
Astronomie
Gerthsen
Physik

1
00:00:13,350 --> 00:00:11,030
[Music]

2
00:00:14,629 --> 00:00:13,360
hello everyone my name is announcer i'm

3
00:00:16,630 --> 00:00:14,639
a master student of physics at the

4
00:00:18,070 --> 00:00:16,640
university of heidelberg and i'm also an

5
00:00:19,750 --> 00:00:18,080
intern with the european space agency

6
00:00:20,950 --> 00:00:19,760
this summer through the leaps program

7
00:00:22,710 --> 00:00:20,960
which is a cooperation between the

8
00:00:24,950 --> 00:00:22,720
university of leiden and the european

9
00:00:26,790 --> 00:00:24,960
space agency i'm going to talk about my

10
00:00:28,310 --> 00:00:26,800
research project we start out with an

11
00:00:30,710 --> 00:00:28,320
internship that is also going to be the

12
00:00:32,709 --> 00:00:30,720
project of my master's thesis so my

13
00:00:34,870 --> 00:00:32,719

project concerns looking at martian

14
00:00:36,790 --> 00:00:34,880
analog environments so environments on

15
00:00:39,110 --> 00:00:36,800
earth that resemble and like things that

16
00:00:40,310 --> 00:00:39,120
we find on mars and to extract samples

17
00:00:42,709 --> 00:00:40,320
there analyze them throughout the

18
00:00:44,790 --> 00:00:42,719
spectroscopy and close imaging and then

19
00:00:48,069 --> 00:00:44,800
have a reference space for the exomars

20
00:00:51,510 --> 00:00:48,079
2022 mission that will land a rover on

21
00:00:53,189 --> 00:00:51,520
mars in 2023 and so it can have like a

22
00:00:56,549 --> 00:00:53,199
reference what to look for when looks

23
00:01:00,389 --> 00:00:58,229
here you can see a world map of the

24
00:01:01,910 --> 00:01:00,399
distribution of samples and but i want

25
00:01:03,830 --> 00:01:01,920
to talk in particular today about one

26
00:01:05,830 --> 00:01:03,840
specific area that is like mount edna

27
00:01:07,590 --> 00:01:05,840
and sicily i went there recently for a

28
00:01:08,870 --> 00:01:07,600
field trip and i want to talk about

29
00:01:10,390 --> 00:01:08,880
specifically about this martian

30
00:01:11,910 --> 00:01:10,400
environment and what you might learn

31
00:01:13,190 --> 00:01:11,920
about this and what might be interesting

32
00:01:15,270 --> 00:01:13,200
to learn from there about the

33
00:01:17,749 --> 00:01:15,280
astrobiology of mars

34
00:01:19,590 --> 00:01:17,759
so the exomars 2022 mission that's like

35
00:01:21,830 --> 00:01:19,600
the one where i'm gathering the samples

36
00:01:24,469 --> 00:01:21,840
for um it's like a mission that already

37
00:01:27,749 --> 00:01:24,479
sent an orbiter to mars was launched in

38
00:01:28,710 --> 00:01:27,759

2016 and in 2022 it will launch also a

39
00:01:30,870 --> 00:01:28,720
rover

40
00:01:33,109 --> 00:01:30,880
and a lander and on the side you can see

41
00:01:34,870 --> 00:01:33,119
the rover and of particular interest to

42
00:01:36,469 --> 00:01:34,880
me is like this little gray box that you

43
00:01:39,510 --> 00:01:36,479
see there because this contains a drill

44
00:01:40,789 --> 00:01:39,520
system and the exomas rover will be this

45
00:01:43,190 --> 00:01:40,799
will basically be called an

46
00:01:44,630 --> 00:01:43,200
astrobiological laboratory in wheels and

47
00:01:47,030 --> 00:01:44,640
will be the first row we're able to

48
00:01:48,870 --> 00:01:47,040
drill into the subsurface up to death of

49
00:01:51,190 --> 00:01:48,880
two meters and would then analyze the

50
00:01:53,109 --> 00:01:51,200
samples from there the landing area is

51
00:01:55,030 --> 00:01:53,119
