2017 Astrobiology Graduate Conference

Charlottesville, VA

1
00:00:00,790 --> 00:00:07,270
[Music]

2
00:00:10,610 --> 00:00:08,720
good afternoon

3
00:00:12,860 --> 00:00:10,620
my name is Kirikou newest I'm a

4
00:00:15,140 --> 00:00:12,870
geologist I'm a microbial paleontologist

5
00:00:17,120 --> 00:00:15,150
and my research focuses on achieving

6
00:00:19,099 --> 00:00:17,130
what I hope to be a more comprehensible

7
00:00:21,200 --> 00:00:19,109
comprehension of the most ancient traces

8
00:00:22,519 --> 00:00:21,210
of life on Earth their settings their

9
00:00:25,220 --> 00:00:22,529
environments and the applicability of

10
00:00:27,740 --> 00:00:25,230
these findings to the potential

11
00:00:30,830 --> 00:00:27,750
existence of a fossil biosphere on an

12
00:00:33,350 --> 00:00:30,840
awakened Mars it's my opinion that we

13
00:00:35,990 --> 00:00:33,360

already have an alien planet for study

14
00:00:38,299 --> 00:00:36,000
at our fingertips most ancient rocks on

15
00:00:40,100 --> 00:00:38,309
this earth represent vestiges of a

16
00:00:42,920 --> 00:00:40,110
planet shockingly different from that we

17
00:00:45,799 --> 00:00:42,930
know at present far from a state of

18
00:00:47,740 --> 00:00:45,809
relatively planetary clemency we have a

19
00:00:51,529 --> 00:00:47,750
world where the skies were a dense

20
00:00:54,799 --> 00:00:51,539
reducing haze the oceans were a mildly

21
00:01:00,020 --> 00:00:54,809
acidic saline solution the shorelines

22
00:01:02,830 --> 00:01:00,030
were fantastically fans the volcanoes

23
00:01:05,390 --> 00:01:02,840
and hydrothermal activity characterized

24
00:01:08,000 --> 00:01:05,400
everything where oxygen its associated

25
00:01:09,440 --> 00:01:08,010
metabolisms could not possibly exist now

26
00:01:12,469 --> 00:01:09,450
from a philosophical point of view I

27
00:01:15,590 --> 00:01:12,479
think this constitutes a good trial run

28
00:01:18,980 --> 00:01:15,600
of how we look for bio signatures not on

29
00:01:20,510 --> 00:01:18,990
a world of our own understanding so I'm

30
00:01:22,190 --> 00:01:20,520
interested in making comparisons between

31
00:01:24,440 --> 00:01:22,200
the Earth and Mars in their earliest

32
00:01:26,030 --> 00:01:24,450
history both of these planets appear to

33
00:01:28,700 --> 00:01:26,040
have supported limited habitable

34
00:01:31,010 --> 00:01:28,710
conditions perhaps over relatively short

35
00:01:34,190 --> 00:01:31,020
geological timescales both had liquid

36
00:01:37,010 --> 00:01:34,200
water vestiges of volcanic hydrothermal

37
00:01:40,310 --> 00:01:37,020
impact they will they were the victims

38
00:01:42,410 --> 00:01:40,320

of incessant impacts it's our opinion

39
00:01:44,389 --> 00:01:42,420
that the short habitable timescales

40
00:01:47,120 --> 00:01:44,399
present on the ancient Mars and the

41
00:01:48,620 --> 00:01:47,130
ancient earth mean that primitive chemo

42
00:01:50,690 --> 00:01:48,630
trophic metabolisms in a world

43
00:01:53,420 --> 00:01:50,700
punctuated habitability are the most

44
00:01:55,069 --> 00:01:53,430
relevant analogues to study in terms of

45
00:02:00,440 --> 00:01:55,079
a Martian biosphere that is why we find

46
00:02:03,350 --> 00:02:00,450
ourselves in the early Archaean so I'll

47
00:02:05,209 --> 00:02:03,360
try to go through these questions in

48
00:02:07,459 --> 00:02:05,219
some sort of order what is it required

49
00:02:09,199 --> 00:02:07,469
to draw a bio signature from the ancient

50
00:02:10,969 --> 00:02:09,209
geological record where do we draw

51
00:02:12,480 --> 00:02:10,979
boundaries between fugitive and

52
00:02:14,340 --> 00:02:12,490
