NExSS & NFoLD

STANDARDS OF EVIDENCE FOR LIFE DETECTION COMMUNITY WORKSHOP

DR. RICHARD QUINN

VIKING BIOLOGY EXPERIMENTS: A HISTORICAL BACKGROUND

1
00:00:05,110 --> 00:00:03,429
this presentation has been prepared for

2
00:00:07,269 --> 00:00:05,120
the standards of evidence for life

3
00:00:09,030 --> 00:00:07,279
detection community workshop

4
00:00:12,230 --> 00:00:09,040
i'm richard quinn and i'll be talking

5
00:00:13,830 --> 00:00:12,240
about the viking biology experiments

6
00:00:15,190 --> 00:00:13,840
in this presentation i'll provide some

7
00:00:17,029 --> 00:00:15,200
background on the viking biology

8
00:00:18,550 --> 00:00:17,039
experiments i'll talk about the life

9
00:00:20,470 --> 00:00:18,560
detection knowledge base which is a

10
00:00:22,470 --> 00:00:20,480
community tool designed to support

11
00:00:23,990 --> 00:00:22,480
discussion about the detection of signs

12
00:00:25,910 --> 00:00:24,000
of life

13
00:00:27,670 --> 00:00:25,920

talk about some of the viking biology

14
00:00:30,070 --> 00:00:27,680
results and interpretations in the

15
00:00:31,589 --> 00:00:30,080
context of the kv structure

16
00:00:34,950 --> 00:00:31,599
and then finally conclude with some

17
00:00:36,470 --> 00:00:34,960
thoughts for our upcoming workshop

18
00:00:38,069 --> 00:00:36,480
to begin i'd like to point out that

19
00:00:39,750 --> 00:00:38,079
during the time of the viking mission

20
00:00:41,510 --> 00:00:39,760
the way science and technology was

21
00:00:43,830 --> 00:00:41,520
developed for flight was in many ways

22
00:00:45,590 --> 00:00:43,840
the same as it's done today

23
00:00:46,869 --> 00:00:45,600
including performing analog field

24
00:00:48,389 --> 00:00:46,879
studies and the development of

25
00:00:50,549 --> 00:00:48,399
instrument concepts

26
00:00:52,549 --> 00:00:50,559
in the case of viking this included the

27
00:00:53,430 --> 00:00:52,559
biological capacity to generate

28
00:00:56,470 --> 00:00:53,440
metabolic

29
00:00:58,549 --> 00:00:56,480
carbon dioxide from labeled organics and

30
00:01:00,549 --> 00:00:58,559
the ability of soils to fixate labeled

31
00:01:02,150 --> 00:01:00,559
carbon dioxide

32
00:01:03,910 --> 00:01:02,160
these instrument concepts were then

33
00:01:04,149 --> 00:01:03,920
further developed for flight as part of

34
00:01:06,310 --> 00:01:04,159
the

35
00:01:08,149 --> 00:01:06,320
viking biology experiment payload under

36
00:01:10,310 --> 00:01:08,159
a demanding delivery schedule that

37
00:01:12,870 --> 00:01:10,320
included a preliminary design review in

38
00:01:16,070 --> 00:01:12,880

october of 1971

39
00:01:18,630 --> 00:01:16,080
a critical design review in may of 73

40
00:01:21,109 --> 00:01:18,640
and then in march to 75 the simultaneous

41
00:01:24,230 --> 00:01:21,119
delivery of the qualification unit

42
00:01:25,910 --> 00:01:24,240
the biological payload for viking 1

43
00:01:27,749 --> 00:01:25,920
and the biological payload for the

44
00:01:30,069 --> 00:01:27,759
viking 2 lander

45
00:01:32,069 --> 00:01:30,079
shown in parentheses is the number of

46
00:01:35,749 --> 00:01:32,079
months the delivery was behind the

47
00:01:37,429 --> 00:01:35,759
originally scheduled delivery date

48
00:01:39,510 --> 00:01:37,439
the viking life detection payload

49
00:01:40,149 --> 00:01:39,520
ultimately developed into three biology

50
00:01:42,149 --> 00:01:40,159
experiments

51