oxyplanar it's of particular interest

52
00:01:57,510 --> 00:01:55,040
because it looks like a hydrated clay

53
00:02:01,190 --> 00:01:57,520
rich batter so it might be a good chance

54
00:02:03,270 --> 00:02:01,200
to find like organic or organic signs or

55
00:02:05,270 --> 00:02:03,280
signs of formal life on mars

56
00:02:06,789 --> 00:02:05,280
um you're probably familiar with the

57
00:02:08,710 --> 00:02:06,799
early geological history of earth and

58
00:02:10,309 --> 00:02:08,720
mars and that actually earth and mars

59
00:02:11,430 --> 00:02:10,319
very early in the development were quite

60
00:02:13,350 --> 00:02:11,440
similar

61
00:02:15,830 --> 00:02:13,360
so for example if you look um if you go

62
00:02:18,470 --> 00:02:15,840
back for four billion years that is

63
00:02:21,110 --> 00:02:18,480

actually the time when oxyplanum was

64
00:02:24,070 --> 00:02:21,120
formed and actually the time also where

65
00:02:26,150 --> 00:02:24,080
it might be most likely to find signs of

66
00:02:27,270 --> 00:02:26,160
formal life on mouth why because there

67
00:02:28,949 --> 00:02:27,280
might have been the possibility that

68
00:02:31,509 --> 00:02:28,959
during this time there was actually

69
00:02:32,869 --> 00:02:31,519
liquid water on the surface so indeed

70
00:02:34,070 --> 00:02:32,879
you see a substance you see an artist's

71
00:02:36,150 --> 00:02:34,080
impression what this might have looked

72
00:02:38,150 --> 00:02:36,160
like so you see the northern hemisphere

73
00:02:40,470 --> 00:02:38,160
is basically covered by an ocean

74
00:02:41,990 --> 00:02:40,480
um however there is like dispute over

75
00:02:43,110 --> 00:02:42,000
this if there was ever the conditions of

76
00:02:44,470 --> 00:02:43,120
the atmosphere

77
00:02:46,150 --> 00:02:44,480
were well enough if there was ever

78
00:02:48,390 --> 00:02:46,160
enough pressure to actually sustain

79
00:02:50,949 --> 00:02:48,400
liquid water so take this with like a

80
00:02:52,229 --> 00:02:50,959
grain of caution um the interesting

81
00:02:54,309 --> 00:02:52,239
thing is about the formation of these

82
00:02:56,550 --> 00:02:54,319
salts is so there's an idea of how the

83
00:02:58,550 --> 00:02:56,560
environment could look like um you have

84
00:03:00,630 --> 00:02:58,560
geothermal vents and so that you

85
00:03:02,550 --> 00:03:00,640
actually have like volcanic activity and

86
00:03:04,390 --> 00:03:02,560
volcanic activity was very widespread on

87
00:03:05,910 --> 00:03:04,400
both early earth and mars it might have

88
00:03:08,470 --> 00:03:05,920

provided very important and very

89
00:03:10,309 --> 00:03:08,480
distinct environments where life might

90
00:03:11,430 --> 00:03:10,319
have lived so therefore it's like

91
00:03:13,430 --> 00:03:11,440
interesting for us to understand

92
00:03:16,710 --> 00:03:13,440
volcanic environment nowadays on earth

93
00:03:22,630 --> 00:03:20,309
this is um the exomas um resin franklin

94
00:03:24,550 --> 00:03:22,640
rover and as you can see there is like

95
00:03:26,470 --> 00:03:24,560
you can now look inside um this little

96
00:03:28,149 --> 00:03:26,480
gray box inside a little gray box there

97
00:03:29,589 --> 00:03:28,159
are two instruments like there many

98
00:03:31,430 --> 00:03:29,599
instruments but the two instruments of

99
00:03:33,190 --> 00:03:31,440
particular interest to me are the

100
00:03:34,789 --> 00:03:33,200
close-up imager and the raman laser

101
00:03:36,390 --> 00:03:34,799
spectrometer because i have analog

102
