



tim morley



Dianne Newman



Tim Lyons



Dave Johnston



Michael New

Attendees (38)

▼ Hosts (2)

Estelle Dodson

Mike Toillion

▼ Presenters (6)

Dave Johnston

David Lomas

Dianne Newman

Michael New

Tim Lyons

tim morley

▼ Participants (30)

Aaron Gronstal

Andy Czaja

Arpita Bose

Betul Kacar

Burckhard Seelig

Chad Saltikov

Dan Jones

Dominic Papineau

Emily H

Frank Corsetti

Gady

Open Chat (Everyone)

sample, but you bring up a good question
----- (05/20/2013 10:25) -----

Uli Muller: I would like to pick up Burckhard's comment on early evolution before LUCA: The first primordial cell cannot have had a sophisticated metabolism and thereby relied initially on the same prebiotic reactions that made the rise of a primordial cell (perhaps an RNA world organism) to emerge. Therefore, I suggest that the early stages of early evolution had the function to 'wean the protocell off' from some inefficient prebiotic reactions and replacing them with RNA-catalyzed reactions. Therefore, I suggest that early prebiotic evolution would be to incorporate prebiotic reactions into the metabolism of the protocell, by generating the macromolecular catalysts that allowed it to do so.

----- (05/20/2013 10:26) -----
Pauli Laine: If we define the beginning of Archean when life probably started, then we need to know conditions then more accurate.

Michael New is typing...

Teleconference Instructions (Partic...)

Teleconference Line: (866) 692-4538
Passcode: 7496560#
More info:

Live Notes

Q: What types of approaches are needed to answer mechanistic questions about the early evolution of life and the biosphere, and which specific approaches are most helpful for particular types of questions?

Need to be clear which questions need which approaches.

Vital to understand function of biomarkers in living cells.

Mars sample return missions of high importance, and new instruments offering possibilities not available before. Need to be clear on what kinds of questions require this approach.

Q: Are there problems you think are vital to understanding the early evolution of life and the biosphere that have not yet been articulated by NASA?

Microanalytical is essential (e.g. for rover tech), but also other ways of measuring how atmosphere works - e.g. when did oxygen first appear.

Early Evolutions of Life and the Biosphere

Full Screen

Opening Panel Questions

- What types of approaches are needed to answer mechanistic questions about the early evolution of life and the biosphere, and which specific approaches are most helpful for particular types of questions?
- Are there problems you think are vital to understanding the early evolution of life and the biosphere that have not yet been articulated by NASA?
- How has the exponential growth in our discovery and understanding of exoplanets impacted the kinds of questions and information we extract from the early Earth record?

