within the Mars exploration

729
00:26:28,970 --> 00:26:26,640
program NASA charged this mission with

730
00:26:30,890 --> 00:26:28,980
detecting organics on Mars and we've

731
00:26:32,930 --> 00:26:30,900
certainly done that and expanded how

732
00:26:35,060 --> 00:26:32,940
mange of organics that we know of today

733
00:26:37,100 --> 00:26:35,070
but it was more than that to we also

734
00:26:39,919 --> 00:26:37,110
wanted to understand how organic

735
00:26:42,560 --> 00:26:39,929
molecules organic matter on Mars that

736
00:26:43,650 --> 00:26:42,570
was incorporated in rocks three billion

737
00:26:45,240 --> 00:26:43,660
years ago

738
00:26:46,890 --> 00:26:45,250

would be there for us to survive it

739
00:26:49,050 --> 00:26:46,900
would be there for us to discover all

740
00:26:50,880 --> 00:26:49,060
those years later what are the processes

741
00:26:53,970 --> 00:26:50,890
that and environments that allowed it to

742
00:26:56,100 --> 00:26:53,980
resist that degradation and that really

743
00:26:58,380 --> 00:26:56,110
is remarkable from Jen's results that

744
00:27:00,450 --> 00:26:58,390
she's been able to determine what types

745
00:27:03,270 --> 00:27:00,460
of molecules and what types of

746
00:27:05,580 --> 00:27:03,280
environments allowed those molecules to

747
00:27:07,500 --> 00:27:05,590
persist to today and this is not only

748
00:27:08,760 --> 00:27:07,510
important for curiosity as you know

749
00:27:10,710 --> 00:27:08,770
fulfilling one of our main mission

750
00:27:12,750 --> 00:27:10,720
objectives but it's also important for

751
00:27:16,200 --> 00:27:12,760
future Mars missions who will seek

752
00:27:18,840 --> 00:27:16,210
direct signs of life missions like XO

753
00:27:20,700 --> 00:27:18,850
Mars and Mars 2020 and what this does is

754
00:27:22,710 --> 00:27:20,710
gives us it gives us confidence that

755
00:27:24,150 --> 00:27:22,720
when those missions get to Mars there

756
00:27:26,670 --> 00:27:24,160
still can be something for them to

757
00:27:28,320 --> 00:27:26,680
discover so Ashwin you were just

758
00:27:29,790 --> 00:27:28,330
mentioning that via the Martian year is

759
00:27:31,560 --> 00:27:29,800
a bit longer than the earth year and

760
00:27:33,090 --> 00:27:31,570
another thing is that the Martian day

761
00:27:34,800 --> 00:27:33,100
tell us about how similar the Martian

762
00:27:36,180 --> 00:27:34,810
day is to an earth day and how different

763
00:27:38,400 --> 00:27:36,190

it is I think you actually have some

764
00:27:42,270 --> 00:27:38,410
personal stories relating to this well

765
00:27:43,710 --> 00:27:42,280
yeah you know there's enormous number of

766
00:27:46,110 --> 00:27:43,720
similarities between Mars and Earth

767
00:27:47,730 --> 00:27:46,120
they're very similar planets in some

768
00:27:50,430 --> 00:27:47,740
ways that are purely coincidental Mars

769
00:27:52,620 --> 00:27:50,440
is a 24 and 1/2 hour day and it has a

770
00:27:54,420 --> 00:27:52,630
tilt on its axis about 25 degrees

771
00:27:56,700 --> 00:27:54,430
similar to Earth's tilt of 23 degrees

772
00:27:59,040 --> 00:27:56,710
which makes the days and the seasons

773
00:28:01,200 --> 00:27:59,050
remarkably earth-like it also makes it

774
00:28:02,910 --> 00:28:01,210
incredibly interesting to operate a

775
00:28:07,620 --> 00:28:02,920
rover in the most efficient way on Mars

776
00:28:10,020 --> 00:28:07,630
because the best way actually live on a

777
00:28:11,430 --> 00:28:10,030
21 37 minute day which all of us on the

778
00:28:13,200 --> 00:28:11,440
Mars Science Laboratory did for the

779
00:28:16,800 --> 00:28:13,210
first 90 days of the mission before we

780
00:28:18,600 --> 00:28:16,810
all started going crazy just comment

781
00:28:19,860 --> 00:28:18,610
about you know 40 minutes later every

782
00:28:21,810 --> 00:28:19,870
day that that would disrupt your sleep I

783
00:28:23,400 --> 00:28:21,820
would think yeah somebody who's just

784
00:28:25,020 --> 00:28:23,410
joined us has asked us oh where are you

785
00:28:26,070 --> 00:28:25,030
to give us another sense about where

786
00:28:26,610 --> 00:28:26,080
you're standing and what sort of room

787
00:28:28,650 --> 00:28:26,620
you're in right now

788
00:28:30,510 --> 00:28:28,660

sure yeah we're at the Jet Propulsion

789
00:28:32,790 --> 00:28:30,520
Laboratory we're in a place called the

790
00:28:34,230 --> 00:28:32,800
Mars yard it doesn't look like a yard in

791
00:28:37,200 --> 00:28:34,240
here of course because we're in a shed

792
00:28:39,420 --> 00:28:37,210
where the twin model of curiosity lives

793
00:28:41,100 --> 00:28:39,430
so behind us you see the engineering

794
00:28:43,110 --> 00:28:41,110
model some people call her Maggie and

795
00:28:45,120 --> 00:28:43,120
she's very much like the one that's on

796
00:28:46,560 --> 00:28:45,130
Mars especially in terms of all the

797
00:28:48,390 --> 00:28:46,570
software on board and all the

798
00:28:50,340 --> 00:28:48,400
electronics we have some of the

799
00:28:52,560 --> 00:28:50,350
instruments here as well and this model

800
00:28:55,050 --> 00:28:52,570
can drive out into the yard and we've

801
00:28:56,490 --> 00:28:55,060
used it for tests including all solving

802
00:28:57,360 --> 00:28:56,500
anomalies that occur on the surface of

803
00:28:59,280 --> 00:28:57,370
Mars

804
00:29:01,080 --> 00:28:59,290
this is the model that was used to teach

805
00:29:03,210 --> 00:29:01,090
the rover on Mars how to drive and how

806
00:29:04,860 --> 00:29:03,220
to navigate we can use it for a lot of

807
00:29:07,170 --> 00:29:04,870
things where we don't want to use the

808
00:29:10,830 --> 00:29:07,180
precious time and resources of the

809
00:29:11,940 --> 00:29:10,840
actual Rover on Mars well but we're good

810
00:29:13,410 --> 00:29:11,950
we're gonna start by taking some

811
00:29:14,340 --> 00:29:13,420
questions now but before we do that I

812
00:29:16,020 --> 00:29:14,350
actually want to go back to Paul for

813
00:29:17,730 --> 00:29:16,030

just one more last thing so you know

814
00:29:19,260 --> 00:29:17,740
we've talked about landing this amazing

815
00:29:21,000 --> 00:29:19,270
Rover on Mars and then you have this

816
00:29:23,280 --> 00:29:21,010
incredible chemical laboratory on Mars

817
00:29:24,870 --> 00:29:23,290
tell us that story how did we get this

818
00:29:26,880 --> 00:29:24,880
sensitive chemical laboratory on another

819
00:29:30,390 --> 00:29:26,890
planet let me get to that question

820
00:29:32,430 --> 00:29:30,400
you're asking me have you throw one in

821
00:29:34,350 --> 00:29:32,440
my direction first okay but nobody will

822
00:29:40,230 --> 00:29:34,360
ask and what did you do this morning

823
00:29:42,450 --> 00:29:40,240
Paul what we did this morning actually

824
00:29:45,660 --> 00:29:42,460
was look at data that came down from

825
00:29:47,730 --> 00:29:45,670
curiosity that was deposited into Sam

826
00:29:50,250 --> 00:29:47,740
and it's been months and months so like

827
00:29:52,830 --> 00:29:50,260
Ashwin mentioned were just in the

828
00:29:54,450 --> 00:29:52,840
process of getting the drill back in

829
00:29:56,400 --> 00:29:54,460
order we're just tremendously excited

830
00:29:58,290 --> 00:29:56,410