00:01:44,550 --> 00:01:42,159
designed to identify the presence of

52
00:01:45,910 --> 00:01:44,560
microbial metabolism in martian surface

53
00:01:47,670 --> 00:01:45,920
samples

54
00:01:49,190 --> 00:01:47,680
each experiment used different induced

55
00:01:52,310 --> 00:01:49,200
test environments

56
00:01:55,190 --> 00:01:52,320
which included dry to wet light and dark

57
00:01:56,389 --> 00:01:55,200
no additional nutrients the addition of

58
00:01:59,590 --> 00:01:56,399
simple nutrients

59
00:02:01,910 --> 00:01:59,600
or the addition of complex nutrients

60
00:02:04,950 --> 00:02:01,920
for each experiment a heat sterilized

61
00:02:07,030 --> 00:02:04,960
sample served as the control

62
00:02:08,389 --> 00:02:07,040
the viking gas exchange experiment was

63
00:02:10,790 --> 00:02:08,399

based on the hypothesis

64
00:02:12,470 --> 00:02:10,800
that soil gas exchange kinetics could be

65
00:02:14,309 --> 00:02:12,480
used to determine the absence or

66
00:02:15,990 --> 00:02:14,319
presence of biology

67
00:02:18,150 --> 00:02:16,000
and correspondingly was designed to

68
00:02:19,270 --> 00:02:18,160
measure changes in gas composition that

69
00:02:22,070 --> 00:02:19,280
headspace above

70
00:02:24,070 --> 00:02:22,080
martian samples it was based on the

71
00:02:25,990 --> 00:02:24,080
assumption that gas compensational

72
00:02:27,589 --> 00:02:26,000
changes in soils are mainly the result

73
00:02:29,750 --> 00:02:27,599
of biology

74
00:02:31,589 --> 00:02:29,760
second that metabolism and populations

75
00:02:34,470 --> 00:02:31,599
of soil organisms change when

76
00:02:36,470 --> 00:02:34,480
environmental conditions are perturbed

77
00:02:38,470 --> 00:02:36,480
and finally a complex nutrient medium

78
00:02:42,070 --> 00:02:38,480
can be used to alter the conditions and

79
00:02:43,910 --> 00:02:42,080
induce or inhibit metabolism

80
00:02:46,150 --> 00:02:43,920
the design of the experiment was quite

81
00:02:46,949 --> 00:02:46,160
simple a surface sample was placed in a

82
00:02:48,470 --> 00:02:46,959
test cell

83
00:02:50,390 --> 00:02:48,480
the cell was sealed and gas

84
00:02:52,070 --> 00:02:50,400
chromatography was used to monitor the

85
00:02:54,150 --> 00:02:52,080
headspace as a function of time

86
00:02:56,150 --> 00:02:54,160
under different conditions which

87
00:02:58,390 --> 00:02:56,160
included dry incubation

88
00:02:59,350 --> 00:02:58,400

a human mode and the addition of a

89
00:03:02,630 --> 00:02:59,360
complex

90
00:03:04,710 --> 00:03:02,640
aqueous nutrient medium

91
00:03:06,229 --> 00:03:04,720
the carbon assimilation experiment also

92
00:03:07,110 --> 00:03:06,239
known as the pyrolytic release

93
00:03:09,110 --> 00:03:07,120
experiment

94
00:03:11,190 --> 00:03:09,120
is based on the hypothesis that martian

95
00:03:13,990 --> 00:03:11,200
life would be carbonaceous and exchange

96
00:03:15,110 --> 00:03:14,000
carbon with the atmosphere corresponding

97
00:03:17,270 --> 00:03:15,120
was designed to measure the

98
00:03:19,670 --> 00:03:17,280
incorporation of radioactively labeled

99
00:03:21,509 --> 00:03:19,680
carbon monoxide and carbon dioxide into

100
00:03:22,869 --> 00:03:21,519
organic matter

101
00:03:24,630 --> 00:03:22,879
the experiment could measure either

102
00:03:25,310 --> 00:03:24,640
photosynthetic or chemosynthetic

103
00:03:26,390 --> 00:03:25,320
fixation

104
00:03:28,550 --> 00:03:26,400
[Music]