1
00:00:15,580 --> 00:00:12,680
thank you well good morning and going to

2
00:00:20,769 --> 00:00:15,590
all up Spence thank you for joining us

3
00:00:25,340 --> 00:00:20,779
this is the maybe fourth one of these

4
00:00:28,839 --> 00:00:25,350
webinars is that we're holding with the

5
00:00:31,939 --> 00:00:28,849
community to talk about astrobiology

6
00:00:34,760 --> 00:00:31,949
today we'll be talking to the early

7
00:00:37,220 --> 00:00:34,770
evolution of life and the biosphere so

8
00:00:41,150 --> 00:00:37,230
if that ring any bells with you you

9
00:00:44,900 --> 00:00:41,160
might be in the wrong well we go run for

10
00:00:46,520 --> 00:00:44,910
walleye and we are going to see the

11
00:00:49,100 --> 00:00:46,530
paneling now they're going to introduce

12
00:00:50,750 --> 00:00:49,110
themselves very shortly we have a series

13
00:00:54,400 --> 00:00:50,760

of questions which is designed to

14

00:00:58,430 --> 00:00:54,410

stimulate conversation amongst the

15

00:01:01,639 --> 00:00:58,440

community we'll probably talk for I

16

00:01:05,840 --> 00:01:01,649

don't for me about 30 do this and open

17

00:01:09,340 --> 00:01:05,850

up the microphones to to engage the

18

00:01:12,950 --> 00:01:09,350

audience the presenters are presenting

19

00:01:15,109 --> 00:01:12,960

thoroughly encourage you please to up

20

00:01:16,100 --> 00:01:15,119

into the open chat wonder you should see

21

00:01:20,780 --> 00:01:16,110

that on the left hand side of your

22

00:01:22,850 --> 00:01:20,790

screen please please engage in

23

00:01:25,010 --> 00:01:22,860

conversation there my colleague David

24

00:01:28,010 --> 00:01:25,020

low mass will be picking through there

25

00:01:29,569 --> 00:01:28,020

and trying to pick out useful and

26
00:01:31,910 --> 00:01:29,579
interesting comments which he will then

27
00:01:33,679 --> 00:01:31,920
transpose into the live notes area which

28
00:01:37,580 --> 00:01:33,689
will use a little bit later after this

29
00:01:40,219 --> 00:01:37,590
event if you have any questions at any

30
00:01:42,710 --> 00:01:40,229
stage we would ask you to put it into

31
00:01:44,719 --> 00:01:42,720
the open chat window we'd ask you to

32
00:01:46,700 --> 00:01:44,729
keep your microphones closed for this

33
00:01:49,069 --> 00:01:46,710
moment and when we come to the Q&A

34
00:01:52,550 --> 00:01:49,079
session in short while we'll ask you to

35
00:01:54,050 --> 00:01:52,560
raise your hand in the attendees window

36
00:01:55,760 --> 00:01:54,060
there's a little icon at the top of your

37
00:01:58,160 --> 00:01:55,770
screen for raising your hand and then we

38
00:02:00,679 --> 00:01:58,170

can draw you into the conference and we

39

00:02:02,389 --> 00:02:00,689

can speak live with you then so

40

00:02:04,880 --> 00:02:02,399

hopefully that's that sort of sets the

41

00:02:06,440 --> 00:02:04,890

scene Michael do I hand across to you

42

00:02:09,380 --> 00:02:06,450

too because a little bit of context

43

00:02:11,180 --> 00:02:09,390

about this particular whatever everybody

44

00:02:12,710 --> 00:02:11,190

I'm Michael new I'm the astrobiology

45

00:02:13,730 --> 00:02:12,720

discipline scientist at NASA

46

00:02:15,530 --> 00:02:13,740

headquarters

47

00:02:18,620 --> 00:02:15,540

and I'm one of the people at NASA

48

00:02:20,540 --> 00:02:18,630

headquarters who are eagerly awaiting

49

00:02:22,550 --> 00:02:20,550

the outcome of this webinar as well as

50

00:02:26,660 --> 00:02:22,560

the previous webinars and the online

51
00:02:31,460 --> 00:02:26,670
discussion um we are so the purpose of

52
00:02:33,620 --> 00:02:31,470
this webinar is to talk about some big

53
00:02:36,710 --> 00:02:33,630
questions in the early evolution of life

54
00:02:39,560 --> 00:02:36,720
and the biosphere now by this we tend to

55
00:02:43,550 --> 00:02:39,570
think of life on Earth or anywhere else

56
00:02:45,860 --> 00:02:43,560
uh not just evolving on some fixed

57
00:02:48,470 --> 00:02:45,870