00:03:38,229 --> 00:03:36,400
instruments that can actually match the

103
00:03:41,110 --> 00:03:38,239
capabilities of these instruments this

104
00:03:42,789 --> 00:03:41,120
allows me to go to marginal environments

105
00:03:45,750 --> 00:03:42,799
take samples there and then have a base

106
00:03:48,470 --> 00:03:45,760
of comparison with when exomars goes on

107
00:03:49,830 --> 00:03:48,480
mars so the close-up imager is basically

108
00:03:51,990 --> 00:03:49,840
a camera system that can take up

109
00:03:53,910 --> 00:03:52,000
close-up images as the name says

110
00:03:55,670 --> 00:03:53,920
of old crops on mars

111
00:03:57,830 --> 00:03:55,680
and the process actually is like you

112
00:04:00,149 --> 00:03:57,840
have the mask this like mask and the pan

113
00:04:01,670 --> 00:04:00,159

cam it looks for an interesting outcrop

114
00:04:03,429 --> 00:04:01,680
then the rover moves there takes a

115
00:04:05,509 --> 00:04:03,439
picture with a close-up imager from

116
00:04:06,949 --> 00:04:05,519
different um from different distances

117
00:04:08,630 --> 00:04:06,959
you can also have that stacking so you

118
00:04:10,229 --> 00:04:08,640
can basically have like kind of like um

119
00:04:11,190 --> 00:04:10,239
you have you can focus in different

120
00:04:13,190 --> 00:04:11,200
layers

121
00:04:15,030 --> 00:04:13,200
um and then the drills and then they can

122
00:04:16,629 --> 00:04:15,040
decide where they want to drill where it

123
00:04:18,390 --> 00:04:16,639
looks like morphologically interesting

124
00:04:20,310 --> 00:04:18,400
for them to drill you can also see the

125
00:04:22,150 --> 00:04:20,320
drill can be tilted so it cannot only

126
00:04:24,310 --> 00:04:22,160
drill into the subsurface they can also

127
00:04:26,390 --> 00:04:24,320
drill to an outcrop and then once they

128
00:04:28,629 --> 00:04:26,400
have a drill core they can actually use

129
00:04:31,350 --> 00:04:28,639
the rls the raman spectrometer to make a

130
00:04:33,030 --> 00:04:31,360
ramen like ramen analysis of it good

131
00:04:34,390 --> 00:04:33,040
thing about raman is it can also like

132
00:04:36,550 --> 00:04:34,400
even if you have small traces of a

133
00:04:38,150 --> 00:04:36,560
diagonic material ramen can tell you

134
00:04:40,070 --> 00:04:38,160
then it is there

135
00:04:42,469 --> 00:04:40,080
um however

136
00:04:44,469 --> 00:04:42,479
even if we have like interesting results

137
00:04:45,909 --> 00:04:44,479
from exomars we also need a certain

138
00:04:48,150 --> 00:04:45,919

context in which to interpret this so

139
00:04:50,150 --> 00:04:48,160
this is like very important for us to go

140
00:04:51,990 --> 00:04:50,160
to martian analog environments to look

141
00:04:54,469 --> 00:04:52,000
for environments of nitrogen conditions

142
00:04:57,030 --> 00:04:54,479
on mars or on on form

143
00:04:58,469 --> 00:04:57,040
past mars and for this i want to talk

144
00:04:59,909 --> 00:04:58,479
about a particular mass analog

145
00:05:02,070 --> 00:04:59,919
environment where i collect my samples

146
00:05:04,950 --> 00:05:02,080
from that is mount aetna

147
00:05:06,790 --> 00:05:04,960
so i went to mont etna in july as part

148
00:05:08,870 --> 00:05:06,800
of the euromoon mass network aetna

149
00:05:10,550 --> 00:05:08,880
campaign we were a team of several

150
00:05:11,909 --> 00:05:10,560
scientists several engineers who were

151
00:05:14,629 --> 00:05:11,919
all students it was like a student

152
00:05:16,870 --> 00:05:14,639
campaign so the engineers were very very