105
00:03:30,550 --> 00:03:28,560
and it approximated martian surface

106
00:03:33,670 --> 00:03:30,560
conditions of pressure

107
00:03:36,789 --> 00:03:33,680
atmospheric composition solar radiation

108
00:03:38,789 --> 00:03:36,799
and water abundance

109
00:03:40,470 --> 00:03:38,799
in a pyrolytic release experiment a

110
00:03:40,949 --> 00:03:40,480
surface sample is placed in the test

111
00:03:42,949 --> 00:03:40,959
cell

112
00:03:45,190 --> 00:03:42,959
and after sealing a small amount of

113
00:03:46,070 --> 00:03:45,200

radioactively labeled carbon dioxide and

114
00:03:49,350 --> 00:03:46,080
carbon monoxide

115
00:03:51,830 --> 00:03:49,360
was injected after incubation

116
00:03:54,070 --> 00:03:51,840
the sample was heated to 600 degrees c

117
00:03:55,110 --> 00:03:54,080
driving fragments of any organics that

118
00:03:59,509 --> 00:03:55,120
had formed

119
00:04:02,229 --> 00:03:59,519
onto a sample trap excess labeled co2

120
00:04:04,309 --> 00:04:02,239
and co was then purged from the system

121
00:04:07,350 --> 00:04:04,319
and following that the trap was heated

122
00:04:09,030 --> 00:04:07,360
to 700 degrees to decompose any labeled

123
00:04:14,869 --> 00:04:09,040
organics that had formed

124
00:04:16,870 --> 00:04:14,879
for detection as co2 or co

125
00:04:19,270 --> 00:04:16,880
the labeled release experiment assumed

126
00:04:21,430 --> 00:04:19,280
that martian organisms if present could

127
00:04:22,870 --> 00:04:21,440
assimilate carbon compounds and produce

128
00:04:25,990 --> 00:04:22,880
carbon dioxide

129
00:04:27,990 --> 00:04:26,000
or carbon monoxide as an end product

130
00:04:29,110 --> 00:04:28,000
correspondingly was designed to measure

131
00:04:31,189 --> 00:04:29,120
radioactively

132
00:04:32,230 --> 00:04:31,199
labeled carbon dioxide or carbon

133
00:04:34,469 --> 00:04:32,240
monoxide

134
00:04:36,790 --> 00:04:34,479
evolved from the assimilation of

135
00:04:38,790 --> 00:04:36,800
radioactively labeled organics that were

136
00:04:41,110 --> 00:04:38,800
added to the soil

137
00:04:42,629 --> 00:04:41,120
metabolism and growth could be detected

138
00:04:43,189 --> 00:04:42,639

and rates could be determined by

139
00:04:46,390 --> 00:04:43,199
measuring

140
00:04:46,950 --> 00:04:46,400
radioactivity over time and a positive

141
00:04:48,710 --> 00:04:46,960
result

142
00:04:51,030 --> 00:04:48,720
could be confirmed using a heat

143
00:04:52,790 --> 00:04:51,040
sterilized control

144
00:04:54,950 --> 00:04:52,800
very simply in a labeled release

145
00:04:55,749 --> 00:04:54,960
experiment a surface sample is sealed in

146
00:04:57,830 --> 00:04:55,759
a test cell

147
00:04:59,990 --> 00:04:57,840
and a dilute aqueous mixture of simple

148
00:05:01,830 --> 00:05:00,000
labeled organics was added

149
00:05:03,670 --> 00:05:01,840
following that the sample is allowed to

150
00:05:05,990 --> 00:05:03,680
incubate and the production of labeled

151
00:05:07,990 --> 00:05:06,000
carbon containing gas was monitored as a

152
00:05:09,590 --> 00:05:08,000
function of time

153
00:05:11,590 --> 00:05:09,600
with that brief introduction to the

154
00:05:13,430 --> 00:05:11,600
viking biology experiments

