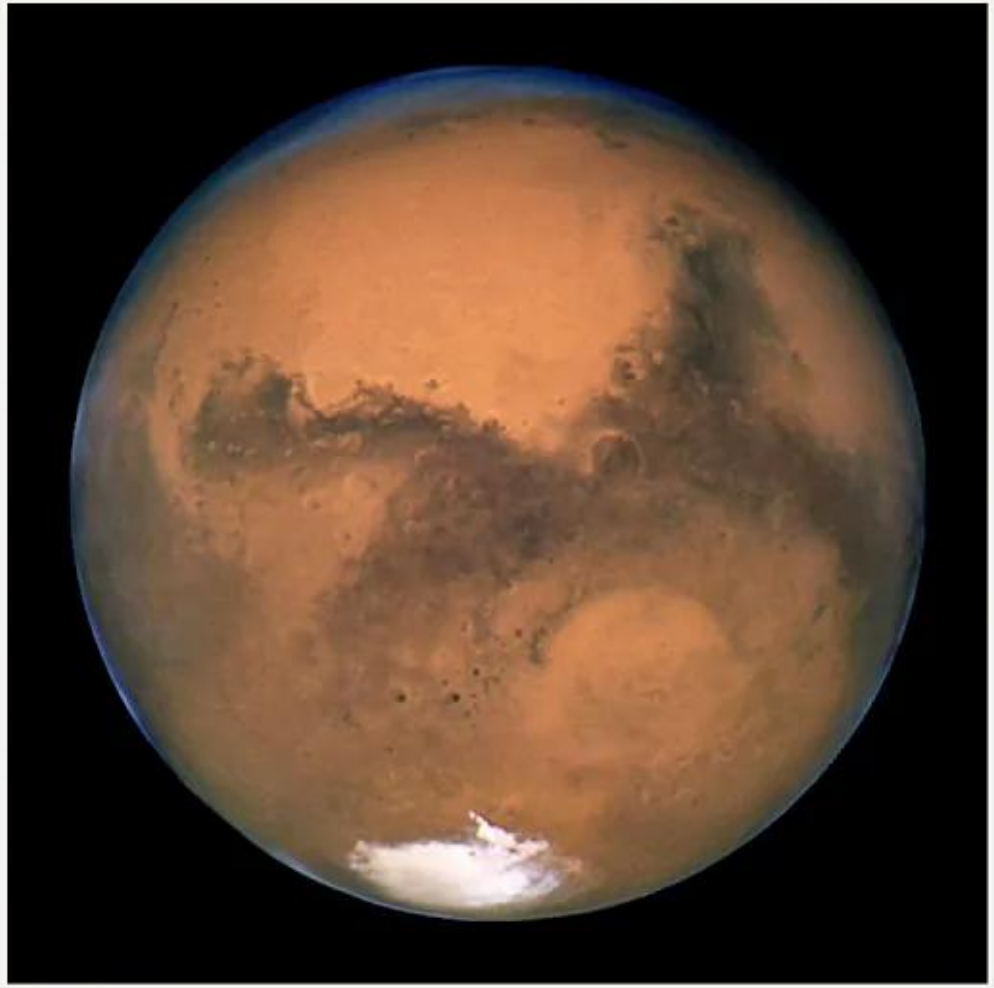
MARS & ANAGLOG ENVIRONMENT

- Mars → (Per)chlorate Found
- Potential Metabolic energy
- Useful for Habitable Life



https://solarsystem.nasa.gov/planets/mars/overview

Hecht et al, 2009

1
00:00:04,870 --> 00:00:01,110
[Music]