153
00:05:19,029 --> 00:05:16,880
excited about the terrain because as you

154
00:05:20,710 --> 00:05:19,039
can see it like very much very much

155
00:05:22,629 --> 00:05:20,720
resembles those outcrops and like the

156
00:05:25,110 --> 00:05:22,639
gravel that you find on mars so the

157
00:05:27,110 --> 00:05:25,120
outcrops are actually lava flows and the

158
00:05:28,390 --> 00:05:27,120
gravel is basically ash that falls when

159
00:05:30,629 --> 00:05:28,400
you have an eruption and you can also

160
00:05:32,550 --> 00:05:30,639
see from the from the little picture of

161
00:05:34,310 --> 00:05:32,560
an eruption we actually witnessed an

162
00:05:36,469 --> 00:05:34,320
eruption that was very close by only we

163
00:05:37,990 --> 00:05:36,479

were only five kilometers away because

164
00:05:39,990 --> 00:05:38,000
mount etna is also one of the most

165
00:05:41,670 --> 00:05:40,000
active volcanoes in the world it's very

166
00:05:43,749 --> 00:05:41,680
well monitored so there's little danger

167
00:05:45,670 --> 00:05:43,759
but it was still very impressive to see

168
00:05:47,430 --> 00:05:45,680
uh i would only want to want to talk

169
00:05:49,749 --> 00:05:47,440
about the lava flows i also want to talk

170
00:05:52,150 --> 00:05:49,759
about another interesting volcanic

171
00:05:54,790 --> 00:05:52,160
environment and those are the saline so

172
00:05:55,909 --> 00:05:54,800
the saline are an area of hydrothermal

173
00:05:58,309 --> 00:05:55,919
activity

174
00:05:59,430 --> 00:05:58,319
um that is little to the to the south

175
00:06:01,430 --> 00:05:59,440
east

176
00:06:02,550 --> 00:06:01,440
southwest of aetna in a town called

177
00:06:04,150 --> 00:06:02,560
patano

178
00:06:05,189 --> 00:06:04,160
um and they're very interesting because

179
00:06:07,029 --> 00:06:05,199
they

180
00:06:08,870 --> 00:06:07,039
resemble an environment on mars that are

181
00:06:10,469 --> 00:06:08,880
also called mud volcanoes but i will

182
00:06:12,150 --> 00:06:10,479
talk about this later

183
00:06:14,390 --> 00:06:12,160
so first of all what makes a volcanic

184
00:06:16,230 --> 00:06:14,400
environment interesting for astrologers

185
00:06:18,230 --> 00:06:16,240
of course you want to know how life can

186
00:06:19,990 --> 00:06:18,240
adapt and survive in these environments

187
00:06:21,909 --> 00:06:20,000
as you can see there are very few plants

188
00:06:23,590 --> 00:06:21,919

in this area because actually it is very

189
00:06:25,430 --> 00:06:23,600
difficult for plants to grow there

190
00:06:27,590 --> 00:06:25,440
because there is no there are no organic

191
00:06:29,270 --> 00:06:27,600
materials in the soil so most plants you

192
00:06:31,110 --> 00:06:29,280
have some pioneer plants that can like

193
00:06:32,790 --> 00:06:31,120
that can survive in these conditions but

194
00:06:34,710 --> 00:06:32,800
usually for most other plants the soil

195
00:06:37,510 --> 00:06:34,720
has the volcanic rock has to be broken

196
00:06:39,430 --> 00:06:37,520
down first into endosol

197
00:06:42,230 --> 00:06:39,440
and here you can see um the ones that

198
00:06:43,830 --> 00:06:42,240
produce endosol this is a lichen lichen

199
00:06:46,550 --> 00:06:43,840
colonized lava rocks they're one of the

200
00:06:48,710 --> 00:06:46,560
first that can actually colonize them

201
00:06:50,150 --> 00:06:48,720
and as you know like light can grow very

202
00:06:52,309 --> 00:06:50,160
very slowly so you need a lot of

203
00:06:54,070 --> 00:06:52,319