definitive bio signatures

53
00:02:16,320 --> 00:02:14,350
once we've got those boundaries how do

54
00:02:18,960 --> 00:02:16,330
we test the hypotheses of biogenesis

55
00:02:20,850 --> 00:02:18,970
that we create and what are the

56
00:02:24,480 --> 00:02:20,860
implications there upon the search for

57
00:02:25,320 --> 00:02:24,490
life elsewhere chapter one claims and

58
00:02:28,320 --> 00:02:25,330
refutations

59
00:02:29,580 --> 00:02:28,330
of unexpected by Odin isset II or my

60
00:02:31,470 --> 00:02:29,590
oldest fossils are older than your

61
00:02:33,840 --> 00:02:31,480
fondest fossils and the complications

62
00:02:35,730 --> 00:02:33,850
thereof so that's how the acronym goes

63
00:02:37,410 --> 00:02:35,740

we have four places for studying the

64
00:02:39,390 --> 00:02:37,420
most ancient traces of life on Earth

65
00:02:41,940 --> 00:02:39,400
a sewer and new agate oak which I will

66
00:02:43,590 --> 00:02:41,950
not talk about and the Bob and the

67
00:02:45,180 --> 00:02:43,600
underbar Burton and the Pilbara which I

68
00:02:48,750 --> 00:02:45,190
most certainly will talk about the

69
00:02:50,190 --> 00:02:48,760
latter to present us with our our best

70
00:02:53,040 --> 00:02:50,200
preserved there admittedly still

71
00:02:54,020 --> 00:02:53,050
imperfect sedimentary sequences of the

72
00:02:56,520 --> 00:02:54,030
early archaea

73
00:02:59,220 --> 00:02:56,530
in our quest to biosignatures we seek

74
00:03:01,080 --> 00:02:59,230
out original convincing morphological

75
00:03:03,360 --> 00:03:01,090
traces of life such as these copper idol

76
00:03:05,550 --> 00:03:03,370
microorganisms from Kitty's captured we

77
00:03:06,870 --> 00:03:05,560
reinterpret previous assertions of

78
00:03:09,210 --> 00:03:06,880
biodiversity such as this

79
00:03:11,370 --> 00:03:09,220
reinterpretation of the apex Journal

80
00:03:14,430 --> 00:03:11,380
fossils we approach with new techniques

81
00:03:15,840 --> 00:03:14,440
previously unrecognized biological

82
00:03:18,300 --> 00:03:15,850
phenomena such as these microbial

83
00:03:21,480 --> 00:03:18,310
structures from the apex chart we search

84
00:03:24,570 --> 00:03:21,490
an ever more ancient rocks ever more

85
00:03:27,860 --> 00:03:24,580
bizarre taphonomic windows and ever

86
00:03:30,840 --> 00:03:27,870
further from home in Chapter two

87
00:03:33,060 --> 00:03:30,850
principles of deep time recall the

88
00:03:35,610 --> 00:03:33,070

Archaean earth produces a unique

89
00:03:37,200 --> 00:03:35,620
challenge for Austria lodgest s-- it's a

90
00:03:39,900 --> 00:03:37,210
very different world view to be had here

91
00:03:43,860 --> 00:03:39,910
the early ijen hypothesis that we can

92
00:03:45,060 --> 00:03:43,870
find on the present day environments

93
00:03:48,330 --> 00:03:45,070
which are perfectly good for the

94
00:03:51,030 --> 00:03:48,340
existence of life may not necessarily be

95
00:03:53,520 --> 00:03:51,040
true for or even applicable to a distant

96
00:03:55,350 --> 00:03:53,530
alien world this is because the

97
00:03:57,840 --> 00:03:55,360
principle of uniformitarianism that the

98
00:03:59,640 --> 00:03:57,850
past is the key to the present is pushed

99
00:04:02,370 --> 00:03:59,650
woefully beyond its limits in the

100
00:04:04,170 --> 00:04:02,380
Archaean punctuated habitability is not

101
00:04:06,300 --> 00:04:04,180
a thing we know on earth today though

102
00:04:08,160 --> 00:04:06,310
individual life may be patchy in its

103
00:04:10,260 --> 00:04:08,170
habitability life is pretty ubiquitous

104
00:04:12,510 --> 00:04:10,270
and this leads to the fact that there

105
00:04:14,340 --> 00:04:12,520