physical substrate but actually

58
00:02:50,150 --> 00:02:48,480
coevolving with that substrate for the

59
00:02:52,340 --> 00:02:50,160
way to think about it or an example

60
00:02:54,350 --> 00:02:52,350
rather is you look at the early Earth

61
00:02:57,440 --> 00:02:54,360
well the early Earth we think has very

62
00:03:00,800 --> 00:02:57,450
little or no oxygen in his app in the

63
00:03:03,920 --> 00:03:00,810

atmosphere that oxygen came from life so

64

00:03:05,750 --> 00:03:03,930

we had a an oxy atmosphere and that led

65

00:03:08,030 --> 00:03:05,760

to a bunch of geochemical cycles of

66

00:03:11,060 --> 00:03:08,040

various metals and and other elements

67

00:03:13,850 --> 00:03:11,070

and then life figured out how to do

68

00:03:15,500 --> 00:03:13,860

oxygenating photosynthesis and all of a

69

00:03:18,290 --> 00:03:15,510

sudden there was all this nasty toxic

70

00:03:21,560 --> 00:03:18,300

oxygen everywhere it's not only drove

71

00:03:23,870 --> 00:03:21,570

the evolution of the biology it also

72

00:03:27,170 --> 00:03:23,880

changed old geochemical cycles or many

73

00:03:30,110 --> 00:03:27,180

of them and so the purpose of this

74

00:03:31,730 --> 00:03:30,120

webinar is to begin our online

75

00:03:33,980 --> 00:03:31,740

conversation about where are the

76

00:03:36,110 --> 00:03:33,990

compelling questions facing us for the

77

00:03:37,400 --> 00:03:36,120

next decade or so in this area of the

78

00:03:41,600 --> 00:03:37,410

early evolution of life and it's

79

00:03:44,060 --> 00:03:41,610

coevolution with the biosphere we are

80

00:03:47,420 --> 00:03:44,070

hoping you will all take vigorous part

81

00:03:49,280 --> 00:03:47,430

in this discussion today now as well as

82

00:03:52,370 --> 00:03:49,290

in the online part of it there are

83

00:03:55,160 --> 00:03:52,380

discussion for that will be open after

84

00:03:56,510 --> 00:03:55,170

this dealing with major questions we and

85

00:03:58,700 --> 00:03:56,520

we're going to and there's two reasons

86

00:04:02,600 --> 00:03:58,710

to participate in those dis online

87

00:04:05,150 --> 00:04:02,610

discussions the first is that you know

88

00:04:07,130 --> 00:04:05,160

what you say will affect what we think

89

00:04:09,620 --> 00:04:07,140

and the people who in the end of the day

90

00:04:10,930 --> 00:04:09,630

are going to be writing the roadmap or

91

00:04:12,740 --> 00:04:10,940

I'm going to be listening and reading

92

00:04:15,170 --> 00:04:12,750

more importantly we're going to be

93

00:04:16,760 --> 00:04:15,180

picking some of those people from active

94

00:04:19,729 --> 00:04:16,770

interesting participants in the online

95

00:04:22,060 --> 00:04:19,739

discussion and so this gives you even

96

00:04:25,880 --> 00:04:22,070

more direct route into writing the

97

00:04:27,090 --> 00:04:25,890

roadmap so without any further ado of

98

00:04:31,800 --> 00:04:27,100

their own attorney

99

00:04:35,770 --> 00:04:31,810

I will be happy to turn this over to go

100

00:04:39,740 --> 00:04:38,600

thank you very much Michael before we

101
00:04:42,830 --> 00:04:39,750
start could we just have a little

102
00:04:47,629 --> 00:04:42,840
instruction from our pal Diane Tim and

103
00:04:50,180 --> 00:04:47,639
Dave ever do I could do cos oh sure hi

104
00:04:52,010 --> 00:04:50,190
everybody thank you for joining this we

105
00:04:54,559 --> 00:04:52,020
have designed the questions for our

106
00:04:56,360 --> 00:04:54,569
discussion today wanting to hear from

107
00:04:59,210 --> 00:04:56,370
you we really don't want to do a lot of

108
00:05:02,200 --> 00:04:59,220
talking our goal is to make this an open

109
00:05:05,180 --> 00:05:02,210
discussion so that we get new ideas and

110
00:05:07,550 --> 00:05:05,190
that's why the opening questions are

111
00:05:10,129 --> 00:05:07,560
very broad so we really encourage you to

112
00:05:12,290 --> 00:05:10,139
please speak up and let us know what you

113
00:05:16,100 --> 00:05:12,300