about that so the search of organics is

831
00:30:00,630 --> 00:29:58,300
going to go on but getting back to your

832
00:30:04,230 --> 00:30:00,640
other question which is what it took to

833
00:30:07,290 --> 00:30:04,240
get the I mean the Sam instrument is

834
00:30:09,900 --> 00:30:07,300
just very complicated it took a huge

835
00:30:12,150 --> 00:30:09,910
team of scientists and engineers and

836
00:30:13,680 --> 00:30:12,160
software programmers it's an

837
00:30:16,110 --> 00:30:13,690
international team we put this

838
00:30:19,380 --> 00:30:16,120

instrument together at NASA Goddard but

839
00:30:20,600 --> 00:30:19,390
Chris Webster team at Jet Propulsion lab

840
00:30:23,880 --> 00:30:20,610
developed the tunable laser spectrometer

841
00:30:25,980 --> 00:30:23,890
our French colleagues developed the gas

842
00:30:27,419 --> 00:30:25,990
chromatograph mass spectrometer in fact

843
00:30:29,120 --> 00:30:27,429
this morning they were calling in from

844
00:30:32,130 --> 00:30:29,130
Toulouse because they were supporting

845
00:30:35,100 --> 00:30:32,140
operations of our instrument from

846
00:30:36,799 --> 00:30:35,110
Toulouse so what we did was we spent

847
00:30:38,970 --> 00:30:36,809
several years putting this together

848
00:30:40,560 --> 00:30:38,980
assembled it at goddard tested it at

849
00:30:42,169 --> 00:30:40,570
Goddard we put it in environmental

850
00:30:44,160 --> 00:30:42,179
chambers that exactly match the

851
00:30:46,860 --> 00:30:44,170
conditions we would have on the surface

852
00:30:48,419 --> 00:30:46,870
of Mars we tested out the scripts the

853
00:30:50,490 --> 00:30:48,429
software that we're going to run on Mars

854
00:30:53,400 --> 00:30:50,500
and then eventually we brought it to Jet

855
00:30:56,520 --> 00:30:53,410
Propulsion lab and this image that you

856
00:30:58,169 --> 00:30:56,530
see shows Sam that's at gold coated box

857
00:31:02,250 --> 00:30:58,179
about the size of the microwave oven

858
00:31:04,680 --> 00:31:02,260
being gently lowered into the rover the

859
00:31:06,510 --> 00:31:04,690
rover is upside down at that point and

860
00:31:08,250 --> 00:31:06,520
we lowered Sam into it and then we did

861
00:31:10,200 --> 00:31:08,260
some more testing we put the whole Rover

862
00:31:11,160 --> 00:31:10,210
intact in a big environmental chamber at

863
00:31:12,330 --> 00:31:11,170

JPL

864
00:31:14,490 --> 00:31:12,340
and who we should we were sure

865
00:31:16,140 --> 00:31:14,500
everything was perfect then the rover

866
00:31:17,940 --> 00:31:16,150
was ready to ship to the Cape and

867
00:31:20,250 --> 00:31:17,950
everything got launched so you see

868
00:31:22,320 --> 00:31:20,260
everybody there in bunny suits the

869
00:31:24,570 --> 00:31:22,330
reason they're in those white suits is

870
00:31:26,940 --> 00:31:24,580
we did not want to bring our skin oils

871
00:31:29,160 --> 00:31:26,950
and everything else to Mars because then

872
00:31:31,230 --> 00:31:29,170
Jen would have to report that we were

873
00:31:33,540 --> 00:31:31,240
finding things that look like they came

874
00:31:36,390 --> 00:31:33,550
from Chris Webster or somebody else in

875
00:31:38,460 --> 00:31:36,400
the cleanroom at JPL so it took a lot of

876
00:31:40,710 --> 00:31:38,470
work and a great team work and and

877
00:31:42,360 --> 00:31:40,720
several nations joining us has just been

878
00:31:43,350 --> 00:31:42,370
tremendously exciting well actually what

879
00:31:44,580 --> 00:31:43,360
what you were just talking about leads

880
00:31:46,410 --> 00:31:44,590
into one of the social media questions

881
00:31:48,390 --> 00:31:46,420
so a person named 3d physics from

882
00:31:49,650 --> 00:31:48,400
Twitter asks how do you verify that the

883
00:31:50,430 --> 00:31:49,660
sensitive experiments haven't been

884
00:31:52,440 --> 00:31:50,440
compromised

885
00:31:56,280 --> 00:31:52,450
either before reaching on Mars or after

886
00:31:59,400 --> 00:31:56,290
landing on Mars yeah what we do is we

887
00:32:01,440 --> 00:31:59,410
bring along standards for example we do

888
00:32:03,900 --> 00:32:01,450

but any good analytic chemist us in the

889
00:32:06,450 --> 00:32:03,910
lab we run blanks so for example if

890
00:32:08,790 --> 00:32:06,460
we're looking to make sure that none of

891
00:32:10,230 --> 00:32:08,800
the residual organics and the

892
00:32:12,030 --> 00:32:10,240
instruments are producing the signals

893
00:32:14,220 --> 00:32:12,040
that we see we go ahead and we run a

894
00:32:15,690 --> 00:32:14,230
full sequence of runs but we don't put

895
00:32:18,030 --> 00:32:15,700
sample in the cup and then we see what

896
00:32:19,530 --> 00:32:18,040
we got so we work very very hard to make

897
00:32:22,890 --> 00:32:19,540
sure that what we're seeing is from Mars

898
00:32:25,080 --> 00:32:22,900
and we're very confident that what we're

899
00:32:26,580 --> 00:32:25,090
seeing is from Mars there's a there's a

900
00:32:27,750 --> 00:32:26,590
lot of questions coming in right now as

901
00:32:29,250 --> 00:32:27,760
I mentioned you're welcome to give us

902
00:32:31,680 --> 00:32:29,260
any questions that you have you can

903
00:32:33,240 --> 00:32:31,690
either use the hashtag ask NASA or if

904
00:32:34,980 --> 00:32:33,250
you're on Facebook to simply put your

905
00:32:36,870 --> 00:32:34,990
questions in the comments so there's

906
00:32:38,310 --> 00:32:36,880
several questions from many people sorry

907
00:32:40,110 --> 00:32:38,320
that I'm not going to name you all about

908
00:32:41,910 --> 00:32:40,120
can this methane that we're detecting be

909
00:32:43,470 --> 00:32:41,920
ever be used as a fuel for future

910
00:32:45,960 --> 00:32:43,480
missions is it something that's useful

911
00:32:48,530 --> 00:32:45,970
for a human presence on Mars should we

912
00:32:50,850 --> 00:32:48,540
should be good at rigor Chris for that I

913
00:32:54,900 --> 00:32:50,860

want to take a stab at that question

914
00:32:56,970 --> 00:32:54,910
Chris well of course there isn't right

915
00:32:58,650 --> 00:32:56,980
now we're seeing low background levels

916
00:33:01,290 --> 00:32:58,660
we're not seeing a lot of methane of

917
00:33:04,230 --> 00:33:01,300
course methane is always useful as a

918
00:33:08,880 --> 00:33:04,240
fuel that the the ability to extract it

919
00:33:10,620 --> 00:33:08,890
from the atmosphere would be wouldn't we

920
00:33:12,540 --> 00:33:10,630
would not be efficient but if there's a

921
00:33:14,310 --> 00:33:12,550
way one could access subsurface

922
00:33:16,620 --> 00:33:14,320
reservoirs then it becomes a whole new

923
00:33:19,740 --> 00:33:16,630
ballgame but that's really speculation

924
00:33:20,940 --> 00:33:19,750
at this point and I guess I'll sing as

925
00:33:22,530 --> 00:33:20,950
we're out of JPL right now I'll give

926
00:33:23,850 --> 00:33:22,540
another one - Ashwin so we have a

927
00:33:24,780 --> 00:33:23,860
question about if you could have if you

928
00:33:26,700 --> 00:33:24,790
could add it just

929
00:33:27,870 --> 00:33:26,710
more tool to the rover what would have

930
00:33:28,920 --> 00:33:27,880
been right well yeah but what was the

931
00:33:32,580 --> 00:33:28,930
thing that you really want on the rover

932