are uninhabited habitats on the ancient

106
00:04:16,860 --> 00:04:14,350
earth now that's something that we do

107
00:04:19,830 --> 00:04:16,870
not have on the modern day miss apply

108
00:04:21,870 --> 00:04:19,840
either of these tenets of habitability

109
00:04:23,550 --> 00:04:21,880
and you will find yourself in a world of

110
00:04:25,750 --> 00:04:23,560
mistaken conclusions and wayward

111
00:04:30,160 --> 00:04:25,760
assertions of Biogen isset ii

112
00:04:32,110 --> 00:04:30,170
exist on all spacial scales so in this

113
00:04:33,610 --> 00:04:32,120

microbe oriented planetary analog we

114
00:04:35,290 --> 00:04:33,620
will be considering phylogenetically

115
00:04:37,750 --> 00:04:35,300
primitive there's our thermophilic kima

116
00:04:40,060 --> 00:04:37,760
trophic organisms from such environments

117
00:04:42,070 --> 00:04:40,070
as in which they demonstrate endurance

118
00:04:45,100 --> 00:04:42,080
and recurrence over the geological

119
00:04:46,120 --> 00:04:45,110
timescale sadly all analog environments

120
00:04:47,680 --> 00:04:46,130
on the modern earth are somewhat

121
00:04:49,030 --> 00:04:47,690
compromised thus it is prudent for us

122
00:04:52,900 --> 00:04:49,040
also to consider those environments

123
00:04:55,390 --> 00:04:52,910
which depict chemo trophic ecosystem

124
00:04:56,770 --> 00:04:55,400
dominance that's the earlier Qian is it

125
00:04:59,980 --> 00:04:56,780
possible for us to make a comparison

126
00:05:02,470 --> 00:04:59,990
between post oxygenated world's

127
00:05:05,370 --> 00:05:02,480
ecosystems I don't know

128
00:05:08,100 --> 00:05:05,380
that question I won't answer chapter 3

129
00:05:10,570 --> 00:05:08,110
drawing the defining line of biogenesis

130
00:05:12,100 --> 00:05:10,580
criteria I study the record of

131
00:05:14,110 --> 00:05:12,110
carbonaceous matter in ancient sediments

132
00:05:16,090 --> 00:05:14,120
we know that much of this carbon comes

133
00:05:18,040 --> 00:05:16,100
from the proven biological reservoir but

134
00:05:21,010 --> 00:05:18,050
an equally great quantity can stem from

135
00:05:22,720 --> 00:05:21,020
terrestrial abiotic carbon factories the

136
00:05:25,090 --> 00:05:22,730
youthful Earth was also under constant

137
00:05:27,070 --> 00:05:25,100
bombardment from perhaps up to 1,000

138
00:05:29,440 --> 00:05:27,080

times present levels of meteoritic

139
00:05:31,390 --> 00:05:29,450
impact and 7% of these impactors

140
00:05:33,460 --> 00:05:31,400
carbonaceous chondrites and micro

141
00:05:35,710 --> 00:05:33,470
meteorites delivered buffed quantities

142
00:05:37,540 --> 00:05:35,720
of third sort of enigmatic carbon that I

143
00:05:41,440 --> 00:05:37,550
will comment no further on

144
00:05:43,330 --> 00:05:41,450
can I go forward yes I don't Ford too

145
00:05:47,280 --> 00:05:43,340
much that slide apparently didn't work

146
00:05:49,720 --> 00:05:47,290
okay so I will say that therefore in any

147
00:05:51,280 --> 00:05:49,730
aggregation of carbonaceous matter on

148
00:05:53,530 --> 00:05:51,290
the ancient earth you are potentially

149
00:05:57,670 --> 00:05:53,540
looking at a confusing a large of the

150
00:05:59,770 --> 00:05:57,680
three how to draw a bio signature out of

151
00:06:01,270 --> 00:05:59,780
this some one of the recent apps icon

152
00:06:03,880 --> 00:06:01,280
making and I do wish I remember who

153
00:06:06,700 --> 00:06:03,890
stated that bio signature acceptance is

154
00:06:09,280 --> 00:06:06,710
the summation of evidence and community

155
00:06:11,470 --> 00:06:09,290
consensus the evidence we can we can

156
00:06:16,090 --> 00:06:11,480
provide the community set consensus