2
00:00:07,510 --> 00:00:04,880
hello my name is pratisha sai machinini

3
00:00:08,950 --> 00:00:07,520
i am a master's student at the

4
00:00:12,310 --> 00:00:08,960
university of houston

5
00:00:14,910 --> 00:00:12,320
clear lake in houston texas i am

6
00:00:16,070 --> 00:00:14,920
currently working on my master's in

7
00:00:18,230 --> 00:00:16,080
biotechnology

8
00:00:19,910 --> 00:00:18,240
and i am currently working on my thesis

9
00:00:24,390 --> 00:00:19,920
project

10
00:00:30,070 --> 00:00:24,400
pathways for microbial perchlorate

11
00:00:32,709 --> 00:00:30,080
reduction in a mars analog environment

12
00:00:34,389 --> 00:00:32,719
to start off with some background we

13
00:00:37,270 --> 00:00:34,399

will be talking about the mars

14
00:00:39,430 --> 00:00:37,280
and the analog environment first so

15
00:00:42,150 --> 00:00:39,440
during the phoenix lander mission

16
00:00:42,630 --> 00:00:42,160
perchlorate was detected and observed at

17
00:00:45,910 --> 00:00:42,640
the

18
00:00:49,270 --> 00:00:45,920
vasatas borealis landing site

19
00:00:50,069 --> 00:00:49,280
perchlorate was also evident in the rock

20
00:00:54,069 --> 00:00:50,079
nest

21
00:00:57,189 --> 00:00:54,079
sand patches of the gale gale crater

22
00:01:00,950 --> 00:00:57,199
gathered by the curiosity rover in

23
00:01:02,150 --> 00:01:00,960
2012 also after the viking land

24
00:01:05,189 --> 00:01:02,160
emissions

25
00:01:07,590 --> 00:01:05,199
evaluation and detection of perchlorate

26
00:01:08,950 --> 00:01:07,600
it can mean that it is globally

27
00:01:12,310 --> 00:01:08,960
distributed

28
00:01:13,510 --> 00:01:12,320
across mars martian perchlorate can be

29
00:01:15,910 --> 00:01:13,520
an essential

30
00:01:17,510 --> 00:01:15,920
energy and oxygen research for future

31
00:01:19,590 --> 00:01:17,520
exploration

32
00:01:22,789 --> 00:01:19,600
there are places on earth that are

33
00:01:24,950 --> 00:01:22,799
analog environments

34
00:01:26,149 --> 00:01:24,960
these include the atacama desert in

35
00:01:29,910 --> 00:01:26,159
chile

36
00:01:30,710 --> 00:01:29,920
morocco and the pilot valley basin in

37
00:01:33,830 --> 00:01:30,720
utah

38
00:01:37,350 --> 00:01:33,840

usa these environments have shown

39
00:01:38,630 --> 00:01:37,360
abundance of perchlorate examining

40
00:01:40,710 --> 00:01:38,640
different sites for

41
00:01:42,630 --> 00:01:40,720
biological and geological study can

42
00:01:44,870 --> 00:01:42,640
provide an interpretation

43
00:01:46,230 --> 00:01:44,880
of the biosignatures for comprehending

44
00:01:49,429 --> 00:01:46,240
the evolution

45
00:01:59,590 --> 00:01:49,439
of the martian environment and possibly

46
00:02:08,469 --> 00:02:03,429
so for some basic on perchlorate

47
00:02:12,390 --> 00:02:08,479
so perchlorate or clo4 minus is a highly

48
00:02:17,190 --> 00:02:12,400
oxidizing anion with an oxidation state

49
00:02:21,670 --> 00:02:17,200
of plus 7 and a redox potential of 1.287

50
00:02:25,190 --> 00:02:21,680
volts anthropogenic perchlorate

51
00:02:26,390 --> 00:02:25,200
in the environment results from various

52
00:02:29,830 --> 00:02:26,400
industries such as

53
00:02:33,030 --> 00:02:29,840
rocket propellants pyrotechnics

54
00:02:35,430 --> 00:02:33,040
fireworks and the chemical industry

55
00:02:37,509 --> 00:02:35,440
perchlorate has been mainly studied as a

56
00:02:40,630 --> 00:02:37,519
drinking water contaminant

57
00:02:43,670 --> 00:02:40,640
because pleurcherate perchlorate can be

58
00:02:46,790 --> 00:02:43,680
a health threat to the thyroid

59
00:02:48,710 --> 00:02:46,800
by the inhibition of the uptake of

60
00:02:51,670 --> 00:02:48,720
iodide

61
00:02:54,150 --> 00:02:51,680
i also have cited the papers along with

62
00:02:55,910 --> 00:02:54,160
the pictures just for a reference

63
00:02:57,589 --> 00:02:55,920

as well and they will also be shown at

64
00:02:59,580 --> 00:02:57,599
the end of the presentation

65
00:03:01,589 --> 00:02:59,590
for further reading

66
00:03:03,830 --> 00:03:01,599
[Music]