00:33:36,920 --> 00:33:32,590
that just don't happen to have that's a

933
00:33:41,820 --> 00:33:39,780
I'm gonna deflect you say the next thing

934
00:33:42,990 --> 00:33:41,830
we want to do on Mars is exactly what

935
00:33:45,240 --> 00:33:43,000
we're doing with the Mars 2020 mission

936
00:33:47,580 --> 00:33:45,250
building on all the results from

937
00:33:49,260 --> 00:33:47,590
habitability and organics and the

938
00:33:51,780 --> 00:33:49,270

possibility of life that curiosity has

939
00:33:53,100 --> 00:33:51,790
opened up and looking ahead to having

940
00:33:54,840 --> 00:33:53,110
instruments on Mars that are built

941
00:33:58,320 --> 00:33:54,850
specifically to look for those signs of

942
00:34:00,120 --> 00:33:58,330
life so Jen this seems like a good one

943
00:34:02,160 --> 00:34:00,130
for an astrobiologist I mean this is a

944
00:34:04,560 --> 00:34:02,170
difficult question I mean we have

945
00:34:06,000 --> 00:34:04,570
organic molecules how do you know if

946
00:34:07,590 --> 00:34:06,010
they're processed by life you know what

947
00:34:09,149 --> 00:34:07,600
signs would you look for that might hint

948
00:34:11,430 --> 00:34:09,159
to you that this is something based on

949
00:34:13,710 --> 00:34:11,440
life well all life that we know of is

950
00:34:15,090 --> 00:34:13,720
based on organic molecules even though

951
00:34:17,250 --> 00:34:15,100
we know that that's not the only way you

952
00:34:18,510 --> 00:34:17,260
can make them so if we're going to look

953
00:34:20,879 --> 00:34:18,520
for life the first thing you probably

954
00:34:23,419 --> 00:34:20,889
want to do is look for signatures

955
00:34:25,980 --> 00:34:23,429
associated with organic materials and

956
00:34:27,840 --> 00:34:25,990
that was part of the reason why it's so

957
00:34:29,129 --> 00:34:27,850
significant we found organic materials

958
00:34:31,440 --> 00:34:29,139
in the first place it helps us guide

959
00:34:34,050 --> 00:34:31,450
guide where we're going to look for more

960
00:34:35,580 --> 00:34:34,060
of these now in those signatures they

961
00:34:38,520 --> 00:34:35,590
might be things about the chemistry of

962
00:34:40,139 --> 00:34:38,530
the organic materials or perhaps they're

963
00:34:42,659 --> 00:34:40,149

things about how the organic materials

964
00:34:44,310 --> 00:34:42,669
are stuck together in shapes how they're

965
00:34:46,730 --> 00:34:44,320
packaged maybe it's going to be about

966
00:34:49,530 --> 00:34:46,740
their isotopes there's a whole suite of

967
00:34:51,659 --> 00:34:49,540
chemical and physical things that we can

968
00:34:54,450 --> 00:34:51,669
measure that might indicate signatures

969
00:34:56,280 --> 00:34:54,460
of life let me jump in there I mean Jen

970
00:34:58,740 --> 00:34:56,290
herself went up to small guard one time

971
00:35:00,870 --> 00:34:58,750
to one of the farthest most northern

972
00:35:02,730 --> 00:35:00,880
Springs a hot spring way up in that cold

973
00:35:04,110 --> 00:35:02,740
area and then we put some of this

974
00:35:06,270 --> 00:35:04,120
material in the gas chromatograph mass

975
00:35:08,250 --> 00:35:06,280
spectrometer and these patterns showed

976
00:35:10,200 --> 00:35:08,260
up that showed the length of the carbon

977
00:35:12,570 --> 00:35:10,210
chains and bingo that was the signature

978
00:35:14,340 --> 00:35:12,580
for lights so those are one of the many

979
00:35:15,780 --> 00:35:14,350
types of things we'll look for that's

980
00:35:17,880 --> 00:35:15,790
right and there happens to be another

981
00:35:20,070 --> 00:35:17,890
experiment on Sam that we haven't used

982
00:35:22,530 --> 00:35:20,080
yet it's one of the wet chemistry

983
00:35:25,500 --> 00:35:22,540
experiments and if those types of things

984
00:35:26,940 --> 00:35:25,510
are left behind in the organic material

985
00:35:29,640 --> 00:35:26,950
that we come across assuming we will

986
00:35:31,200 --> 00:35:29,650
come across more perhaps if it's the

987
00:35:33,960 --> 00:35:31,210
right sample and the right compounds are

988
00:35:35,190 --> 00:35:33,970

there maybe we'll get some hints so I

989
00:35:36,390 --> 00:35:35,200
understand we actually have a media

990
00:35:37,740 --> 00:35:36,400
question that they're gonna try to feed

991
00:35:39,450 --> 00:35:37,750
in on audio so

992
00:35:40,500 --> 00:35:39,460
if I could ask for that question we're

993
00:36:00,930 --> 00:35:40,510
gonna try to have an audio feed at the

994
00:36:03,960 --> 00:36:00,940
moment why is methane so exciting him

995
00:36:06,569 --> 00:36:03,970
what what is it that you found that is

996
00:36:11,730 --> 00:36:06,579
so intriguing about this organic

997
00:36:12,900 --> 00:36:11,740
chemical compound difference then what

998
00:36:14,460 --> 00:36:12,910
we kind of already knew that there

999
00:36:17,550 --> 00:36:14,470
already the building blocks of life

1000
00:36:18,839 --> 00:36:17,560
essentially a mark okay should we should

1001
00:36:21,300 --> 00:36:18,849
we go to Chris for the methane question

1002
00:36:23,400 --> 00:36:21,310
did you hear that yes yes I would start

1003
00:36:25,230 --> 00:36:23,410
right away by saying whenever you have

1004
00:36:27,480 --> 00:36:25,240
an oxidizing atmosphere and you see

1005
00:36:29,400 --> 00:36:27,490
reduce compounds like methane or

1006
00:36:32,309 --> 00:36:29,410
hydrogen sulfide they're always very

1007
00:36:35,880 --> 00:36:32,319
exciting and in particular for the Mars

1008
00:36:37,890 --> 00:36:35,890
methane because 95% of the methane on

1009
00:36:40,410 --> 00:36:37,900
earth is produced from biology it's

1010
00:36:44,970 --> 00:36:40,420
produced from termites or rice paddies

1011
00:36:46,319 --> 00:36:44,980
or cows or sheep or termites etc because

1012
00:36:48,930 --> 00:36:46,329
of that there's always been this

1013
00:36:52,050 --> 00:36:48,940

interest in Mars methane as its

1014
00:36:54,480 --> 00:36:52,060
potential biological origin and that's

1015
00:36:56,010 --> 00:36:54,490
true also because we know it only can

1016
00:36:57,990 --> 00:36:56,020
last for 300 years

1017
00:37:00,480 --> 00:36:58,000
so if we see methane in the Martian

1018
00:37:02,099 --> 00:37:00,490
atmosphere that means it has to do

1019
00:37:06,150 --> 00:37:02,109
something is happening today it's being

1020
00:37:09,540 --> 00:37:06,160
released or it's being created and I'll

1021
00:37:12,120 --> 00:37:09,550
hand over to to Paul to answer the

1022
00:37:15,510 --> 00:37:12,130
second part well that's let me add to

1023
00:37:16,950 --> 00:37:15,520
that I mean on earth like Chris

1024
00:37:18,780 --> 00:37:16,960
mentioned most of the methane in the

1025
00:37:21,660 --> 00:37:18,790
atmosphere comes from biology from rice

1026
00:37:25,620 --> 00:37:21,670
paddies or you know from a lot of

1027
00:37:27,420 --> 00:37:25,630
different processes but all the most of

1028
00:37:29,550 --> 00:37:27,430
the oxygen on earth also comes from

1029
00:37:32,250 --> 00:37:29,560
biology billions of years ago the

1030
00:37:34,230 --> 00:37:32,260
cyanobacteria got serious and they

1031
00:37:36,630 --> 00:37:34,240
started cranking away and so in our

1032
00:37:39,569 --> 00:37:36,640
atmosphere we have both a combination of

1033