157
00:06:17,640 --> 00:06:16,100
comes from biodiversity criteria we have

158
00:06:19,570 --> 00:06:17,650
criteria for micro fossil stromatolites

159
00:06:20,830 --> 00:06:19,580
microbial induced sedimentary structures

160
00:06:23,110 --> 00:06:20,840
microbial segments trace fossils an

161
00:06:24,870 --> 00:06:23,120
organic carbon itself I think if you

162
00:06:27,850 --> 00:06:24,880
look up those references you will find

163
00:06:29,890 --> 00:06:27,860

157 criteria that you can apply to your

164
00:06:34,189 --> 00:06:29,900
structures and yet still the overlap

165
00:06:35,360 --> 00:06:34,199
between biology and a biology is vast

166
00:06:37,850 --> 00:06:35,370
the next thing we have to prove that

167
00:06:39,589 --> 00:06:37,860
these structures of whatever origin us

168
00:06:41,149 --> 00:06:39,599
in genetic with their rocks on the

169
00:06:42,499 --> 00:06:41,159
short-term things are very altered on

170
00:06:44,600 --> 00:06:42,509
the medium-term things are tremendously

171
00:06:47,839 --> 00:06:44,610
altered and go back in time three and a

172
00:06:50,119 --> 00:06:47,849
half billion years ago and you find once

173
00:06:52,459 --> 00:06:50,129
again a world that is far removed from

174
00:06:54,230 --> 00:06:52,469
the present so let's suppose we have

175
00:06:55,999 --> 00:06:54,240
something that is putative ly biological

176
00:06:59,450 --> 00:06:56,009
we have something that is certainly as

177
00:07:00,830 --> 00:06:59,460
old as we would like it to be ah yes let

178
00:07:02,659 --> 00:07:00,840
me go that's another process of

179
00:07:04,480 --> 00:07:02,669
alteration we then need to open the

180
00:07:07,730 --> 00:07:04,490
greatest can of worms and that is

181
00:07:09,499 --> 00:07:07,740
biodiversity itself chapter four

182
00:07:11,600 --> 00:07:09,509
Sisyphean myths versus Herculean Labor's

183
00:07:14,779 --> 00:07:11,610
or how to reliably extricate a bio

184
00:07:16,550 --> 00:07:14,789
signature from its lithic prison bio

185
00:07:18,890 --> 00:07:16,560
signatures can be classified by a

186
00:07:20,360 --> 00:07:18,900
tripartite division morphological

187
00:07:22,730 --> 00:07:20,370
signatures are doubtless the most iconic

188
00:07:25,100 --> 00:07:22,740

but for every biological morphology and

189
00:07:27,110 --> 00:07:25,110
abiotic doppelganger is lying in wait as

190
00:07:30,559 --> 00:07:27,120
you will see I have been very dishonest

191
00:07:32,300 --> 00:07:30,569
on this slide there you go so that the

192
00:07:33,829 --> 00:07:32,310
bottom set the bottom section those are

193
00:07:38,619 --> 00:07:33,839
in fact wonderful silica spheres and

194
00:07:42,950 --> 00:07:40,969
morphological signatures of all scales I

195
00:07:44,899 --> 00:07:42,960
told you all scales have goodness that

196
00:07:48,200 --> 00:07:44,909
oh no there was a problem and Microsoft

197
00:07:51,019 --> 00:07:48,210
PowerPoint has decided to close it

198
00:07:52,219 --> 00:07:51,029
actually crashed my presentation has

199
00:07:57,769 --> 00:07:52,229
more pictures in it than the National

200
00:08:02,989 --> 00:07:57,779
Gallery I'm sorry here I was I I was

201
00:08:04,909 --> 00:08:02,999
here okay so how about these beautiful

202
00:08:07,339 --> 00:08:04,919
microbial mats from the huggin oak well

203
00:08:10,329 --> 00:08:07,349
they're on the right hand side what you

204
00:08:12,939 --> 00:08:10,339
find on the left hand side is basically

205
00:08:16,429 --> 00:08:12,949
equivalent structures but which have

206
00:08:18,589 --> 00:08:16,439
micron scale peculiarities which tell us

207
00:08:20,480 --> 00:08:18,599