patience but this is like an old lava

204
00:06:56,309 --> 00:06:54,080
flow from the 18th century and you can

205
00:06:57,909 --> 00:06:56,319
always see like almost the entire rock

206
00:06:59,589 --> 00:06:57,919
is covered with different types of

207
00:07:01,510 --> 00:06:59,599
lichen there are also some liken

208
00:07:04,710 --> 00:07:01,520
specialists that specialized on this

209
00:07:07,350 --> 00:07:04,720
basaltic on this basaltic lava

210
00:07:09,270 --> 00:07:07,360
and they actually change the surface of

211
00:07:11,589 --> 00:07:09,280
the rock so they enrich it with for

212
00:07:13,350 --> 00:07:11,599
example aluminium and iron and they can

213
00:07:15,110 --> 00:07:13,360

actually chemically out of the at the

214
00:07:18,150 --> 00:07:15,120
surface and also enrich it um with

215
00:07:20,550 --> 00:07:18,160
organics so if like over the centuries

216
00:07:22,710 --> 00:07:20,560
this soil breaks down we produce endosol

217
00:07:24,550 --> 00:07:22,720
and endosol is like a very rich very

218
00:07:26,309 --> 00:07:24,560
good fertilizer and that's also the

219
00:07:28,629 --> 00:07:26,319
reason why you have like on slopes of

220
00:07:31,110 --> 00:07:28,639
volcanoes so much agriculture because

221
00:07:33,029 --> 00:07:31,120
this is like a very rich soil but only

222
00:07:34,629 --> 00:07:33,039
after it's been broken down from the

223
00:07:36,390 --> 00:07:34,639
master biological perspective this is

224
00:07:38,629 --> 00:07:36,400
interesting because um it gives you a

225
00:07:41,110 --> 00:07:38,639
chemical signature that this rock was

226
00:07:42,230 --> 00:07:41,120
altered by life so if you analyze this

227
00:07:44,869 --> 00:07:42,240
rock this might actually give us

228
00:07:46,710 --> 00:07:44,879
interesting clues if we later find like

229
00:07:48,790 --> 00:07:46,720
fossilized versions of this so we might

230
00:07:51,350 --> 00:07:48,800
not find the life form that did this but

231
00:07:53,909 --> 00:07:51,360
we still might find a clue about erosion

232
00:07:55,909 --> 00:07:53,919
that happened due to the weathering of

233
00:07:57,270 --> 00:07:55,919
rocks by life

234
00:07:59,189 --> 00:07:57,280
so the other interesting area that i

235
00:08:03,430 --> 00:07:59,199
want to talk about are the salinella so

236
00:08:04,790 --> 00:08:03,440
like these um very salty um like mud uh

237
00:08:09,029 --> 00:08:04,800
mud volcanoes

238
00:08:10,550 --> 00:08:09,039

be on mars particularly in the northern

239
00:08:12,710 --> 00:08:10,560
hemisphere where there might have been

240
00:08:14,629 --> 00:08:12,720
once this large ocean so on the left

241
00:08:16,070 --> 00:08:14,639
side you see an image of orbit from

242
00:08:17,830 --> 00:08:16,080
orbit you can see

243
00:08:20,070 --> 00:08:17,840
from the scale it's actually like much

244
00:08:21,510 --> 00:08:20,080
smaller it looks like your usual volcano

245
00:08:23,270 --> 00:08:21,520
but like it's much much smaller so it

246
00:08:25,510 --> 00:08:23,280
only has a diameter of a kilometer a

247
00:08:27,350 --> 00:08:25,520
kilometer or so hundreds of meters

248
00:08:28,869 --> 00:08:27,360
and on the on the right side you can see

249
00:08:30,469 --> 00:08:28,879
the same phenomenon on earth there are

250
00:08:33,110 --> 00:08:30,479
some mud volcanoes from azerbaijan

251
00:08:34,469 --> 00:08:33,120
azerbaijan has the highest amount of

252
00:08:35,509 --> 00:08:34,479
material kings in the world like half of

253
00:08:36,709 --> 00:08:35,519