think my background I should introduce

114

00:05:18,469 --> 00:05:16,110

myself sorry i work at Caltech in

115

00:05:20,029 --> 00:05:18,479

pasadena california i'm also an

116

00:05:23,210 --> 00:05:20,039

investigator of the hierarchies medical

117

00:05:24,830 --> 00:05:23,220

institute and i'm a molecular geo

118

00:05:26,830 --> 00:05:24,840

biologist and by that I mean I'm

119

00:05:29,510 --> 00:05:26,840

somebody who studies modern

120

00:05:32,420 --> 00:05:29,520

microorganisms with molecular genetic

121

00:05:34,040 --> 00:05:32,430

and cellular biological tools with the

122

00:05:36,980 --> 00:05:34,050

hope of understanding how it is that

123

00:05:39,860 --> 00:05:36,990

modern bacteria catalyzed processes that

124

00:05:42,439 --> 00:05:39,870

are of relevance both to modern shoe

125

00:05:45,969 --> 00:05:42,449

chemical cycles and also of relevance to

126
00:05:48,110 --> 00:05:45,979
helping us interpret ancient imprints of

127
00:05:52,420 --> 00:05:48,120
microorganisms be they in the form of

128
00:05:56,120 --> 00:05:52,430
biomarkers that are organic or larger

129
00:05:57,529 --> 00:05:56,130
bio signatures that are inorganic so

130
00:06:04,249 --> 00:05:57,539
that's my introduction I'm going to sign

131
00:06:06,379 --> 00:06:04,259
off this is tim life very much yeah this

132
00:06:08,089 --> 00:06:06,389
is tim lines and i would on i welcome

133
00:06:09,560 --> 00:06:08,099
you all also and thank you for

134
00:06:12,379 --> 00:06:09,570
participating and I would echo her

135
00:06:14,240 --> 00:06:12,389
comments that that she and dave and i

136
00:06:15,980 --> 00:06:14,250
will have a lot of time to talk offline

137
00:06:17,600 --> 00:06:15,990
about these things and so the point here

138
00:06:19,939 --> 00:06:17,610

is really to get your feedback so please

139

00:06:22,159 --> 00:06:19,949

do that and for those of you that i

140

00:06:23,450 --> 00:06:22,169

don't know i'm a bio geochemist at the

141

00:06:25,159 --> 00:06:23,460

University of California Riverside I

142

00:06:28,070 --> 00:06:25,169

work with the wide range of elemental

143

00:06:29,779 --> 00:06:28,080

and isotopic approaches towards basic

144

00:06:32,810 --> 00:06:29,789

questions about the earliest oxygenation

145

00:06:34,939 --> 00:06:32,820

of the ocean and atmosphere on this work

146

00:06:36,589 --> 00:06:34,949

often involves novel proxies including

147

00:06:38,420 --> 00:06:36,599

sulfur and trace metal concentrations

148

00:06:40,730 --> 00:06:38,430

and increasingly isotopic approaches

149

00:06:42,649 --> 00:06:40,740

with metals that are first are often

150

00:06:44,540 --> 00:06:42,659

developed and validated and calibrated

151
00:06:46,279 --> 00:06:44,550
in modern oxygen deficient settings and

152
00:06:47,750 --> 00:06:46,289
this work is all done really with the

153
00:06:48,380 --> 00:06:47,760
goal of providing a backdrop for the

154
00:06:50,000 --> 00:06:48,390
earlier

155
00:06:51,890 --> 00:06:50,010
of life and concluding the first

156
00:06:53,600 --> 00:06:51,900
appearance of osteogenic photosynthesis

157
00:06:55,760 --> 00:06:53,610
and the first appear at the

158
00:06:57,590 --> 00:06:55,770
diversification of eukaryotes and

159
00:07:00,590 --> 00:06:57,600
ultimately animals and so it's all about

160
00:07:02,540 --> 00:07:00,600
feedbacks and tipping points controls on

161
00:07:04,190 --> 00:07:02,550
early habitability and specifically the

162
00:07:06,320 --> 00:07:04,200
cause-effect relationship with the

163
00:07:09,290 --> 00:07:06,330

between the evolving environments and as

164

00:07:11,540 --> 00:07:09,300

Michael noted the coevolution of life in

165

00:07:16,370 --> 00:07:11,550

its diversity so I'll go ahead and turn

166

00:07:18,200 --> 00:07:16,380

it over two days great thanks thanks to

167

00:07:21,050 --> 00:07:18,210

everybody for joining us all my name is

168

00:07:24,080 --> 00:07:21,060

Dave Johnson and isotope trio biologist