that they are in fact abiotic so

208
00:08:27,649 --> 00:08:20,490
morphological signatures on their own

209
00:08:31,010 --> 00:08:27,659
not exactly ideal for our bipartite

210
00:08:33,019 --> 00:08:31,020
splitting of biology and a biology

211
00:08:35,329 --> 00:08:33,029
isotopic and metabolic signatures are

212
00:08:37,430 --> 00:08:35,339
becoming ever more useful we have to tie

213
00:08:39,290 --> 00:08:37,440

morphology to geochemistry and

214
00:08:41,149 --> 00:08:39,300
especially promising research direction

215
00:08:45,199 --> 00:08:41,159
seems to be sulfur isotopes although

216
00:08:47,570 --> 00:08:45,209
also biomineralization third chemical

217
00:08:50,150 --> 00:08:47,580
bio signatures integral or disseminated

218
00:08:51,620 --> 00:08:50,160
organic molecules and biomarkers sadly

219
00:08:52,970 --> 00:08:51,630
these are of no use to me because

220
00:08:54,820 --> 00:08:52,980
they're not nearly old enough they only

221
00:08:59,210 --> 00:08:54,830
go back to point seven billion years

222
00:09:01,880 --> 00:08:59,220
very young so we come to the approach

223
00:09:03,800 --> 00:09:01,890
that I think ensures us a robust

224
00:09:05,540 --> 00:09:03,810
biological signature correlative

225
00:09:07,520 --> 00:09:05,550
microscopy a single line of

226
00:09:10,730 --> 00:09:07,530
morphological or isotopic evidence is no

227
00:09:15,680 --> 00:09:10,740
longer sufficient you want morphology I

228
00:09:18,380 --> 00:09:15,690
know deer am I going to crash again no

229
00:09:21,320 --> 00:09:18,390
no no okay you want morphology you start

230
00:09:22,970 --> 00:09:21,330
off with petrographic of observations

231
00:09:24,650 --> 00:09:22,980
for example of these chemo trophic

232
00:09:26,560 --> 00:09:24,660
colonies suspended in hydrothermal

233
00:09:29,960 --> 00:09:26,570
silica you move your way to

234
00:09:32,300 --> 00:09:29,970
three-dimensional morphology such as

235
00:09:35,090 --> 00:09:32,310
these confocal laser scanning microscopy

236
00:09:38,080 --> 00:09:35,100
images of putative microbial structures

237
00:09:40,430 --> 00:09:38,090
you move closer you move to thai

238
00:09:41,870 --> 00:09:40,440

chemistry to your morphology somewhat

239
00:09:44,360 --> 00:09:41,880
perhaps you'd like to put your sample

240
00:09:46,490 --> 00:09:44,370
into a CT scanner and get something akin

241
00:09:48,110 --> 00:09:46,500
to that but that's only morphology

242
00:09:50,000 --> 00:09:48,120
perhaps you'd like to include include

243
00:09:52,130 --> 00:09:50,010
some EDS mapping you'd like to include

244
00:09:54,380 --> 00:09:52,140
some pixie analysis you'd like to

245
00:09:56,450 --> 00:09:54,390
include raman studies of the mineralogy

246
00:09:59,680 --> 00:09:56,460
you'd like to include nano sins of

247
00:10:02,120 --> 00:09:59,690
forits isotopic mapping this is

248
00:10:04,190 --> 00:10:02,130
difficult now as you can see we've got

249
00:10:05,920 --> 00:10:04,200
so much on the screen we can hardly see

250
00:10:08,660 --> 00:10:05,930
the wood for the trees

251
00:10:12,800 --> 00:10:08,670
what's important is choosing the

252
00:10:15,880 --> 00:10:12,810
appropriate combination of techniques

253
00:10:20,210 --> 00:10:15,890
for your bio signature of interest

254
00:10:22,520 --> 00:10:20,220
chapter 5 critics versus cynics don't be

255
00:10:24,200 --> 00:10:22,530
a cynic the burden of proof on ancient

256
00:10:27,290 --> 00:10:24,210
micro fossils and their associated

257
00:10:28,550 --> 00:10:27,300
structures is an i interminable load to

258
00:10:31,340 --> 00:10:28,560
give you the example of something I

259
00:10:33,220 --> 00:10:31,350