all much volcanoes in the world are

254
00:08:38,469 --> 00:08:36,719
nazan

255
00:08:40,070 --> 00:08:38,479
and you can also see some in canada so

256
00:08:41,990 --> 00:08:40,080
you see there's a lot of similarity

257
00:08:43,509 --> 00:08:42,000
between these structures so like you can

258
00:08:45,430 --> 00:08:43,519
understand why people assume that these

259
00:08:47,670 --> 00:08:45,440
might be mud volcanoes

260
00:08:50,310 --> 00:08:47,680
there's another clue that there's those

261
00:08:52,310 --> 00:08:50,320
might be mod related because we find um

262
00:08:53,430 --> 00:08:52,320
these type of mud cracks

263
00:08:55,030 --> 00:08:53,440

and they're also very similar to the

264
00:08:56,710 --> 00:08:55,040
ones that i observed in the mud volcano

265
00:08:59,430 --> 00:08:56,720
area in aetna so you can see like

266
00:09:01,350 --> 00:08:59,440
there's my pen for scale and this large

267
00:09:03,269 --> 00:09:01,360
slab of rock was 1.2 meters across so

268
00:09:05,430 --> 00:09:03,279
it's kind of like a quite very similar

269
00:09:07,190 --> 00:09:05,440
very similar scale

270
00:09:10,470 --> 00:09:07,200
how do much volcanoes form so they are

271
00:09:13,509 --> 00:09:10,480
not formed by lava but instead you need

272
00:09:14,949 --> 00:09:13,519
underground liquid water and gases and

273
00:09:17,430 --> 00:09:14,959
the pressure of these gases actually

274
00:09:19,990 --> 00:09:17,440
kind of like leads to small eruption and

275
00:09:22,470 --> 00:09:20,000
the gases are usually methane and co2

276
00:09:24,630 --> 00:09:22,480
but usually they are related to volcanic

277
00:09:26,790 --> 00:09:24,640
activity like in the like in the case of

278
00:09:28,070 --> 00:09:26,800
not volcanoes in edna

279
00:09:30,389 --> 00:09:28,080
the interesting thing about this for

280
00:09:32,150 --> 00:09:30,399
astrobiologists is of course that um if

281
00:09:34,070 --> 00:09:32,160
you have a subterranean biosphere where

282
00:09:35,670 --> 00:09:34,080
you have liquid water but it's harder

283
00:09:37,350 --> 00:09:35,680
for you to access this from the surface

284
00:09:39,350 --> 00:09:37,360
a much volcano may give you a direct

285
00:09:41,590 --> 00:09:39,360
access to this to this subterranean

286
00:09:43,990 --> 00:09:41,600
subsurface if you look at these bubbling

287
00:09:45,910 --> 00:09:44,000
pools at the saline in paterno you see a

288
00:09:47,910 --> 00:09:45,920

large variety of different types so you

289
00:09:49,350 --> 00:09:47,920
see some that are very very clear water

290
00:09:51,509 --> 00:09:49,360
others are like mixed with clays and

291
00:09:54,070 --> 00:09:51,519
they're very muddy you also see a large

292
00:09:56,150 --> 00:09:54,080
kind of like differences in shape um in

293
00:09:58,389 --> 00:09:56,160
size some around 10 centimeters larger

294
00:09:59,750 --> 00:09:58,399
ones are over one meter and you can also

295
00:10:02,230 --> 00:09:59,760
see what they look like when they dried

296
00:10:03,670 --> 00:10:02,240
out which is of course very interesting

297
00:10:05,509 --> 00:10:03,680
for people who want to study much

298
00:10:07,750 --> 00:10:05,519
volcanoes because the one that you will

299
00:10:09,030 --> 00:10:07,760
most likely find are the ones that are

300
00:10:10,870 --> 00:10:09,040
dried out

301
00:10:13,509 --> 00:10:10,880
they're called saline so they are quite

302
00:10:15,269 --> 00:10:13,519
salty it's um mostly sodium chloride you

303
00:10:16,630 --> 00:10:15,279
can also see like some of these crystals