169

00:07:26,630 --> 00:07:24,090

at Harvard and I use a mixture of kind

170

00:07:28,820 --> 00:07:26,640

of tools like Tim uses and tools like

171

00:07:31,430 --> 00:07:28,830

Diane uses to try to reconstruct valeo

172

00:07:34,250 --> 00:07:31,440

environment and so that kind of takes me

173

00:07:36,350 --> 00:07:34,260

a little bit into microbial ecology

174

00:07:37,910 --> 00:07:36,360

where we look to study rate laws and

175

00:07:40,280 --> 00:07:37,920

physiology organisms and how that

176

00:07:42,560 --> 00:07:40,290

translates isotope records and then also

177

00:07:45,110 --> 00:07:42,570

going out and working in sedimentary

178

00:07:47,480 --> 00:07:45,120

basins from deeper kielian to try to

179

00:07:49,220 --> 00:07:47,490

then reconstruct isotope records through

180

00:07:51,530 --> 00:07:49,230

those environments and then we use some

181

00:07:56,200 --> 00:07:51,540

modeling to bridge between the two so

182

00:08:03,500 --> 00:08:00,410

thank you very much Tim and done let's

183

00:08:05,660 --> 00:08:03,510

let's kick straight off into the into

184

00:08:08,600 --> 00:08:05,670

the big questions leave the questions

185

00:08:11,330 --> 00:08:08,610

that have arisen from a whole whole line

186

00:08:13,070 --> 00:08:11,340

of questions these are decided as

187

00:08:15,050 --> 00:08:13,080

probably the most interesting at the

188

00:08:17,210 --> 00:08:15,060

moment so could I kick off with this

189

00:08:18,920 --> 00:08:17,220

first question what types of approaches

190

00:08:20,840 --> 00:08:18,930

are needed to answer mechanistic

191

00:08:24,020 --> 00:08:20,850

questions about the early evolution of

192

00:08:35,300 --> 00:08:24,030

life in the biosphere anyone want to

193

00:08:41,820 --> 00:08:40,170

okay now I'm not hearing anybody I'm

194

00:08:43,500 --> 00:08:41,830

just hearing crickets chirping come on

195

00:08:52,530 --> 00:08:43,510

it's like 20 people involved is it

196

00:08:57,000 --> 00:08:52,540

somebody must have something to say so

197

00:09:00,630 --> 00:08:57,010

can we start with Diane please what is

198

00:09:03,120 --> 00:09:00,640

it an important question I think this is

199

00:09:07,110 --> 00:09:03,130

an important question because we've had

200

00:09:10,380 --> 00:09:07,120

a real revolution in technical

201
00:09:12,840 --> 00:09:10,390
capabilities that bear on biological

202
00:09:15,900 --> 00:09:12,850
problems within the past decade both at

203
00:09:18,720 --> 00:09:15,910
the level of an explosion of sequencing

204
00:09:22,079 --> 00:09:18,730
capability as well as improvements in

205
00:09:26,720 --> 00:09:22,089
our analytical abilities with regard to

206
00:09:30,660 --> 00:09:26,730
detecting a whole variety of isotopes at

207
00:09:33,329 --> 00:09:30,670
very small levels of spatial resolution

208
00:09:35,130 --> 00:09:33,339
those are just two examples and I think

209
00:09:38,519 --> 00:09:35,140
with these advances and technologies

210
00:09:41,370 --> 00:09:38,529
comes this question which is there are

211
00:09:45,120 --> 00:09:41,380
many really interesting topics in the

212
00:09:49,290 --> 00:09:45,130
field of geobiology and we need to be

213
00:09:51,510 --> 00:09:49,300

clear I think in regard to which

214

00:09:55,110 --> 00:09:51,520

questions require certain types of

215

00:09:57,569 --> 00:09:55,120

approaches and so as an example just to

216

00:10:01,440 --> 00:09:57,579

get the discussion going I would say

217

00:10:03,990 --> 00:10:01,450

that if one is trying to understand the

218

00:10:06,600 --> 00:10:04,000

meaning of an ancient biomarker for

219

00:10:08,790 --> 00:10:06,610

instance it is really vital to

220

00:10:12,150 --> 00:10:08,800

understand this function of that

221

00:10:14,819 --> 00:10:12,160

biomarker in living cells and the only

222

00:10:17,670 --> 00:10:14,829

way we can really understand function is

223

00:10:21,300 --> 00:10:17,680

through doing work with modern organisms