worked on the apex chert microbial

260
00:10:35,410 --> 00:10:33,230
structures here points in favor

261
00:10:37,910 --> 00:10:35,420
laminated textures which pass multiple

262
00:10:39,920 --> 00:10:37,920
morphological criteria for biodiversity

263
00:10:41,300 --> 00:10:39,930

a Raman spectra consistent with the

264
00:10:43,700 --> 00:10:41,310
syndrome isset II of the structures with

265
00:10:46,070 --> 00:10:43,710
their host rock nano Sims showing the

266
00:10:49,280 --> 00:10:46,080
co-occurrence of three bio essential

267
00:10:50,840 --> 00:10:49,290
elements points against proximity to a

268
00:10:52,520 --> 00:10:50,850
hydrothermal vane means that there's an

269
00:10:54,920 --> 00:10:52,530
increased chance of these structures

270
00:10:58,040 --> 00:10:54,930
stemming from a biogenic lis derived

271
00:11:00,440 --> 00:10:58,050
carbon also a point against I can't find

272
00:11:01,369 --> 00:11:00,450
any micro fossils here the architects of

273
00:11:08,089 --> 00:11:01,379
these edifices

274
00:11:09,979 --> 00:11:08,099
nowhere in sight chapter 6 the defeat of

275
00:11:13,549 --> 00:11:09,989
absurdity null hypotheses are

276
00:11:15,650 --> 00:11:13,559
biosignatures on trial an assertion of

277
00:11:17,419 --> 00:11:15,660
Archaean or alien biogenesis is

278
00:11:19,279 --> 00:11:17,429
worthless and that the simultaneous

279
00:11:21,799 --> 00:11:19,289
rejection of all conceivable null

280
00:11:25,099 --> 00:11:21,809
hypotheses this is the Geo philosophy

281
00:11:27,979 --> 00:11:25,109
part of the presentation it's important

282
00:11:30,109 --> 00:11:27,989
not to reduce your evidence to a

283
00:11:31,879 --> 00:11:30,119
reductive stacking of the odds all the

284
00:11:34,069 --> 00:11:31,889
best proofs of biodiversity are those

285
00:11:35,989 --> 00:11:34,079
which in the same breath are at once

286
00:11:38,749 --> 00:11:35,999
a demonstration of biology and an

287
00:11:41,829 --> 00:11:38,759
appropriate way biogenesis for existence

288
00:11:45,279 --> 00:11:41,839

for instance in the apex chert microbial

289
00:11:48,139 --> 00:11:45,289
structures I believe we have proven some

290
00:11:49,849 --> 00:11:48,149
characteristics of a concentration of

291
00:11:52,939 --> 00:11:49,859
organic molecules which means that the

292
00:11:56,409 --> 00:11:52,949
morphological abiotic null hypothesis of

293
00:11:59,299 --> 00:11:56,419
tube pumice cannot possibly be true

294
00:12:00,889 --> 00:11:59,309
chapter 7 I promised you we'd get off

295
00:12:04,279 --> 00:12:00,899
the planet at some point and we will

296
00:12:06,049 --> 00:12:04,289
worlds beyond our own so it's my opinion

297
00:12:08,210 --> 00:12:06,059
that the earlier Qian provides a

298
00:12:11,179 --> 00:12:08,220
planetary analogue with microbial scale

299
00:12:12,649 --> 00:12:11,189
similarities to the Noah Qian mass we

300
00:12:14,749 --> 00:12:12,659
have numerous complexities to

301
00:12:17,090 --> 00:12:14,759
disentangle and therefore we require a

302
00:12:18,739 --> 00:12:17,100
multi approach technique so many

303
00:12:21,319 --> 00:12:18,749
approaches that you crash PowerPoint

304
00:12:22,519 --> 00:12:21,329
multiple times this will doubtless be

305
00:12:24,049 --> 00:12:22,529
more difficult with a limited

306
00:12:26,869 --> 00:12:24,059
instrumentation that we will have on

307
00:12:28,579 --> 00:12:26,879
Mars the range of biomes possible for

308
00:12:31,749 --> 00:12:28,589
fossil life on Mars will be greatly

309
00:12:34,189 --> 00:12:31,759
reduced relative to those on earth

310
00:12:37,340 --> 00:12:34,199
coincidentally the remaining biomes on