67
00:03:05,110 --> 00:03:03,840
so this picture shows the different

68
00:03:11,430 --> 00:03:05,120
pathways

69
00:03:13,670 --> 00:03:11,440
including the enzymes and how it breaks

70
00:03:16,869 --> 00:03:13,680
down

71
00:03:18,710 --> 00:03:16,879
so there are known different reduction

72
00:03:22,229 --> 00:03:18,720
pathways which include

73
00:03:25,110 --> 00:03:22,239
canonical symbiotic and cryptic

74
00:03:26,470 --> 00:03:25,120
the common perchlorate reduction pathway

75
00:03:28,949 --> 00:03:26,480
is canonical

76
00:03:29,589 --> 00:03:28,959
perchlorate reduction which includes

77
00:03:33,190 --> 00:03:29,599
specific

78
00:03:37,509 --> 00:03:33,200
enzymes pcra

79
00:03:40,949 --> 00:03:37,519
known as perchlorate reductase and cld

80
00:03:44,149 --> 00:03:40,959
known as chloride dismutase

81
00:03:47,509 --> 00:03:44,159
the cld enzyme is also present across

82
00:03:50,229 --> 00:03:47,519
chloride reducing bacteria and nitrate

83
00:03:53,509 --> 00:03:50,239
oxidizing bacteria which also uses

84
00:03:54,149 --> 00:03:53,519
nyxar which is another type of specific

85
00:03:57,830 --> 00:03:54,159
enzyme

86
00:03:58,869 --> 00:03:57,840
only specific to or plausibly only

87
00:04:02,229 --> 00:03:58,879
specific to

88
00:04:05,350 --> 00:04:02,239

nitrite oxidizing bacteria

89
00:04:07,030 --> 00:04:05,360
the symbiotic pathway has

90
00:04:10,630 --> 00:04:07,040
so far only been observed in the

91
00:04:13,589 --> 00:04:10,640
laboratory and not in the environment

92
00:04:14,949 --> 00:04:13,599
cryptic perchlorate reduction is noted

93
00:04:17,270 --> 00:04:14,959
as

94
00:04:18,789 --> 00:04:17,280
an incomplete reduction because of the

95
00:04:22,710 --> 00:04:18,799
lack of the cld

96
00:04:25,749 --> 00:04:22,720
enzyme or chlorite dismutase

97
00:04:27,350 --> 00:04:25,759
and it also has only been observed in

98
00:04:31,430 --> 00:04:27,360
the laboratory

99
00:04:33,590 --> 00:04:31,440
just like symbiotic

100
00:04:34,629 --> 00:04:33,600
the significance of cryptic perchlorate

101
00:04:36,870 --> 00:04:34,639
reduction

102
00:04:38,629 --> 00:04:36,880
in the environment is anticipated for

103
00:04:41,830 --> 00:04:38,639
further further

104
00:04:42,390 --> 00:04:41,840
studies as it could be an evolutionary

105
00:04:44,710 --> 00:04:42,400
step

106
00:04:45,830 --> 00:04:44,720
in the timeline of perchlord and as

107
00:04:49,990 --> 00:04:45,840
shown in this figure

108
00:04:50,870 --> 00:04:50,000
we can see how it is broken down through

109
00:04:53,830 --> 00:04:50,880
pcra

110
00:04:58,230 --> 00:04:53,840
and cld so the end products are chloride

111
00:05:04,870 --> 00:05:01,270
and this is the paper that the figures

112
00:05:11,350 --> 00:05:08,830
[Music]

113
00:05:17,189 --> 00:05:11,360

reading

114
00:05:20,070 --> 00:05:17,199
so a previous study by lynch etl 2019

115
00:05:22,310 --> 00:05:20,080
a previous study has shown evidence of

116
00:05:25,430 --> 00:05:22,320
naturally occurring perchlorate or

117
00:05:26,469 --> 00:05:25,440
nlp found in the sediments of the pilot

118
00:05:31,000 --> 00:05:26,479
valley basin

119
00:05:33,189 --> 00:05:31,010
utah according to the study site pv4

120
00:05:36,310 --> 00:05:33,199
[Music]

121
00:05:38,990 --> 00:05:36,320
has shown a greater concentration of

122
00:05:41,990 --> 00:05:39,000
perchlorate and microbial

123
00:05:43,590 --> 00:05:42,000
microbially induced sedimentary

124
00:05:47,630 --> 00:05:43,600
structures also called

125
00:05:52,469 --> 00:05:49,189
[Music]