155
00:05:14,629 --> 00:05:13,440
i'd like to introduce the life detection

156
00:05:16,629 --> 00:05:14,639
knowledge base

157
00:05:18,150 --> 00:05:16,639
which is an online community-owned

158
00:05:20,230 --> 00:05:18,160
resource to provide knowledge and

159
00:05:21,830 --> 00:05:20,240
support discourse about the detection of

160
00:05:23,749 --> 00:05:21,840
signs of life

161
00:05:25,590 --> 00:05:23,759
these signs known as biosignatures

162
00:05:27,350 --> 00:05:25,600
consist of substances structures

163
00:05:29,189 --> 00:05:27,360

patterns or processes

164
00:05:30,710 --> 00:05:29,199
that indicate the current or form or

165
00:05:32,390 --> 00:05:30,720
presence of life

166
00:05:34,070 --> 00:05:32,400
in the life detection knowledge base

167
00:05:36,469 --> 00:05:34,080
information is presented according to

168
00:05:38,390 --> 00:05:36,479
arguments that support or contradict

169
00:05:39,670 --> 00:05:38,400
the value of a given bio signature is a

170
00:05:42,230 --> 00:05:39,680
sign of life

171
00:05:43,830 --> 00:05:42,240
all organized according to criteria and

172
00:05:45,749 --> 00:05:43,840
supported by evidence drawn from the

173
00:05:47,670 --> 00:05:45,759
scientific literature

174
00:05:50,150 --> 00:05:47,680
currently the astrobiology community is

175
00:05:51,590 --> 00:05:50,160
engaged in populating the knowledge base

176
00:05:53,350 --> 00:05:51,600
if you'd like to become involved you can

177
00:05:55,430 --> 00:05:53,360
find more information at the link shown

178
00:05:56,790 --> 00:05:55,440
at the bottom of this slide

179
00:05:58,309 --> 00:05:56,800
when you enter the life detection

180
00:06:00,309 --> 00:05:58,319
knowledge base you'll be asked to select

181
00:06:01,830 --> 00:06:00,319
a biosignature category

182
00:06:04,230 --> 00:06:01,840
in the case of the viking biology

183
00:06:05,990 --> 00:06:04,240
experiments we'd select activity

184
00:06:07,990 --> 00:06:06,000
the knowledge base is structured using

185
00:06:09,990 --> 00:06:08,000
criteria where criteria

186
00:06:11,590 --> 00:06:10,000
are a set of standards against which to

187
00:06:14,710 --> 00:06:11,600
evaluate the utility

188
00:06:16,070 --> 00:06:14,720

of specific life detection measurements

189
00:06:17,830 --> 00:06:16,080
two of the criteria in the knowledge

190
00:06:19,749 --> 00:06:17,840
base are feature strength which is the

191
00:06:21,830 --> 00:06:19,759
prominence of a feature that provides

192
00:06:23,350 --> 00:06:21,840
evidence regarding the past or extant

193
00:06:26,550 --> 00:06:23,360
presence of life

194
00:06:27,350 --> 00:06:26,560
or a non-biological process and feature

195
00:06:29,590 --> 00:06:27,360
prevalence

196
00:06:31,430 --> 00:06:29,600
which expresses the likelihood that the

197
00:06:32,469 --> 00:06:31,440
feature is produced by a particular

198
00:06:35,909 --> 00:06:32,479
source

199
00:06:37,590 --> 00:06:35,919
such as life or non-biological process

200
00:06:39,430 --> 00:06:37,600
and on the lower left hand side of the

201
00:06:40,790 --> 00:06:39,440
slide you can see that strength and

202
00:06:43,110 --> 00:06:40,800
prevalence criteria

203
00:06:43,909 --> 00:06:43,120