311
00:12:39,229 --> 00:12:37,350
this diagram are also those which were

312
00:12:41,179 --> 00:12:39,239
dominant on the Archaean earth their

313
00:12:42,889 --> 00:12:41,189

biomes which are controlled by internal

314
00:12:46,239 --> 00:12:42,899
heats and which thus favor the

315
00:12:49,009 --> 00:12:46,249
accumulation of keema trophic biomass

316
00:12:51,189 --> 00:12:49,019
Martian rock record could also give us

317
00:12:53,719 --> 00:12:51,199
more than four billion years of

318
00:12:56,599 --> 00:12:53,729
unspoiled geological delights and this

319
00:12:58,519 --> 00:12:56,609
sequence could be uninterrupted it

320
00:13:00,679 --> 00:12:58,529
should be more pristine than on earth

321
00:13:03,139 --> 00:13:00,689
once we make it into depth and we can

322
00:13:05,029 --> 00:13:03,149
therefore start filling in the gaps of

323
00:13:09,710 --> 00:13:05,039
the horribly shattered terrestrial

324
00:13:12,039 --> 00:13:09,720
jigsaw understanding of the records of

325
00:13:14,419 --> 00:13:12,049
carbonaceous material is challenging I

326
00:13:15,220 --> 00:13:14,429
think we are currently required to base

327
00:13:16,990 --> 00:13:15,230
a lot of our

328
00:13:19,000 --> 00:13:17,000
the standing of the Martian geological

329
00:13:21,700 --> 00:13:19,010
record in earth centric observations but

330
00:13:25,320 --> 00:13:21,710
I'd like to see that reverse upon the

331
00:13:28,960 --> 00:13:25,330
return of Martian samples of course a

332
00:13:32,140 --> 00:13:28,970
sample return mission to that end is

333
00:13:34,240 --> 00:13:32,150
absolutely necessary we bring it back to

334
00:13:37,650 --> 00:13:34,250
earth we build a synchrotron around it

335
00:13:41,280 --> 00:13:37,660
and we study the hell out of it

336
00:13:44,950 --> 00:13:41,290
chapter 7 or dentes fortunate I do that

337
00:13:46,540 --> 00:13:44,960
the burden of proof associated with

338
00:13:49,090 --> 00:13:46,550

biosignature searches in the early

339
00:13:51,720 --> 00:13:49,100
Archaean is monumental but with care and

340
00:13:54,370 --> 00:13:51,730
diligence rewards can be reliable

341
00:13:56,740 --> 00:13:54,380
fortune favors the bold and in our

342
00:14:01,060 --> 00:13:56,750
quests through the solar system we

343
00:14:02,640 --> 00:14:01,070
should not and shall not go gently thank

344
00:14:18,060 --> 00:14:02,650
you for your attention

345
00:14:22,570 --> 00:14:20,470
ok first off let me say that is quite

346
00:14:24,310 --> 00:14:22,580
possibly one of the most riveting talks

347
00:14:27,640 --> 00:14:24,320
I've ever seen at a science conference

348
00:14:29,140 --> 00:14:27,650
um secondly so I study exoplanet

349
00:14:30,460 --> 00:14:29,150
biosignatures and I find the idea of

350
00:14:33,310 --> 00:14:30,470
like coming up with the idea by a

351
00:14:35,470 --> 00:14:33,320
signature plus evidence plus community

352
00:14:37,330 --> 00:14:35,480
consensus you can you're a signature so

353
00:14:39,160 --> 00:14:37,340
do you think you could that kind of be

354
00:14:40,930 --> 00:14:39,170
generalized to a sort of a general

355
00:14:42,430 --> 00:14:40,940
framework of how do we approach this

356
00:14:44,020 --> 00:14:42,440
because we're dealing with a lot of same

357
00:14:46,050 --> 00:14:44,030
problems in the exoplanet community as

358
00:14:50,440 --> 00:14:46,060
well as oxygen about a signature made

359
00:14:52,300 --> 00:14:50,450
maybe maybe not etc etc etc I think it

360
00:14:54,940 --> 00:14:52,310
certainly could yes I thought I thought

361
00:14:57,790 --> 00:14:54,950
I thought I think a combination of

362
00:15:00,880 --> 00:14:57,800