00:37:40,980 --> 00:37:39,579
methane and oxygen and that's what some

1034
00:37:43,440 --> 00:37:40,990
of the folks who are building these big

1035
00:37:45,120 --> 00:37:43,450
telescopes follow-on telescopes to the

1036
00:37:46,890 --> 00:37:45,130
James Webb for example that are going to

1037
00:37:48,120 --> 00:37:46,900
be out in space looking at exoplanets

1038
00:37:49,829 --> 00:37:48,130

they're going to be looking for

1039
00:37:51,240 --> 00:37:49,839
combinations of oxidizing and reducing

1040
00:37:53,130 --> 00:37:51,250
things the

1041
00:37:55,320 --> 00:37:53,140
might be evidence of life so it's really

1042
00:37:58,520 --> 00:37:55,330
fundamental it's really interesting and

1043
00:38:00,270 --> 00:37:58,530
and I sure hope grandma understood that

1044
00:38:01,560 --> 00:38:00,280
and I understand we have another

1045
00:38:11,910 --> 00:38:01,570
question for the media that will come

1046
00:38:14,250 --> 00:38:11,920
over audio hi there was a similar

1047
00:38:17,250 --> 00:38:14,260
announcement of detection of both

1048
00:38:20,970 --> 00:38:17,260
methane and organic materials back in

1049
00:38:24,570 --> 00:38:20,980
2014 also by the Curiosity rover how is

1050
00:38:29,400 --> 00:38:24,580
this announcement different or how have

1051
00:38:32,130 --> 00:38:29,410
you built on the findings from 2014 for

1052
00:38:33,570 --> 00:38:32,140
this this detection I know we were just

1053
00:38:34,980 --> 00:38:33,580
talking about that beforehand is that

1054
00:38:36,090 --> 00:38:34,990
being a very good question to ask so I

1055
00:38:39,240 --> 00:38:36,100
think did you Jennifer do what you want

1056
00:38:41,550 --> 00:38:39,250
take that sure in 2014 we reported the

1057
00:38:43,290 --> 00:38:41,560
discovery of chlorinated molecules now

1058
00:38:45,120 --> 00:38:43,300
these are carbon structures that have a

1059
00:38:47,580 --> 00:38:45,130
chlorine attached to them and there was

1060
00:38:49,320 --> 00:38:47,590
a few of them it was a significant

1061
00:38:51,600 --> 00:38:49,330
discovery it was the first time we were

1062
00:38:53,760 --> 00:38:51,610
able to confirm organic molecules on

1063
00:38:55,530 --> 00:38:53,770

Mars for the it was the first time and

1064
00:38:57,360 --> 00:38:55,540
we've been looking for this for a very

1065
00:38:59,070 --> 00:38:57,370
long time with the hopes that we would

1066
00:39:01,560 --> 00:38:59,080
find it with the with the Viking

1067
00:39:04,440 --> 00:39:01,570
instruments in 1976 and finally with

1068
00:39:06,740 --> 00:39:04,450
curiosity in landing and on a lake bed

1069
00:39:10,020 --> 00:39:06,750
that we could actually discover these

1070
00:39:12,120 --> 00:39:10,030
now we were left with what do these mean

1071
00:39:14,220 --> 00:39:12,130
the thing about the chlorine molecules

1072
00:39:17,100 --> 00:39:14,230
is that it's not what you typically find

1073
00:39:18,720 --> 00:39:17,110
in natural samples and so we weren't

1074
00:39:21,570 --> 00:39:18,730
sure what the significant was at the

1075
00:39:23,790 --> 00:39:21,580
time however it did give us a lot of

1076
00:39:25,770 --> 00:39:23,800
motivation to keep looking there have to

1077
00:39:28,020 --> 00:39:25,780
be other layers in in the Gale Crater

1078
00:39:30,690 --> 00:39:28,030
other layers of the lake sediments and

1079
00:39:32,700 --> 00:39:30,700
we wanted to find more organic molecules

1080
00:39:34,920 --> 00:39:32,710
and that's exactly what happened we

1081
00:39:36,600 --> 00:39:34,930
drove for miles away we started down at

1082
00:39:38,340 --> 00:39:36,610
the lowest part of the crater we drove

1083
00:39:40,470 --> 00:39:38,350
for miles away and got to the base of

1084
00:39:42,990 --> 00:39:40,480
the mountain and the first layers that

1085
00:39:45,030 --> 00:39:43,000
we looked at contain all of this organic

1086
00:39:47,310 --> 00:39:45,040
material that we're reporting today so

1087
00:39:49,290 --> 00:39:47,320
we have essentially expanded upon the

1088
00:39:52,140 --> 00:39:49,300

inventory of the organic molecules and

1089
00:39:53,460 --> 00:39:52,150
now we have a better sense of how they

1090
00:39:56,430 --> 00:39:53,470
were preserved in the rocks in the first

1091
00:39:59,490 --> 00:39:56,440
place so should mention that your report

1092
00:40:01,620 --> 00:39:59,500
Jen showed significantly greater

1093
00:40:04,680 --> 00:40:01,630
abundance than we had detected before

1094
00:40:07,829 --> 00:40:04,690
and one more thing to add is in almost

1095
00:40:10,589 --> 00:40:07,839
every experiment we do as we heat up the

1096
00:40:12,420 --> 00:40:10,599
sample in this little quartz cup we see

1097
00:40:15,390 --> 00:40:12,430
a big oxygen signal and the oxygen

1098
00:40:17,640 --> 00:40:15,400
signal comes from a mineral mineral that

1099
00:40:20,760 --> 00:40:17,650
breaks apart that contains chlorine and

1100
00:40:22,589 --> 00:40:20,770
oxygen but then the hot oxygen can react

1101
00:40:24,329 --> 00:40:22,599
with some of the organics and produce

1102
00:40:27,240 --> 00:40:24,339
carbon dioxide that's called combustion

1103
00:40:28,920 --> 00:40:27,250
and what Jen did with part of her

1104
00:40:31,140 --> 00:40:28,930
analysis was really to look at the high

1105
00:40:32,309 --> 00:40:31,150
temperature release of organics that

1106
00:40:34,440 --> 00:40:32,319
might have escaped some of that

1107
00:40:35,849 --> 00:40:34,450
destruction but there still things there

1108
00:40:38,609 --> 00:40:35,859
that we're not seeing so I mean that's

1109
00:40:40,920 --> 00:40:38,619
really motivating our desire to get back

1110
00:40:42,720 --> 00:40:40,930
and with different techniques really

1111
00:40:44,490 --> 00:40:42,730
look for a more comprehensive suite of

1112
00:40:47,579 --> 00:40:44,500
organics try and figure out where they

1113
00:40:49,410 --> 00:40:47,589

really came from and Christy would you

1114
00:40:50,970 --> 00:40:49,420
like to continue your answer as to why

1115
00:40:52,650 --> 00:40:50,980
what we're announcing today is different

1116
00:40:54,990 --> 00:40:52,660
from what was detected before as far as

1117
00:40:57,420 --> 00:40:55,000
the the seasonality of the methane yes

1118
00:40:59,550 --> 00:40:57,430
it's it's very different because in the

1119
00:41:02,220 --> 00:40:59,560
past we were seeing spikes that we

1120
00:41:04,109 --> 00:41:02,230
couldn't understand and we had ideas

1121
00:41:05,309 --> 00:41:04,119
about them but we couldn't constrain

1122
00:41:07,859 --> 00:41:05,319
them because they only occurred

1123
00:41:10,050 --> 00:41:07,869
occasionally so now we first what we've

1124
00:41:12,599 --> 00:41:10,060
measured the background level over two

1125
00:41:15,000 --> 00:41:12,609
years so we know the total amount of

1126
00:41:18,120 --> 00:41:15,010
methane in the atmosphere is constrained

1127
00:41:21,420 --> 00:41:18,130
by that it's a low average value of only

1128
00:41:24,270 --> 00:41:21,430
0.4 parts per billion it changes a lot

1129
00:41:27,180 --> 00:41:24,280
but the total amount is low so that also

1130
00:41:29,430 --> 00:41:27,190
constrains the magnitude of pulses and

1131
00:41:31,890 --> 00:41:29,440
spikes elsewhere that would mix into the

1132