224

00:10:25,949 --> 00:10:21,310

at the physiological level and

225

00:10:28,470 --> 00:10:25,959

oftentimes we require mutants so that we

226

00:10:31,410 --> 00:10:28,480

can isolate particular genes that are

227

00:10:33,150 --> 00:10:31,420

important for encoding the machinery

228

00:10:36,210 --> 00:10:33,160

necessary to make those biomarkers and

229

00:10:38,400 --> 00:10:36,220

once we delete them then we have mutants

230

00:10:41,460 --> 00:10:38,410

at our disposal that we can interrogate

231

00:10:45,150 --> 00:10:41,470

in many ways to try to identify what the

232

00:10:46,740 --> 00:10:45,160

absence of these molecules does for the

233

00:10:50,070 --> 00:10:46,750

organism that produces them and

234

00:10:52,830 --> 00:10:50,080

i buy these type of approaches we can

235

00:10:54,960 --> 00:10:52,840

get a much clearer understanding of what

236

00:10:56,880 --> 00:10:54,970

the biomarkers actually do for the cells

237

00:10:59,100 --> 00:10:56,890

that produce them and I think that this

238

00:11:01,140 --> 00:10:59,110

is necessary in order to have a rigorous

239

00:11:03,660 --> 00:11:01,150

interpretation of of what these

240

00:11:05,700 --> 00:11:03,670

molecules mean in the rock record so

241

00:11:07,470 --> 00:11:05,710

that's just one example and I think it

242

00:11:12,960 --> 00:11:07,480

would be good to get a discussion going

243

00:11:19,740 --> 00:11:12,970

about that and any other examples that

244

00:11:24,410 --> 00:11:19,750

people would like to talk about thank

245

00:11:26,700 --> 00:11:24,420

you tin Dave you have a comment on this

246

00:11:28,980 --> 00:11:26,710

well I could but it seems like there

247

00:11:31,020 --> 00:11:28,990

might be people who were getting a lot

248

00:11:33,810 --> 00:11:31,030

of typing and it would be nice to have

249

00:11:36,270 --> 00:11:33,820

real-time oral exchange with this too i

250

00:11:41,520 --> 00:11:36,280

think yes yeah and i say that mike

251
00:11:44,040 --> 00:11:41,530
tyson's actually raised his hands can

252
00:11:46,950 --> 00:11:44,050
everybody hear me absolutely in the

253
00:11:49,830 --> 00:11:46,960
lines of my component speakers okay

254
00:11:53,550 --> 00:11:49,840
thanks Oh agree with it public what

255
00:11:56,700 --> 00:11:53,560
Diane said and add that for much of the

256
00:11:59,490 --> 00:11:56,710
time we're finding these questions are

257
00:12:04,550 --> 00:11:59,500
relevant we have very little material

258
00:12:07,290 --> 00:12:04,560
actually preserved and so yeah I think

259
00:12:10,140 --> 00:12:07,300
its weak willd it to think about what

260
00:12:11,970 --> 00:12:10,150
are the high volume records first time

261
00:12:15,079 --> 00:12:11,980
when talk jack businesses like this

262
00:12:18,150 --> 00:12:15,089
might be evolving or other things and

263
00:12:22,230 --> 00:12:18,160

unfortunately I think it's been very

264

00:12:24,870 --> 00:12:22,240

difficult to apply what what has been

265

00:12:27,690 --> 00:12:24,880

done thinking about the heat magazine

266

00:12:31,260 --> 00:12:27,700

awarded his work for that record as of

267

00:12:34,380 --> 00:12:31,270

yet I think it's really required in the

268

00:12:36,270 --> 00:12:34,390

near future as for for people who talk

269

00:12:39,770 --> 00:12:36,280

about mechanisms and particularly work

270

00:12:42,990 --> 00:12:39,780

the rock records to collaborate knobbers

271

00:12:44,610 --> 00:12:43,000

who can help us test my up i pod think

272

00:12:47,840 --> 00:12:44,620

about how very small scale processes

273

00:12:50,640 --> 00:12:47,850

work their way into highly visible

274

00:12:53,010 --> 00:12:50,650

products in the rock record essentially

275

00:12:54,390 --> 00:12:53,020

like roommates and Rovers on Mars for

276

00:12:58,500 --> 00:12:54,400

instance

277

00:13:00,750 --> 00:12:58,510

we know how to scale from from things

278

00:13:02,400 --> 00:13:00,760

are small no biological interest that