evidence and communica munity consensus

363
00:15:05,640 --> 00:15:00,890

is certainly what you require to be

364
00:15:07,750 --> 00:15:05,650
believed I guess the issue with

365
00:15:12,670 --> 00:15:07,760
exoplanets is that it's more difficult

366
00:15:20,110 --> 00:15:12,680
to accrue great amounts of evidence so

367
00:15:21,390 --> 00:15:20,120
community consensus on pivotal slices of

368
00:15:34,190 --> 00:15:21,400
that evidence

369
00:15:39,620 --> 00:15:38,000
so on the slide where you had the side

370
00:15:41,960 --> 00:15:39,630
of the slide that crashed PowerPoint

371
00:15:46,900 --> 00:15:41,970
with all the different methods of

372
00:15:50,180 --> 00:15:46,910
finding BIOS integration has any type of

373
00:15:51,800 --> 00:15:50,190
step wise procedure or I don't know

374
00:15:53,150 --> 00:15:51,810
almost like a dichotomous key of let's

375
00:15:55,040 --> 00:15:53,160
do this test and if you get a good

376
00:15:57,439 --> 00:15:55,050
result go to this test is anything like

377
00:15:59,509 --> 00:15:57,449
that under development broadly you start

378
00:16:00,920 --> 00:15:59,519
off with your least destructive method

379
00:16:07,060 --> 00:16:00,930
and you work your way to your most

380
00:16:13,400 --> 00:16:10,460
yes action actually with the exception

381
00:16:15,530 --> 00:16:13,410
of reversing Raman and pixie that is the

382
00:16:17,180 --> 00:16:15,540
order I would do it in it's always

383
00:16:23,500 --> 00:16:17,190
important to start off with the thin

384
00:16:27,470 --> 00:16:23,510
section microscopy because that is the

385
00:16:30,230 --> 00:16:27,480
scale of observation which is most most

386
00:16:32,889 --> 00:16:30,240
most meaningful to the resolution of the

387
00:16:41,449 --> 00:16:36,710
however it's no longer enough but for

388
00:16:43,460 --> 00:16:41,459

your studies in it involving Sims and

389
00:16:47,470 --> 00:16:43,470
pixie and one that I haven't put up that

390
00:16:49,880 --> 00:16:47,480
a TEM you'll you will find that

391
00:16:52,880 --> 00:16:49,890
destruction means that has to be at the

392
00:16:58,940 --> 00:16:52,890
end of your chain yes always start with

393
00:17:02,810 --> 00:17:00,590
do you think there's a fundamental

394
00:17:05,030 --> 00:17:02,820
problem comparing early Mars earlier

395
00:17:06,949 --> 00:17:05,040
since a Mars would have been much much

396
00:17:10,189 --> 00:17:06,959
colder back then because there you have

397
00:17:12,079 --> 00:17:10,199
the faint young Sun problem the paradox

398
00:17:14,360 --> 00:17:12,089
that people view as a problem for early

399
00:17:17,299 --> 00:17:14,370
Earth it seems to be exacerbated if you

400
00:17:19,669 --> 00:17:17,309
look at early Mars it's true

401
00:17:24,559 --> 00:17:19,679
although the faint young Sun is only a

402
00:17:27,409 --> 00:17:24,569
problem for phototrophic life the the

403
00:17:30,169 --> 00:17:27,419
sorts of biomes I study on the early

404
00:17:34,909 --> 00:17:30,179
Earth are those which take their energy

405
00:17:36,530 --> 00:17:34,919
from the interior of the planet so the

406
00:17:38,360 --> 00:17:36,540
faint young Sun could probably be a

407
00:17:40,700 --> 00:17:38,370
problem right of the surface but that

408
00:17:44,419 --> 00:17:40,710
depends upon the complexity you want for

409
00:17:46,659 --> 00:17:44,429
your ecosystem in terms of the

410
00:17:50,060 --> 00:17:46,669
comparison between keema trophic

411
00:17:55,490 --> 00:17:50,070
biomasses and kamatovic ecosystems

412
00:18:02,240 --> 00:17:55,500
I think localized conditions are much

413
00:18:04,570 --> 00:18:02,250

more important thank you thank you very