00:41:34,680 --> 00:41:31,900
hemisphere so this is a very important

1133
00:41:37,530 --> 00:41:34,690
observation the fact that it changes so

1134
00:41:40,230 --> 00:41:37,540
dramatically this factor of three is has

1135
00:41:42,839 --> 00:41:40,240
got to be duplicated by models that

1136
00:41:45,750 --> 00:41:42,849
explain it now we do think that the

1137
00:41:48,809 --> 00:41:45,760
spikes and the low background seasonal

1138
00:41:50,730 --> 00:41:48,819

cycle are related it's quite conceivable

1139
00:41:53,460 --> 00:41:50,740
that the same reservoirs are slowly

1140
00:41:55,829 --> 00:41:53,470
seeping methane up to the to the surface

1141
00:41:59,490 --> 00:41:55,839
are also occasionally causing large

1142
00:42:00,480 --> 00:41:59,500
pulses of the gas to be released well

1143
00:42:02,579 --> 00:42:00,490
thank you and I understand we have

1144
00:42:17,830 --> 00:42:02,589
another media question so we'll go to

1145
00:42:25,210 --> 00:42:21,670
see is no cycle methane and also quite

1146
00:42:28,360 --> 00:42:25,220
noticeably a detection of thiophene in

1147
00:42:32,530 --> 00:42:28,370
the subsoil so if I could ask what

1148
00:42:36,520 --> 00:42:32,540
follow-up investigations specifically

1149
00:42:42,730 --> 00:42:36,530
from the Europeans could support and add

1150
00:42:49,140 --> 00:42:42,740
to this specifically the trace gas

1151
00:42:51,760 --> 00:42:49,150
orbiter presumably can do the kind of

1152
00:42:54,640 --> 00:42:51,770
isotopic analysis that you can't

1153
00:42:57,040 --> 00:42:54,650
so can you foresee that being able to

1154
00:42:59,680 --> 00:42:57,050
contribute and secondly still with

1155
00:43:02,110 --> 00:42:59,690
ExoMars but in the future you're talking

1156
00:43:06,520 --> 00:43:02,120
about drilling to two meters is the

1157
00:43:11,590 --> 00:43:06,530
graph gas chromatograph on ExoMars the

1158
00:43:14,520 --> 00:43:11,600
same as the one on MSL and planets do

1159
00:43:16,930 --> 00:43:14,530
the work that you say needs to be done

1160
00:43:18,880 --> 00:43:16,940
let me take a first shot at that and

1161
00:43:20,310 --> 00:43:18,890
Chris may want to jump in first of all

1162
00:43:22,930 --> 00:43:20,320
let me say Leo it's great to hear

1163
00:43:25,030 --> 00:43:22,940

somebody saying methane instead of

1164
00:43:28,660 --> 00:43:25,040
methane like Chris Webster does all the

1165
00:43:31,570 --> 00:43:28,670
time but starting with with the ExoMars

1166
00:43:33,940 --> 00:43:31,580
mission we're actually very proud of the

1167
00:43:36,400 --> 00:43:33,950
work that our team did here at Goddard

1168
00:43:39,130 --> 00:43:36,410
to deliver a mass spectrometer to an

1169
00:43:41,020 --> 00:43:39,140
experiment on the ExoMars Rover which is

1170
00:43:44,070 --> 00:43:41,030
planned to launch in 2020 that

1171
00:43:47,080 --> 00:43:44,080
instrument is called MoMA and we greatly

1172
00:43:49,420 --> 00:43:47,090
expand the techniques that we use there

1173
00:43:51,610 --> 00:43:49,430
to look at these samples that come up

1174
00:43:53,950 --> 00:43:51,620
from two meters below the surface the

1175
00:43:55,510 --> 00:43:53,960
first thing we do is totally different

1176
00:43:57,520 --> 00:43:55,520
it's never been done before on the

1177
00:44:01,600 --> 00:43:57,530
surface of another planet we use a laser

1178
00:44:03,010 --> 00:44:01,610
basically to put a pulse of energy into

1179
00:44:05,170 --> 00:44:03,020
the sample that's in front of the

1180
00:44:07,300 --> 00:44:05,180
instrument and then we let some of those

1181
00:44:09,760 --> 00:44:07,310
ions up into a mass spectrometer has a

1182
00:44:12,250 --> 00:44:09,770
very high mass range we can do things

1183
00:44:14,770 --> 00:44:12,260
like find a high mass peak it's a very

1184
00:44:15,910 --> 00:44:14,780
soft ionization technique and we can do

1185
00:44:18,760 --> 00:44:15,920
what's called tandem mass spectrometry

1186
00:44:21,010 --> 00:44:18,770
we can break that molecule apart into

1187
00:44:22,300 --> 00:44:21,020
its constituents and really try and get

1188
00:44:26,110 --> 00:44:22,310

at the structure it's a very powerful

1189
00:44:28,150 --> 00:44:26,120
technique we also have a GCMs a gas

1190
00:44:30,100 --> 00:44:28,160
chromatograph mass spectrometer and then

1191
00:44:31,220 --> 00:44:30,110
also was a contribution from our French

1192
00:44:33,549 --> 00:44:31,230
colleagues they're really

1193
00:44:35,930 --> 00:44:33,559
at understanding how to do that

1194
00:44:38,890 --> 00:44:35,940
separation of gases that Jen talked

1195
00:44:41,000 --> 00:44:38,900
about and they do the derivative

1196
00:44:43,549 --> 00:44:41,010
chemistry the chemistry that tries to

1197
00:44:45,980 --> 00:44:43,559
pull out interesting things like amino

1198
00:44:48,140 --> 00:44:45,990
acids a little bit differently we kind

1199
00:44:50,270 --> 00:44:48,150
of have a lot of fluid in a cup

1200
00:44:52,460 --> 00:44:50,280
we puncture the cup and put sample in

1201
00:44:56,109 --> 00:44:52,470
and they try and control that a little

1202
00:44:59,270 --> 00:44:56,119
bit better by having basically a little

1203
00:45:00,740 --> 00:44:59,280
container that'll break apart at exactly

1204
00:45:03,289 --> 00:45:00,750
the right temperature put the

1205
00:45:05,539 --> 00:45:03,299
derivatives a ssin in and then do

1206
00:45:08,089 --> 00:45:05,549
separation the technologies have also

1207
00:45:10,099 --> 00:45:08,099
advanced a bit for example you know one

1208
00:45:12,020 --> 00:45:10,109
thing we'd be very interested in finding

1209
00:45:14,480 --> 00:45:12,030
is chirality the left and

1210
00:45:16,190 --> 00:45:14,490
right-handedness of an amino acid if

1211
00:45:19,099 --> 00:45:16,200
we're lucky enough to find an amino acid

1212
00:45:21,289 --> 00:45:19,109
on life there's they're not equivalent

1213
00:45:23,780 --> 00:45:21,299

but in in meteorites they're they're

1214
00:45:26,079 --> 00:45:23,790
largely equivalent so with Momo we're

1215
00:45:28,910 --> 00:45:26,089
trying to solve that problem as well so

1216
00:45:31,160 --> 00:45:28,920
technology advances and our ability to

1217
00:45:33,859 --> 00:45:31,170
think through what we can put in place

1218
00:45:35,960 --> 00:45:33,869
on another planet advances and maybe

1219
00:45:38,900 --> 00:45:35,970
Chris should talk about what the

1220
00:45:40,700 --> 00:45:38,910
European trace gas orbiter which is also

1221
00:45:42,230 --> 00:45:40,710
looking for methane what they hope to

1222
00:45:44,150 --> 00:45:42,240
find I understand that's just getting

1223
00:45:45,740 --> 00:45:44,160
going in operation around Mars and

1224
00:45:47,030 --> 00:45:45,750
they've not been doing much reporting

1225
00:45:50,930 --> 00:45:47,040
yet but they're just getting their

1226
00:45:53,359 --> 00:45:50,940
initial set of data yes the the exciting

1227
00:45:55,280 --> 00:45:53,369
thing about t geo is it's cold it's

1228
00:45:57,140 --> 00:45:55,290
going there to look at a lot of gases in

1229
00:45:59,630 --> 00:45:57,150
the atmosphere but especially a methane

1230
00:46:00,829 --> 00:45:59,640
in particular as Paul said they started

1231
00:46:02,630 --> 00:46:00,839
to make measurements and we're all