are categorized by biological feature

204
00:06:46,870 --> 00:06:43,919
strength

205
00:06:48,070 --> 00:06:46,880
biological prevalence as well as abiotic

206
00:06:50,870 --> 00:06:48,080
feature strength

207
00:06:53,510 --> 00:06:50,880
and abiotic prevalence each along with

208
00:06:55,749 --> 00:06:53,520
corresponding pros and cons for a given

209
00:06:57,430 --> 00:06:55,759
argument

210
00:06:58,790 --> 00:06:57,440
now i'd like to briefly walk through the

211
00:06:59,670 --> 00:06:58,800
results of the viking biology

212
00:07:01,110 --> 00:06:59,680
experiments

213
00:07:02,950 --> 00:07:01,120

and loosely place them in the

214
00:07:04,390 --> 00:07:02,960
knowledge-based structure

215
00:07:06,070 --> 00:07:04,400
there are precise ways in which

216
00:07:07,430 --> 00:07:06,080
arguments and their corresponding pros

217
00:07:08,469 --> 00:07:07,440
and cons should be crafted in the

218
00:07:10,790 --> 00:07:08,479
knowledge base

219
00:07:12,629 --> 00:07:10,800
which i'm not doing here nor am i

220
00:07:14,230 --> 00:07:12,639
including all the possible arguments and

221
00:07:15,990 --> 00:07:14,240
evidence related to the biology

222
00:07:18,230 --> 00:07:16,000
experiments that could be included

223
00:07:19,909 --> 00:07:18,240
in the knowledge base instead i'm

224
00:07:21,589 --> 00:07:19,919
demonstrating the basic structure of the

225
00:07:24,790 --> 00:07:21,599
knowledge base that can be used to

226
00:07:26,870 --> 00:07:24,800
evaluate biosignatures

227
00:07:29,029 --> 00:07:26,880
in the gas exchange experiment when a

228
00:07:31,270 --> 00:07:29,039
sample was humidified or wetted

229
00:07:33,029 --> 00:07:31,280
there was a rapid release of oxygen

230
00:07:35,350 --> 00:07:33,039
which was disproportionately large

231
00:07:38,390 --> 00:07:35,360
relative to other gases released

232
00:07:40,309 --> 00:07:38,400
including nitrogen and argon a slow

233
00:07:42,230 --> 00:07:40,319
linear release of carbon dioxide was

234
00:07:44,150 --> 00:07:42,240
also observed which persisted

235
00:07:45,670 --> 00:07:44,160
after a second injection of aqueous

236
00:07:47,589 --> 00:07:45,680
nutrients

237
00:07:50,790 --> 00:07:47,599
additionally no significant changes were

238
00:07:53,110 --> 00:07:50,800

observed during prolonged incubation

239
00:07:55,110 --> 00:07:53,120
this gas release pattern was observed

240
00:07:57,670 --> 00:07:55,120
for all samples tested

241
00:08:01,270 --> 00:07:57,680
including stored samples samples

242
00:08:02,950 --> 00:08:01,280
preheated to 145 c before testing

243
00:08:06,469 --> 00:08:02,960
and a sample that was collected from

244
00:08:10,070 --> 00:08:08,710
if we consider the hypothesis that the

245
00:08:11,909 --> 00:08:10,080
signal is biological

246
00:08:13,749 --> 00:08:11,919
we can examine both pro and con

247
00:08:16,230 --> 00:08:13,759
arguments and the evidence that supports

248
00:08:18,150 --> 00:08:16,240
or refutes this assertion

249
00:08:20,070 --> 00:08:18,160
characteristics of the gas exchange

250
00:08:23,749 --> 00:08:20,080
response included that the reaction

251
00:08:26,790 --> 00:08:23,759
survives heating to 145 degrees c