279

00:13:13,860 --> 00:13:02,410

the things that are largely observable

280

00:13:25,110 --> 00:13:13,870

yeah poorly preserved Raj okay Kenny yes

281

00:13:29,490 --> 00:13:25,120

domina creature I don't know microphone

282

00:13:32,640 --> 00:13:29,500

on now this is Dominic webinar okay this

283

00:13:34,140 --> 00:13:32,650

is complicated I know if its own when

284

00:13:35,550 --> 00:13:34,150

it's red or white but in any case I

285

00:13:38,850 --> 00:13:35,560

wanted to interject because i think that

286

00:13:41,910 --> 00:13:38,860

the n mentioned something very important

287

00:13:43,620 --> 00:13:41,920

about the advancement of my corona

288

00:13:45,180 --> 00:13:43,630

litical techniques and very specific

289

00:13:47,640 --> 00:13:45,190

instruments that are increasingly being

290

00:13:50,100 --> 00:13:47,650

used by members of our community as well

291

00:13:53,010 --> 00:13:50,110

as members of the geobiology community

292

00:13:55,500 --> 00:13:53,020

at large last year i was part of an

293

00:13:57,510 --> 00:13:55,510

effort to redefine or to kind of get the

294

00:14:00,840 --> 00:13:57,520

greater guidelines of the mother

295

00:14:04,140 --> 00:14:00,850

geobiology program would be or ought to

296

00:14:06,000 --> 00:14:04,150

be at at NSF at a symposium and in

297

00:14:09,180 --> 00:14:06,010

washington DC and i propose the field of

298

00:14:10,950 --> 00:14:09,190

nano geobiology and I like to kind of

299

00:14:12,590 --> 00:14:10,960

rephrase that at nano biogeochemistry

300

00:14:16,590 --> 00:14:12,600

which i think is probably the most

301

00:14:18,720 --> 00:14:16,600

exciting approach and of course I'm

302

00:14:20,460 --> 00:14:18,730

speaking from my own from my own

303

00:14:25,760 --> 00:14:20,470

background and I'm preaching for my own

304

00:14:29,220 --> 00:14:25,770

church in a way but overall I think that

305

00:14:32,430 --> 00:14:29,230

that the dire need here from from

306

00:14:34,520 --> 00:14:32,440

everything that everyone seemed to have

307

00:14:36,870 --> 00:14:34,530

discussed in the forums online is

308

00:14:39,300 --> 00:14:36,880

converging towards Mars we want to know

309

00:14:41,460 --> 00:14:39,310

what the origin of life is on earth how

310

00:14:43,800 --> 00:14:41,470

to recognize biomolecules on the early

311

00:14:45,420 --> 00:14:43,810

Earth as an example for finding to

312

00:14:47,310 --> 00:14:45,430

hopefully finding them on Mars and

313

00:14:49,290 --> 00:14:47,320

create the whole Mars and Mars

314

00:14:52,430 --> 00:14:49,300

exploration program is of utmost

315

00:14:54,630 --> 00:14:52,440

elements to astrobiology so I think that

316

00:14:57,450 --> 00:14:54,640

if the efforts of the astrobiology

317

00:14:59,850 --> 00:14:57,460

community were to support a Mars sample

318

00:15:02,070 --> 00:14:59,860

return I think that this would be the

319

00:15:04,440 --> 00:15:02,080

timing I mean it partly with respect to

320

00:15:06,750 --> 00:15:04,450

that to the Russians and the Chinese who

321

00:15:07,369 --> 00:15:06,760

want to send mar sample return missions

322

00:15:09,139 --> 00:15:07,379

that

323

00:15:11,509 --> 00:15:09,149

bodycon our sample return missions over

324

00:15:13,909 --> 00:15:11,519

the neck to the the next decade or 15

325

00:15:16,129 --> 00:15:13,919

years like it in half and of course it

326

00:15:18,349 --> 00:15:16,139

should I mean we're talking about these

327

00:15:22,249 --> 00:15:18,359

projects a MRSA for joint mission but

328

00:15:23,659 --> 00:15:22,259

the the crux of the matter remains how

329

00:15:25,429 --> 00:15:23,669

we can analyze how we're going to

330

00:15:28,489 --> 00:15:25,439

prepare to analyze the samples we do

331

00:15:31,639 --> 00:15:28,499

that a peaceful laboratory enclosed in a

332

00:15:35,059 --> 00:15:31,649

clinic in a class 100 clean room and we

333

00:15:36,829 --> 00:15:35,069