1232
00:46:05,000 --> 00:46:02,640
waiting with bated breath to see what

1233
00:46:07,190 --> 00:46:05,010
they find but they're going to in

1234
00:46:08,870 --> 00:46:07,200
particular by mapping it globally

1235
00:46:11,750 --> 00:46:08,880
they'll be able to relate their

1236
00:46:14,450 --> 00:46:11,760
measurements to ours now one thing that

1237
00:46:17,510 --> 00:46:14,460
they could do is if they see large

1238
00:46:19,970 --> 00:46:17,520

plumes somewhere even though they don't

1239
00:46:22,970 --> 00:46:19,980
have a lot of spatial resolution they

1240
00:46:24,859 --> 00:46:22,980
could potentially pinpoint or hone in on

1241
00:46:27,980 --> 00:46:24,869
an area of Mars that seems to be

1242
00:46:29,720 --> 00:46:27,990
associated with the the increase from

1243
00:46:31,910 --> 00:46:29,730
the surface that would be a very

1244
00:46:33,920 --> 00:46:31,920
exciting fine because it tells us where

1245
00:46:36,319 --> 00:46:33,930
we need to go to to get the better

1246
00:46:38,620 --> 00:46:36,329
signals when we look at it and that's

1247
00:46:41,930 --> 00:46:38,630
important you asked about the carbon 13

1248
00:46:44,390 --> 00:46:41,940
isotope ratio remember there's a hundred

1249
00:46:44,890 --> 00:46:44,400
times less carbon 13 methane and there

1250
00:46:47,050 --> 00:46:44,900
is red

1251
00:46:51,070 --> 00:46:47,060
methane and if you want to measure that

1252
00:46:54,160 --> 00:46:51,080
to 1% you're stuck with this extremely

1253
00:46:56,650 --> 00:46:54,170
high sensitivity needed so if the trace

1254
00:46:58,420 --> 00:46:56,660
gas orbiter sees significant amounts of

1255
00:47:00,220 --> 00:46:58,430
methane they will certainly be able to

1256
00:47:02,860 --> 00:47:00,230
make that measurement but if they see

1257
00:47:05,290 --> 00:47:02,870
mainly the low background levels that we

1258
00:47:06,780 --> 00:47:05,300
are seeing of 0.4 parts per billion it's

1259
00:47:09,700 --> 00:47:06,790
gonna be a challenge

1260
00:47:11,080 --> 00:47:09,710
so those are you don't mind if we have a

1261
00:47:12,400 --> 00:47:11,090
limited time for questions and we've had

1262
00:47:13,870 --> 00:47:12,410
some pretty technical answers I actually

1263
00:47:15,730 --> 00:47:13,880

want to go to some of the middle school

1264
00:47:17,770 --> 00:47:15,740
students that are actually live tweeting

1265
00:47:20,290 --> 00:47:17,780
us right now so apparently I need to

1266
00:47:21,430 --> 00:47:20,300
call out mr. Sol D's aerospace class so

1267
00:47:23,260 --> 00:47:21,440
you guys are sending us lots of

1268
00:47:25,120 --> 00:47:23,270
questions so they're asking us about the

1269
00:47:26,110 --> 00:47:25,130
implications does this discovery have

1270
00:47:28,270 --> 00:47:26,120
any implications for the future

1271
00:47:28,960 --> 00:47:28,280
colonization of Mars or human presence

1272
00:47:32,350 --> 00:47:28,970
on Mars

1273
00:47:34,180 --> 00:47:32,360
sure it could when we have organic

1274
00:47:36,100 --> 00:47:34,190
materials in the rock so we found in

1275
00:47:39,340 --> 00:47:36,110
Gale Crater there might be wider spread

1276
00:47:41,230 --> 00:47:39,350
and perhaps those would be a resource

1277
00:47:43,870 --> 00:47:41,240
for humans we don't know what that would

1278
00:47:46,000 --> 00:47:43,880
be exactly perhaps there are organisms

1279
00:47:48,010 --> 00:47:46,010
there that we don't know about yet they

1280
00:47:49,780 --> 00:47:48,020
might be helpful for farming there might

1281
00:47:54,010 --> 00:47:49,790
be organic materials that could be used

1282
00:47:56,140 --> 00:47:54,020
as fuel for both farming organisms

1283
00:47:59,080 --> 00:47:56,150
including plants need carbon in order to

1284
00:48:00,850 --> 00:47:59,090
turn it into their own biomass and and

1285
00:48:03,460 --> 00:48:00,860
perhaps there's another other ways of

1286
00:48:06,310 --> 00:48:03,470
using it to generate fuels that the

1287
00:48:08,440 --> 00:48:06,320
people there when actually use those

1288
00:48:10,360 --> 00:48:08,450

have not been fully investigated yet but

1289
00:48:11,860 --> 00:48:10,370
I know it's an open book on what

1290
00:48:14,200 --> 00:48:11,870
technologies we might use in the future

1291
00:48:15,670 --> 00:48:14,210
on Mars and actually the sort of the

1292
00:48:17,440 --> 00:48:15,680
follow-on question to this so there

1293
00:48:18,850 --> 00:48:17,450
there's Mack from Pier middle school who

1294
00:48:22,050 --> 00:48:18,860
asked could be possible to bring samples

1295
00:48:24,340 --> 00:48:22,060
back from Mars that's a great question

1296
00:48:25,810 --> 00:48:24,350
Ashwin actually is a perfect person to

1297
00:48:27,460 --> 00:48:25,820
ask that because there's a program at

1298
00:48:32,560 --> 00:48:27,470
Jet Propulsion Laboratory it's doing

1299
00:48:35,470 --> 00:48:32,570
exactly back from Mars yeah we sure hope

1300
00:48:37,120 --> 00:48:35,480
so one of the things that we're working

1301
00:48:38,860 --> 00:48:37,130
on here at JPL is the mission that I

1302
00:48:41,260 --> 00:48:38,870
referred to earlier called the Mars 2020

1303
00:48:42,970 --> 00:48:41,270
Rover it has some really sophisticated

1304
00:48:44,410 --> 00:48:42,980
instruments that it's bringing with it

1305
00:48:46,420 --> 00:48:44,420
to Mars to do these kinds of

1306
00:48:49,570 --> 00:48:46,430
investigations to look directly for

1307
00:48:51,700 --> 00:48:49,580
signs of life but it also is proposed to

1308
00:48:53,650 --> 00:48:51,710
bring samples back to earth one day it

1309
00:48:55,990 --> 00:48:53,660
requires a few follow-on missions to do

1310
00:48:58,210 --> 00:48:56,000
that something to land a rocket on Mars

1311
00:49:00,730 --> 00:48:58,220
and then to gather those Sam

1312
00:49:02,590 --> 00:49:00,740
from 2020 or we're 2020 has left them on

1313
00:49:04,570 --> 00:49:02,600

the surface to bring them back to that

1314
00:49:07,600 --> 00:49:04,580
rocket and then to blast off from Mars

1315
00:49:09,400 --> 00:49:07,610
and then to rendezvous with the the the

1316
00:49:11,830 --> 00:49:09,410
spacecraft that we've now put in Mars

1317
00:49:14,530 --> 00:49:11,840
orbit and bring it back to earth that's

1318
00:49:16,510 --> 00:49:14,540
a lot of really actually cool technology

1319
00:49:18,450 --> 00:49:16,520
that JPL has to invent in the next

1320
00:49:20,350 --> 00:49:18,460
couple decades to accomplish that and

1321
00:49:21,820 --> 00:49:20,360
this is actually something that kind of

1322
00:49:23,590 --> 00:49:21,830
leads on to that yeah we are planning to

1323
00:49:25,390 --> 00:49:23,600
return to Mars we have an active Mars

1324
00:49:26,470 --> 00:49:25,400
exploration program and you know one of

1325
00:49:28,240 --> 00:49:26,480
the things we're trying to do is figure

1326
00:49:30,220 --> 00:49:28,250
out where the best places to land next

1327
00:49:31,750 --> 00:49:30,230
would be so there's some questions here

1328
00:49:33,670 --> 00:49:31,760
about how are we determining the best

1329
00:49:36,250 --> 00:49:33,680
places to we don't where to explore next

1330
00:49:37,750 --> 00:49:36,260
on Mars one of the one of the big

1331
00:49:39,910 --> 00:49:37,760
questions is where else are we going to