252
00:08:28,790 --> 00:08:26,800
the release of oxygen is extremely rapid

253
00:08:31,589 --> 00:08:28,800
and the second injection of nutrient did

254
00:08:33,750 --> 00:08:31,599
not result in additional gas production

255
00:08:36,630 --> 00:08:33,760
which indicates that biological growth

256
00:08:41,190 --> 00:08:38,469
for the hypothesis that the signal is

257
00:08:43,990 --> 00:08:41,200
abiotic we can again examine the results

258
00:08:45,910 --> 00:08:44,000
in the context of pros and cons

259
00:08:47,190 --> 00:08:45,920
post viking it was shown that multiple

260
00:08:49,269 --> 00:08:47,200
plausible inorganic

261
00:08:51,750 --> 00:08:49,279
oxidants can explain the gas exchange

262
00:08:54,550 --> 00:08:51,760
experiment oxygen release

263
00:08:56,949 --> 00:08:54,560

also post post-viking experiments showed

264
00:09:00,070 --> 00:08:56,959
that iron oxide can reproduce the carbon

265
00:09:03,990 --> 00:09:02,150
in the pyrolytic release experiment all

266
00:09:04,630 --> 00:09:04,000
tested samples were statistically

267
00:09:06,710 --> 00:09:04,640
positive

268
00:09:09,590 --> 00:09:06,720
which is indicative of the incorporation

269
00:09:13,110 --> 00:09:09,600
of radioactively labeled carbon dioxide

270
00:09:14,949 --> 00:09:13,120
or carbon monoxide into organic carbon

271
00:09:17,030 --> 00:09:14,959
nine samples were tested under different

272
00:09:20,070 --> 00:09:17,040
conditions that included

273
00:09:22,550 --> 00:09:20,080
dry and wet light and dark a sample that

274
00:09:24,870 --> 00:09:22,560
was heated to 175 degrees c

275
00:09:26,870 --> 00:09:24,880
prior to testing a sample that was

276
00:09:29,590 --> 00:09:26,880
heated to 90 degrees c

277
00:09:31,829 --> 00:09:29,600
and a sample that was stored for 139

278
00:09:34,230 --> 00:09:31,839
soles before testing

279
00:09:35,350 --> 00:09:34,240
additionally sample splits from the same

280
00:09:37,829 --> 00:09:35,360
sample collection

281
00:09:39,030 --> 00:09:37,839
but tested under different conditions

282
00:09:42,710 --> 00:09:39,040
shown in yellow

283
00:09:44,710 --> 00:09:42,720
produce nearly identical results

284
00:09:46,230 --> 00:09:44,720
if we consider whether the signal may be

285
00:09:48,150 --> 00:09:46,240
biological

286
00:09:51,430 --> 00:09:48,160
the results show that heat treatment to

287
00:09:54,389 --> 00:09:51,440
90 degrees c did not reduce the reaction

288
00:09:57,430 --> 00:09:54,399

and heat treatment to 175 degrees c did

289
00:09:59,350 --> 00:09:57,440
not eliminate the reaction

290
00:10:00,550 --> 00:09:59,360
if we consider whether the signal may be

291
00:10:02,550 --> 00:10:00,560
abiotic

292
00:10:04,310 --> 00:10:02,560
the results show again that heat

293
00:10:07,030 --> 00:10:04,320
treatment at 90 degrees c

294
00:10:09,269 --> 00:10:07,040
did not reduce the reaction and heat

295
00:10:12,150 --> 00:10:09,279
treatment at 175 degrees c

296
00:10:14,069 --> 00:10:12,160
did not eliminate the reaction

297
00:10:16,389 --> 00:10:14,079
additionally post viking experiments

298
00:10:17,350 --> 00:10:16,399
demonstrated positive results using iron

299
00:10:20,069 --> 00:10:17,360
oxides

300