126
00:05:54,110 --> 00:05:52,479
prms or perchlorate reducing microbes

127
00:05:56,870 --> 00:05:54,120
have been found to be very

128
00:05:59,029 --> 00:05:56,880
phylogenetically diverse

129
00:06:01,510 --> 00:05:59,039
it has been seen that perchlorate

130
00:06:03,670 --> 00:06:01,520
reducing microbes

131
00:06:06,070 --> 00:06:03,680
have been found to coexist with

132
00:06:09,790 --> 00:06:06,080
naturally occurring perchlorate or

133
00:06:13,909 --> 00:06:09,800
nop from data of 16

134
00:06:17,990 --> 00:06:13,919
srrna gene sequences both from sites pv3

135
00:06:22,390 --> 00:06:18,000
and sld sld-124

136
00:06:26,629 --> 00:06:22,400
shows what phylums or which phylums

137
00:06:27,909 --> 00:06:26,639
are dominant pv3 showed proteobacteria

138
00:06:31,270 --> 00:06:27,919

and bacterioids

139
00:06:33,110 --> 00:06:31,280
are greater and sld124 shows that

140
00:06:37,110 --> 00:06:33,120
bacterioids and from

141
00:06:41,070 --> 00:06:37,120
fermicutes are dominant known taxonomic

142
00:06:44,309 --> 00:06:41,080
groups for prms are azospira

143
00:06:47,189 --> 00:06:44,319
halobacterium and suitamonas

144
00:06:49,670 --> 00:06:47,199
to date over 40 isolates of perchlorate

145
00:06:55,430 --> 00:06:49,680
reducing microorganisms

146
00:07:00,790 --> 00:06:58,070
perchlorate reducers are facultative

147
00:07:02,950 --> 00:07:00,800
anaerobes and can be inhibited by oxygen

148
00:07:05,629 --> 00:07:02,960
and nitrate prms or

149
00:07:06,950 --> 00:07:05,639
perchlorating perchlorate reducing

150
00:07:09,110 --> 00:07:06,960
microorganisms

151
00:07:10,070 --> 00:07:09,120
have been commonly associated with the

152
00:07:13,110 --> 00:07:10,080
subclasses

153
00:07:16,280 --> 00:07:13,120
of alpha beta gamma and epsilon

154
00:07:18,790 --> 00:07:16,290
of the proteobacteria phylum

155
00:07:20,950 --> 00:07:18,800
[Music]

156
00:07:21,909 --> 00:07:20,960
the main goal for this project is to

157
00:07:24,230 --> 00:07:21,919
identify

158
00:07:25,749 --> 00:07:24,240
which microorganisms metabolize

159
00:07:28,790 --> 00:07:25,759
naturally occurring

160
00:07:29,990 --> 00:07:28,800
perchlorate in pilot valley why and how

161
00:07:33,189 --> 00:07:30,000
they are doing it

162
00:07:41,550 --> 00:07:33,199
another important question is why is it

163
00:07:44,550 --> 00:07:42,830

[Music]

164
00:07:47,510 --> 00:07:44,560
environment

165
00:07:48,869 --> 00:07:47,520
so a basic overview the pathways that

166
00:07:51,589 --> 00:07:48,879
prms

167
00:07:53,270 --> 00:07:51,599
use are not entirely known previous work

168
00:07:56,150 --> 00:07:53,280
has shown that the canonical

169
00:07:56,469 --> 00:07:56,160
perchlorate reduction pathway is likely

170
00:07:59,670 --> 00:07:56,479
not

171
00:08:02,150 --> 00:07:59,680
the primary metabolic pathway

172
00:08:03,830 --> 00:08:02,160
nitrate reducing microorganisms are also

173
00:08:05,589 --> 00:08:03,840
known to reduce perchlorate through

174
00:08:08,390 --> 00:08:05,599
nitrate reductase

175
00:08:10,550 --> 00:08:08,400
a plausible pathway is through nitrate

176
00:08:12,309 --> 00:08:10,560
reducing microbes due to the evidence of

177
00:08:15,350 --> 00:08:12,319
the nrg

178
00:08:18,540 --> 00:08:15,360
type reductase gene and the presence

179
00:08:21,029 --> 00:08:18,550
of nitrate reducing microbial species

180
00:08:23,189 --> 00:08:21,039
[Music]