1332
00:49:41,680 --> 00:49:39,920
find the organic carbon and there are

1333
00:49:43,540 --> 00:49:41,690
various environments that we understand

1334
00:49:45,700 --> 00:49:43,550
on earth as being good places that we

1335
00:49:47,950 --> 00:49:45,710
can collect organic materials that get

1336
00:49:50,290 --> 00:49:47,960
preserved and then there's also good

1337
00:49:52,090 --> 00:49:50,300
places for life so for instance a lake

1338
00:49:54,010 --> 00:49:52,100

bed like what we found in Gale Crater is

1339
00:49:56,770 --> 00:49:54,020
a perfect example but there are others

1340
00:49:58,630 --> 00:49:56,780
hydrothermal systems where hot fluids

1341
00:50:00,970 --> 00:49:58,640
and gases coming out of the ground can

1342
00:50:03,340 --> 00:50:00,980
create provide a lot of chemicals that

1343
00:50:05,380 --> 00:50:03,350
organisms can use we see these in the

1344
00:50:08,230 --> 00:50:05,390
ocean on earth as hydrothermal vents

1345
00:50:09,820 --> 00:50:08,240
there are records of of rocks on Mars

1346
00:50:11,950 --> 00:50:09,830
that suggest that our ancient

1347
00:50:13,900 --> 00:50:11,960
hydrothermal systems so that might be

1348
00:50:17,350 --> 00:50:13,910
another place for us to look so right

1349
00:50:19,540 --> 00:50:17,360
now the larger Mars Science community is

1350
00:50:21,160 --> 00:50:19,550
talking about where it is they want to

1351
00:50:23,880 --> 00:50:21,170
go and these are some of the key

1352
00:50:26,800 --> 00:50:23,890
scientific motivators for choosing sites

1353
00:50:29,020 --> 00:50:26,810
let me add to that a little bit we have

1354
00:50:30,880 --> 00:50:29,030
two things we have a huge amount of data

1355
00:50:33,100 --> 00:50:30,890
because we have very capable orbiters

1356
00:50:36,580 --> 00:50:33,110
orbiting Mars and on those orbiters we

1357
00:50:38,110 --> 00:50:36,590
have imagers that can see a few feet we

1358
00:50:40,060 --> 00:50:38,120
can see our Rovers on the surface of

1359
00:50:42,370 --> 00:50:40,070
Mars we can see the rover tracks so

1360
00:50:45,250 --> 00:50:42,380
that's one tool we use the other tool we

1361
00:50:46,630 --> 00:50:45,260
use from space is spectroscopy one thing

1362
00:50:48,220 --> 00:50:46,640
that brought us together ater was

1363
00:50:50,470 --> 00:50:48,230

finding minerals that were hydrated that

1364
00:50:52,150 --> 00:50:50,480
had water so that was a clue there might

1365
00:50:55,300 --> 00:50:52,160
have been a lake there but the other

1366
00:50:57,550 --> 00:50:55,310
really fun thing about Mars is on earth

1367
00:51:00,190 --> 00:50:57,560
it's very very hard to find old rocks

1368
00:51:02,620 --> 00:51:00,200
and the reason is Earth is is so active

1369
00:51:05,380 --> 00:51:02,630
still there's you see the Hawaii

1370
00:51:06,520 --> 00:51:05,390
Volcanoes going off and so the landscape

1371
00:51:08,950 --> 00:51:06,530
keeps changing

1372
00:51:11,620 --> 00:51:08,960
plate tectonics it called it moves it

1373
00:51:14,020 --> 00:51:11,630
continents around on Mars that stuff off

1374
00:51:16,240 --> 00:51:14,030
throws out billions of years ago so you

1375
00:51:18,670 --> 00:51:16,250
know half the surface practically is

1376
00:51:21,310 --> 00:51:18,680
very very very old so we can get at the

1377
00:51:22,720 --> 00:51:21,320
ancient history of Mars by landing on

1378
00:51:24,370 --> 00:51:22,730
the surface and looking what happened

1379
00:51:26,110 --> 00:51:24,380
early in the history of the solar system

1380
00:51:29,260 --> 00:51:26,120
that's right the modern landscape is

1381
00:52:14,650 --> 00:51:29,270
actually a very ancient yeah so we're

1382
00:52:15,940 --> 00:52:14,660
gonna go to another and Ashwin I hope

1383
00:52:17,800 --> 00:52:15,950
that came through well I believe that

1384
00:52:19,120 --> 00:52:17,810
the person's asking about how this how

1385
00:52:21,250 --> 00:52:19,130
these discoveries will fit in with the

1386
00:52:23,260 --> 00:52:21,260
legacy of the the Mars Curiosity rover

1387
00:52:26,820 --> 00:52:23,270
and your view of that some comments from

1388
00:52:29,740 --> 00:52:26,830

it yeah it's a it's a great question and

1389
00:52:31,450 --> 00:52:29,750
sometimes being involved it's so deeply

1390
00:52:33,970 --> 00:52:31,460
in the day-to-day sort of forget to look

1391
00:52:35,500 --> 00:52:33,980
at the bigger picture but you know as I

1392
00:52:38,830 --> 00:52:35,510
mentioned earlier the way I think about

1393
00:52:40,630 --> 00:52:38,840
it is really that we have a role in this

1394
00:52:42,670 --> 00:52:40,640
ongoing exploration of Mars that's now

1395
00:52:48,610 --> 00:52:42,680
been going on for more than 50 years and

1396
00:52:50,800 --> 00:52:48,620
will continue in the future it was life

1397
00:52:52,240 --> 00:52:50,810
ever originated on Mars and and then

1398
00:52:54,910 --> 00:52:52,250
eventually sending humans there and

1399
00:52:56,530 --> 00:52:54,920
maybe even colonizing Mars one day and

1400
00:52:58,510 --> 00:52:56,540
the role that curiosity was designed to

1401
00:52:59,770 --> 00:52:58,520
play was to figure out if Mars ever was

1402
00:53:01,600 --> 00:52:59,780
habitable we didn't know that before

1403
00:53:05,230 --> 00:53:01,610
curiosity went there we didn't know that

1404
00:53:08,140 --> 00:53:05,240
Lakes survived on Mars in this time

1405
00:53:12,580 --> 00:53:08,150
period from three to four billion years

1406
00:53:14,920 --> 00:53:12,590
ago at Doric iving on Mars for up to

1407
00:53:17,080 --> 00:53:14,930
millions of years and we didn't know the

1408
00:53:18,700 --> 00:53:17,090
extent that organic matter was present

1409
00:53:20,650 --> 00:53:18,710
on Mars could be concentrated in these

1410
00:53:22,720 --> 00:53:20,660
environments and would be preserved for

1411
00:53:24,250 --> 00:53:22,730
us to study today so those are some

1412
00:53:25,540 --> 00:53:24,260
really big questions that the mission

1413
00:53:27,280 --> 00:53:25,550

was specifically design

1414
00:53:29,650 --> 00:53:27,290
to address and you know with these

1415
00:53:31,660 --> 00:53:29,660
results you just couldn't be I couldn't

1416
00:53:34,060 --> 00:53:31,670
be happier in how we've been able to

1417
00:53:37,210 --> 00:53:34,070
meet those objectives and provide them

1418
00:53:39,610 --> 00:53:37,220
as material for future missions to use

1419
00:53:42,130 --> 00:53:39,620
when they're designing where to go and

1420
00:53:43,240 --> 00:53:42,140
how to accomplish their science I think

1421
00:53:44,200 --> 00:53:43,250
we just have a little bit of time left

1422
00:53:45,880 --> 00:53:44,210
but I think there's one more question

1423
00:53:54,580 --> 00:53:45,890
from the media or in Drye sneaked in so

1424
00:53:56,020 --> 00:53:54,590
please go ahead hi yeah thanks very

1425
00:53:59,070 --> 00:53:56,030
taking my question I just wanted to ask

1426
00:54:02,500 --> 00:53:59,080
the question about those clathrates the

1427
00:54:04,120 --> 00:54:02,510
methane is coming from do you think that

1428
00:54:05,530 --> 00:54:04,130
it's the rising summer temperatures that

1429
00:54:10,540 --> 00:54:05,540
are warming those up and that's how

1430
00:54:11,830 --> 00:54:10,550
they're releasing it sources for that