304
00:10:18,069 --> 00:10:16,640
on the surface

305
00:10:20,470 --> 00:10:18,079
and they build a very like very nice

306
00:10:21,509 --> 00:10:20,480
layer so actually having these could um

307
00:10:22,949 --> 00:10:21,519
like having these interesting

308
00:10:25,110 --> 00:10:22,959
morphological structures could also be

309
00:10:27,269 --> 00:10:25,120
like a good sign of multiple connect

310
00:10:29,590 --> 00:10:27,279
mechanism having taken place

311
00:10:31,910 --> 00:10:29,600
and in this area um there are also

312
00:10:34,150 --> 00:10:31,920
extremophiles so there are some bacteria

313
00:10:36,069 --> 00:10:34,160

that are particularly adapted to these

314
00:10:37,509 --> 00:10:36,079
conditions they're usually alkalophiles

315
00:10:39,430 --> 00:10:37,519
you don't find thermophiles because

316
00:10:41,430 --> 00:10:39,440
actually not volcanoes are not hot they

317
00:10:43,829 --> 00:10:41,440
are like usually between 10 to 20

318
00:10:45,750 --> 00:10:43,839
degrees and only sometimes saline can be

319
00:10:47,590 --> 00:10:45,760
hotter up to 50 degrees when aetna is

320
00:10:49,430 --> 00:10:47,600
particularly active

321
00:10:51,110 --> 00:10:49,440
so to summarize if you want to

322
00:10:53,190 --> 00:10:51,120
understand the results that we get from

323
00:10:55,030 --> 00:10:53,200
rover instruments we have to understand

324
00:10:56,949 --> 00:10:55,040
and we need a basis of reference for

325
00:10:58,230 --> 00:10:56,959
similar environments on earth

326
00:11:01,110 --> 00:10:58,240
volcanic environments were both

327
00:11:03,350 --> 00:11:01,120
widespread in early earlier earthen mars

328
00:11:06,069 --> 00:11:03,360
understanding the chemical alteration of

329
00:11:08,069 --> 00:11:06,079
rock by life might be an interesting

330
00:11:09,590 --> 00:11:08,079
biosignature that could be further

331
00:11:10,949 --> 00:11:09,600
investigated to find if this could be

332
00:11:12,790 --> 00:11:10,959
useful

333
00:11:14,630 --> 00:11:12,800
lava rock basaltic rock is also a very

334
00:11:16,470 --> 00:11:14,640
good protection from cosmic rays which

335
00:11:18,550 --> 00:11:16,480
also makes for example lava tubes or

336
00:11:20,310 --> 00:11:18,560
lava caves interesting as a shelter or

337
00:11:23,430 --> 00:11:20,320
as a microhabitat

338
00:11:24,949 --> 00:11:23,440

and mud volcanoes are widespread on mars

339
00:11:26,949 --> 00:11:24,959
although we have to be careful because

340
00:11:28,630 --> 00:11:26,959
the actual physics of mud

341
00:11:29,829 --> 00:11:28,640
on mars might be different from earth so

342
00:11:31,590 --> 00:11:29,839
like the structure that looks

343
00:11:34,069 --> 00:11:31,600
morphologically similar may be actually

344
00:11:35,670 --> 00:11:34,079
caused by different processes and things

345
00:11:37,910 --> 00:11:35,680
that look actually look different might

346
00:11:39,509 --> 00:11:37,920
be have caused by similar processes

347
00:11:41,829 --> 00:11:39,519
and of course mud volcanism is also

348
00:11:43,590 --> 00:11:41,839
interesting for astrology because

349
00:11:45,509 --> 00:11:43,600
provides a very particular type of

350
00:11:46,949 --> 00:11:45,519
habitat where you have an availability

351
00:11:48,470 --> 00:11:46,959
of liquid water

352
00:11:51,910 --> 00:11:48,480
and where you actually could get an

353
00:11:55,110 --> 00:11:53,190
thank you very much for listening to my

354
00:11:56,240 --> 00:11:55,120
talk and i'm available for questions in