181
00:08:26,070 --> 00:08:23,199
enrichments have been already initiated

182
00:08:28,070 --> 00:08:26,080
by dr kendall lynch from 2019

183
00:08:29,670 --> 00:08:28,080
the samples are housed in a minimal

184
00:08:32,630 --> 00:08:29,680
enrichment media to match the

185
00:08:34,949 --> 00:08:32,640
geochemistry of the pilot valley basin

186
00:08:36,389 --> 00:08:34,959
there are perchlorate samples chloride

187
00:08:38,310 --> 00:08:36,399
samples nitrate sample

188
00:08:39,589 --> 00:08:38,320

and blank samples that contain no

189
00:08:42,630 --> 00:08:39,599
oxyanions

190
00:08:43,670 --> 00:08:42,640
we also have a kill control the samples

191
00:08:46,230 --> 00:08:43,680
are interacted

192
00:08:47,110 --> 00:08:46,240
with an anaerobic chamber to maintain

193
00:08:53,750 --> 00:08:47,120
anoxic

194
00:08:58,310 --> 00:08:56,790
since samples were since working with

195
00:09:01,829 --> 00:08:58,320
the samples a lot of

196
00:09:03,829 --> 00:09:01,839
protocol development has come away

197
00:09:06,230 --> 00:09:03,839
we've been trying many ways to obtain

198
00:09:09,430 --> 00:09:06,240
better dna yield and concentration

199
00:09:11,910 --> 00:09:09,440
so the the way we came up with it

200
00:09:12,870 --> 00:09:11,920
is we would obtain fresh sample from

201
00:09:17,350 --> 00:09:12,880
culture bought

202
00:09:21,110 --> 00:09:17,360
from the culture bottle the dna samples

203
00:09:23,750 --> 00:09:21,120
are used for dna extraction

204
00:09:24,710 --> 00:09:23,760
with in triplicates plus a blink the

205
00:09:27,910 --> 00:09:24,720
samples are then

206
00:09:28,870 --> 00:09:27,920
cleaned up and concentrated to obtain

207
00:09:31,670 --> 00:09:28,880
cleaner dna

208
00:09:33,670 --> 00:09:31,680
and removing extra hemic substances

209
00:09:37,829 --> 00:09:33,680
these samples are quantified

210
00:09:41,750 --> 00:09:37,839
with a cubit fluorometer

211
00:09:44,790 --> 00:09:41,760
qpcr will be used to is used to detect

212
00:09:46,710 --> 00:09:44,800
nargi and cld the standards are derived

213
00:09:47,190 --> 00:09:46,720

from a known perchlorate reducer which

214
00:09:50,310 --> 00:09:47,200
is

215
00:09:52,230 --> 00:09:50,320
the chloromonas agitator the main goal

216
00:09:55,110 --> 00:09:52,240
is to identify the key enzymes in the

217
00:09:57,910 --> 00:09:55,120
pathways and identify the microorganisms

218
00:10:00,310 --> 00:09:57,920
and we hope that nrg will show an

219
00:10:04,949 --> 00:10:00,320
increase in cld will show an increase

220
00:10:07,350 --> 00:10:04,959
as well some further research

221
00:10:09,190 --> 00:10:07,360
through the continued studied of

222
00:10:11,190 --> 00:10:09,200
per-court-reducing microbes main

223
00:10:13,990 --> 00:10:11,200
perchlorate reduction pathways

224
00:10:16,470 --> 00:10:14,000
can be identified for metabolic energy

225
00:10:16,870 --> 00:10:16,480
genomic analysis and characterizations

226
00:10:19,750 --> 00:10:16,880
of

227
00:10:20,310 --> 00:10:19,760
prms through rna sequencing can also be

228
00:10:23,269 --> 00:10:20,320
done

229
00:10:24,710 --> 00:10:23,279
a perchlorate based ecosystem model

230
00:10:26,069 --> 00:10:24,720
could be produced to study the

231
00:10:28,470 --> 00:10:26,079
implications of past

232
00:10:29,430 --> 00:10:28,480
present and future habitable zones on

233
00:10:35,110 --> 00:10:29,440
mars

234
00:10:38,550 --> 00:10:35,120
finally i would like to thank the

235
00:10:41,030 --> 00:10:38,560
university of houston clear lake

236
00:10:42,389 --> 00:10:41,040
the lunar planetary institute also known

237
00:10:45,430 --> 00:10:42,399
as lpi

238
00:10:47,430 --> 00:10:45,440

usra and nasa for the opportunity and

239
00:10:49,910 --> 00:10:47,440
funding to work on this project

240
00:10:52,790 --> 00:10:49,920
i would like to thank my pi dr kendall

241
00:10:54,710 --> 00:10:52,800
lynch and dr laurie santiago asquez

242
00:10:56,470 --> 00:10:54,720
for their guidance knowledge and support

243
00:10:58,870 --> 00:10:56,480
on this project

244
00:11:01,110 --> 00:10:58,880
i would also like to thank jessica lopez

245
00:11:03,590 --> 00:11:01,120
for her help in the lab

246
00:11:05,030 --> 00:11:03,600
i would also like to thank ab grad khan

247
00:11:09,670 --> 00:11:05,040
for the opportunity

248
00:11:13,190 --> 00:11:11,829
here are the references that are

249
00:11:15,509 --> 00:11:13,200
mentioned in this