1431
00:54:15,370 --> 00:54:11,840
the rising methane levels in the summer

1432
00:54:18,040 --> 00:54:15,380
yes you asked about clathrate so there

1433
00:54:19,240 --> 00:54:18,050
is a clathrates are stable on mars

1434
00:54:21,970 --> 00:54:19,250
they're created through the

1435
00:54:24,730 --> 00:54:21,980
high-pressure course initially they

1436
00:54:26,560 --> 00:54:24,740
could be a source but we don't believe

1437
00:54:31,060 --> 00:54:26,570
remember once you get under the surface

1438
00:54:33,580 --> 00:54:31,070

by several metres and below that you

1439
00:54:36,340 --> 00:54:33,590
don't really have a seasonal cycle there

1440
00:54:38,610 --> 00:54:36,350
it's pretty constant temperature so the

1441
00:54:40,840 --> 00:54:38,620
clathrates or other reservoirs might be

1442
00:54:43,150 --> 00:54:40,850
leaking or seeping the methane

1443
00:54:45,580 --> 00:54:43,160
continuously throughout the year it's

1444
00:54:47,230 --> 00:54:45,590
only when it gets to the surface where

1445
00:54:49,570 --> 00:54:47,240
the surface temperature has that

1446
00:54:51,460 --> 00:54:49,580
seasonal cycle that that modulates the

1447
00:54:53,890 --> 00:54:51,470
release of that methane into the

1448
00:54:56,710 --> 00:54:53,900
atmosphere I think that was your

1449
00:54:58,240 --> 00:54:56,720
question well that's actually all the

1450
00:54:59,680 --> 00:54:58,250
time we have if you submitted questions

1451
00:55:01,390 --> 00:54:59,690
by a social media that we didn't get to

1452
00:55:02,710 --> 00:55:01,400
we're gonna spend the next hours and

1453
00:55:04,630 --> 00:55:02,720
days trying to get to as may them as we

1454
00:55:06,160 --> 00:55:04,640
can and answering them online but for

1455
00:55:08,410 --> 00:55:06,170
now thank you so much for joining us we

1456
00:55:16,270 --> 00:55:08,420
were live at NASA and have a great rest

1457
00:55:19,120 --> 00:55:16,280
of the day bye we want to know has life

1458
00:55:21,220 --> 00:55:19,130
ever existed on Mars do pockets of life

1459
00:55:22,690 --> 00:55:21,230
persist on Mars today

1460
00:55:24,370 --> 00:55:22,700
NASA's approach to answering these

1461
00:55:27,610 --> 00:55:24,380
questions is to break them down into

1462
00:55:29,530 --> 00:55:27,620
smaller and smaller steps first we need

1463
00:55:31,870 --> 00:55:29,540

to know if ancient Mars was habitable

1464
00:55:34,420 --> 00:55:31,880
that it once have the right climate and

1465
00:55:36,250 --> 00:55:34,430
the right chemistry to support life the

1466
00:55:37,840 --> 00:55:36,260
Curiosity rover is investigating these

1467
00:55:40,930 --> 00:55:37,850
questions by looking for organic

1468
00:55:43,060 --> 00:55:40,940
molecules containing carbon organic

1469
00:55:45,070 --> 00:55:43,070
molecules are the backbone of all life

1470
00:55:47,800 --> 00:55:45,080
on Earth though they can also come from

1471
00:55:49,900 --> 00:55:47,810
nonliving sources today the surface of

1472
00:55:54,610 --> 00:55:49,910
Mars readily destroys organics making

1473
00:55:56,860 --> 00:55:54,620
them difficult to chat six years ago

1474
00:55:59,710 --> 00:55:56,870
curiosity landed in Gale Crater on

1475
00:56:02,050 --> 00:55:59,720
ancient lake bed a few months after

1476
00:56:04,150 --> 00:56:02,060
arrival it drilled into sedimentary

1477
00:56:06,250 --> 00:56:04,160
rocks and detected traces of organic

1478
00:56:09,670 --> 00:56:06,260
molecules using an instrument called the

1479
00:56:12,460 --> 00:56:09,680
Sam now curiosity is climbing the mound

1480
00:56:14,530 --> 00:56:12,470
in the middle of Gale Crater and Sam has

1481
00:56:16,480 --> 00:56:14,540
made a subsequent detection of organics

1482
00:56:18,040 --> 00:56:16,490
this new detection is exciting

1483
00:56:20,530 --> 00:56:18,050
because it comes from rocks that are

1484
00:56:22,360 --> 00:56:20,540
billions of years old that means that

1485
00:56:24,850 --> 00:56:22,370
the organic material within them is

1486
00:56:27,220 --> 00:56:24,860
extremely ancient some of the organics

1487
00:56:29,650 --> 00:56:27,230
that Sam has detected contains sulfur

1488
00:56:32,050 --> 00:56:29,660

likely introduced through geological

1489
00:56:34,330 --> 00:56:32,060
processes sulfur can act as a

1490
00:56:35,890 --> 00:56:34,340
preservative binding organic molecules

1491
00:56:38,590 --> 00:56:35,900
together to make them tougher and

1492
00:56:40,720 --> 00:56:38,600
protecting them from oxidation in fact

1493
00:56:42,550 --> 00:56:40,730
sulfur is the element that makes hair

1494
00:56:45,310 --> 00:56:42,560
and fingernails tough as well as

1495
00:56:47,530 --> 00:56:45,320
vulcanized rubber Martian sulfur has

1496
00:56:49,630 --> 00:56:47,540
probably had a similar effect on these

1497
00:56:53,670 --> 00:56:49,640
old organic molecules helping to

1498
00:56:56,350 --> 00:56:53,680
preserve them over geological timescales

1499
00:56:58,270 --> 00:56:56,360
Sam made the new detections by heating

1500
00:57:00,340 --> 00:56:58,280
samples of crushed rock to very high

1501
00:57:02,710 --> 00:57:00,350
temperatures above a thousand degrees

1502
00:57:04,210 --> 00:57:02,720
Fahrenheit this vaporizes samples and

1503
00:57:06,420 --> 00:57:04,220
released several species of small

1504
00:57:08,950 --> 00:57:06,430
hydrocarbons like benzene and propane

1505
00:57:11,170 --> 00:57:08,960
because the hydrocarbons were released

1506
00:57:12,820 --> 00:57:11,180
as such high temperatures they may be

1507
00:57:15,040 --> 00:57:12,830
the fragments of bigger heavier

1508
00:57:18,190 --> 00:57:15,050
molecules within the rock similar to

1509
00:57:20,950 --> 00:57:18,200
keratins on earth carriages are found in

1510
00:57:22,780 --> 00:57:20,960
rocks like black shale and cold and are

1511
00:57:27,550 --> 00:57:22,790
the products of ancient plant and

1512
00:57:29,410 --> 00:57:27,560
bacteria we don't know if the recently

1513
00:57:31,630 --> 00:57:29,420

discovered organics on Mars are a

1514
00:57:32,300 --> 00:57:31,640
biological origin but it's exciting to

1515
00:57:33,800 --> 00:57:32,310
find such

1516
00:57:36,320 --> 00:57:33,810
old material preserved right at the

1517
00:57:38,780 --> 00:57:36,330
surface this finding is also encouraging

1518
00:57:40,910 --> 00:57:38,790
for future exploration NASA and the

1519
00:57:43,070 --> 00:57:40,920
European Space Agency are preparing to

1520
00:57:44,510 --> 00:57:43,080
send the next generation of Rovers to

1521
00:57:46,730 --> 00:57:44,520
Mars in 2020

1522
00:57:49,490 --> 00:57:46,740
Guerry new technologies the search for

1523
00:57:52,340 --> 00:57:49,500
signs of microbial life in the distant

1524
00:57:55,190 --> 00:57:52,350
past Mars was much warmer and wetter

1525
00:57:57,140 --> 00:57:55,200
than it is today the rocks at Gale

1526
00:57:59,270 --> 00:57:57,150
Crater tell us it was once an

1527
00:58:02,060 --> 00:57:59,280
environment where life as we know it

1528
00:58:04,400 --> 00:58:02,070
could have survived the discovery of

1529
00:58:06,560 --> 00:58:04,410
ancient organic molecules shows that

1530
00:58:08,600 --> 00:58:06,570
another ingredient of life was present

1531
00:58:10,850 --> 00:58:08,610
at that time and it broadens our