00:10:21,910 --> 00:10:20,079
clays and mars analog mixtures

301
00:10:25,990 --> 00:10:21,920
indicating that the viking pyrolytic

302
00:10:28,069 --> 00:10:26,000
release results were false positives

303
00:10:30,230 --> 00:10:28,079
in the labeled release experiment when a

304
00:10:31,829 --> 00:10:30,240
dilute solution of simple organics was

305
00:10:33,829 --> 00:10:31,839
added to the sample

306
00:10:35,910 --> 00:10:33,839
shown at zero hours in the plot on the

307
00:10:37,829 --> 00:10:35,920
right there was a rapid release of

308
00:10:41,110 --> 00:10:37,839
radioactively labeled gas

309
00:10:43,269 --> 00:10:41,120
presumably carbon dioxide a second slow

310
00:10:44,710 --> 00:10:43,279
log linear release of carbon dioxide was

311
00:10:47,110 --> 00:10:44,720
also observed

312
00:10:48,630 --> 00:10:47,120
significant gas release was not observed

313
00:10:50,949 --> 00:10:48,640

after the injection of additional

314
00:10:52,630 --> 00:10:50,959
organics

315
00:10:54,630 --> 00:10:52,640
additionally the gas release was

316
00:10:56,389 --> 00:10:54,640
observed in the sample excavated from

317
00:10:58,230 --> 00:10:56,399
under a rock

318
00:11:00,949 --> 00:10:58,240
the initial release was reduced by

319
00:11:04,230 --> 00:11:00,959
preheating the sample to 50 degrees c

320
00:11:05,750 --> 00:11:04,240
for 3 hours it was eliminated by heating

321
00:11:09,750 --> 00:11:05,760
to 160 c

322
00:11:10,069 --> 00:11:09,760
for 3 hours also the slow release was

323
00:11:14,150 --> 00:11:10,079
not

324
00:11:16,150 --> 00:11:14,160
eliminated by heating to 160 degrees

325
00:11:17,590 --> 00:11:16,160
and finally the initial release was

326
00:11:20,069 --> 00:11:17,600
observed from a sample

327
00:11:23,509 --> 00:11:20,079
stored for three souls but not from the

328
00:11:25,190 --> 00:11:23,519
sample stored for 80 souls

329
00:11:26,949 --> 00:11:25,200
for the hypothesis that the labeled

330
00:11:28,630 --> 00:11:26,959
release signal is biological

331
00:11:30,630 --> 00:11:28,640
the results indicate that the initial

332
00:11:32,710 --> 00:11:30,640
release of gas resembled biological

333
00:11:34,069 --> 00:11:32,720
responses observed with the flight test

334
00:11:35,990 --> 00:11:34,079
module

335
00:11:38,790 --> 00:11:36,000
also the initial release was not

336
00:11:41,350 --> 00:11:38,800
observed in samples preheated to 160

337
00:11:43,030 --> 00:11:41,360
degrees prior to testing

338
00:11:45,190 --> 00:11:43,040

on the other hand as chuck klein has

339
00:11:47,829 --> 00:11:45,200
pointed out the initial response would

340
00:11:50,470 --> 00:11:47,839
require a large biological load

341
00:11:53,670 --> 00:11:50,480
a lag phase was not observed the

342
00:11:55,509 --> 00:11:53,680
reaction lasts only about 24 hours

343
00:11:58,389 --> 00:11:55,519
only approximately 10 percent of the

344
00:12:00,310 --> 00:11:58,399
available carbon substrate is utilized

345
00:12:03,829 --> 00:12:00,320
an injection of additional organics did

346
00:12:05,670 --> 00:12:03,839
not result in additional gas release

347
00:12:08,069 --> 00:12:05,680
for the hypothesis that the signal is

348
00:12:09,350 --> 00:12:08,079
abiotic the post viking literature shows

349
00:12:10,069 --> 00:12:09,360
that there are multiple plausible

350
00:12:11,750 --> 00:12:10,079
inorganic

351
00:12:13,590 --> 00:12:11,760
oxidants that can explain the labeled

352
00:12:15,910 --> 00:12:13,600
release results

353
00:12:17,590 --> 00:12:15,920
the gex results also provide evidence

354
00:12:19,670 --> 00:12:17,600
for the presence of oxidants at the

355
00:12:21,910 --> 00:12:19,680
viking sites

356
00:12:22,710 --> 00:12:21,920
which is also supported by the findings

357
00:12:25,829 --> 00:12:22,720
of the phoenix

358
00:12:27,190 --> 00:12:25,839
and out missions

359
00:12:28,949 --> 00:12:27,200
to conclude i hope that this

360
00:12:30,710 --> 00:12:28,959
presentation can serve as a starting

361
00:12:31,670 --> 00:12:30,720
point for discussion at the upcoming

362
00:12:33,430 --> 00:12:31,680
workshop

363
00:12:35,269 --> 00:12:33,440

in particular how the life detection

364
00:12:37,350 --> 00:12:35,279
knowledge base can be used as a tool

365
00:12:39,030 --> 00:12:37,360
to achieve both short-term and long-term

366
00:12:40,949 --> 00:12:39,040
workshop goals

367
00:12:42,389 --> 00:12:40,959
also going back to the third slide in

368
00:12:44,389 --> 00:12:42,399
this presentation

369
00:12:46,069 --> 00:12:44,399
a discussion on the risk associated with

370
00:12:48,629 --> 00:12:46,079
the application of standards to

371
00:12:50,550 --> 00:12:48,639
instrument verification and validation

372
00:12:53,190 --> 00:12:50,560
this is a quote from levin and strat

373
00:12:55,430 --> 00:12:53,200
about the labeled release experiment

374
00:12:56,870 --> 00:12:55,440
a science testing program was evolved to

375
00:12:59,509 --> 00:12:56,880
obtain data relevant to the

376
00:13:01,829 --> 00:12:59,519
interpretation of a flight experiment

377
00:13:03,990 --> 00:13:01,839
however because a program demands on the

378
00:13:05,190 --> 00:13:04,000
test standards module for engineering

379
00:13:07,190 --> 00:13:05,200
purposes

380
00:13:10,150 --> 00:13:07,200
not as much science data has been

381
00:13:11,910 --> 00:13:10,160
collected as had been planned

382
00:13:13,190 --> 00:13:11,920
i think that every scientist who has

383
00:13:15,190 --> 00:13:13,200
been involved with the

384
00:13:17,509 --> 00:13:15,200
delivery of a flight instrument has said

385
00:13:19,670 --> 00:13:17,519
these very words

386
00:13:21,350 --> 00:13:19,680
and finally a discussion on the risk of

387
00:13:23,350 --> 00:13:21,360
false positives

388
00:13:25,430 --> 00:13:23,360

there was a tremendous amount of testing

389
00:13:27,509 --> 00:13:25,440
for biology and analog samples in

390
00:13:29,509 --> 00:13:27,519
preparation for viking

391
00:13:31,750 --> 00:13:29,519
but for the most part consideration of

392
00:13:32,629 --> 00:13:31,760
abiotic feature strength and prevalence

393
00:13:35,670 --> 00:13:32,639
is absent

394
00:13:36,870 --> 00:13:35,680
in the pre-viking literature i'm looking

395
00:13:38,550 --> 00:13:36,880
forward to seeing everyone at the

396
00:13:40,230 --> 00:13:38,560
upcoming workshop and beginning a

397
00:13:42,949 --> 00:13:40,240
discussion on these aspects of