need like these these these astronaut

334

00:15:37,969 --> 00:15:36,839

Sciences if you wish working in a

335

00:15:40,309 --> 00:15:37,979

facility that they're completely

336

00:15:43,269 --> 00:15:40,319

protected from any potential pathogens

337

00:15:46,059 --> 00:15:43,279

from a planetary protection

338

00:15:49,609 --> 00:15:46,069

consideration but a project like this

339

00:15:51,499 --> 00:15:49,619

that by this details and a lot more

340

00:15:53,710 --> 00:15:51,509

detailed and I'm going to talk with

341

00:15:56,799 --> 00:15:53,720

because I realize I'm talking about this

342

00:15:59,210 --> 00:15:56,809

it does detail in a forum for the

343

00:16:02,149 --> 00:15:59,220

planetary biosafety microanalysis

344

00:16:04,429 --> 00:16:02,159

laboratory that I contributed online so

345

00:16:05,779 --> 00:16:04,439

anyways my ideas are there and and I

346

00:16:08,749 --> 00:16:05,789

think that there will be a potentially

347

00:16:11,869 --> 00:16:08,759

huge appeal / education public outreach

348

00:16:14,769 --> 00:16:11,879

as well as a tremendous opportunity for

349

00:16:17,149 --> 00:16:14,779

the whole geobiology community the whole

350

00:16:19,399 --> 00:16:17,159

precambrian biochemistry community but

351
00:16:22,069 --> 00:16:19,409
also the cosmochemistry communities the

352
00:16:24,109 --> 00:16:22,079
meijer communities and as well as the

353
00:16:25,369 --> 00:16:24,119
virologist and follicular biologists

354
00:16:28,539 --> 00:16:25,379
because I think that's many instruments

355
00:16:32,269 --> 00:16:28,549
that should be enclosed in such a p4

356
00:16:34,340 --> 00:16:32,279
value of safeties i will pass pass 100

357
00:16:36,739 --> 00:16:34,350
painting room these instruments should

358
00:16:38,269 --> 00:16:36,749
be should be instruments that are very

359
00:16:41,749 --> 00:16:38,279
versatile for our range of different

360
00:16:44,929 --> 00:16:41,759
analyses in terms of what at the end

361
00:16:48,469 --> 00:16:44,939
talk about i think that that Diane

362
00:16:50,269 --> 00:16:48,479
mentioned very clearly that there's a an

363
00:16:52,309 --> 00:16:50,279

increased recognition that instruments

364

00:16:53,569 --> 00:16:52,319

today are offering possibilities that

365

00:16:55,579 --> 00:16:53,579

they were not offering before and

366

00:16:57,259 --> 00:16:55,589

campuses that opportunity while you know

367

00:16:59,449 --> 00:16:57,269

we're still developing the approach but

368

00:17:02,029 --> 00:16:59,459

as a top Sims would be a very good for

369

00:17:03,189 --> 00:17:02,039

organic biomarkers as Vienna is raising

370

00:17:05,480 --> 00:17:03,199

your hand I'm sorry I asking too much

371

00:17:09,289 --> 00:17:05,490

and anyways what is an instrument will

372

00:17:11,990 --> 00:17:09,299

include a GM with a cryo stage a focused

373

00:17:15,169 --> 00:17:12,000

ion beam with a cryo stage as well as a

374

00:17:16,840 --> 00:17:15,179

laser Rahman ftir optical microscopes

375

00:17:19,929 --> 00:17:16,850

nano sim and

376

00:17:21,189 --> 00:17:19,939

yeah austin by gosh yeah iiii think all

377

00:17:23,770 --> 00:17:21,199

the clothes in a facility like this

378

00:17:26,130 --> 00:17:23,780

would very good noble goal for NASA and

379

00:17:29,770 --> 00:17:26,140

I urge all the disciplines we represent

380

00:17:31,419 --> 00:17:29,780

well ma am I just asked can I just ask

381

00:17:35,740 --> 00:17:31,429

em to respond to that the young had a

382

00:17:37,299 --> 00:17:35,750

response I would just like I agree with

383

00:17:40,659 --> 00:17:37,309

everything you're saying I think it'll

384

00:17:43,360 --> 00:17:40,669

be even more helpful if you can frame

385

00:17:46,000 --> 00:17:43,370

very specific types of questions where

386

00:17:48,190 --> 00:17:46,010

this type of microanalysis is essential

387

00:17:50,710 --> 00:17:48,200

I think it depends on the question and

388

00:17:53,620 --> 00:17:50,720

it's important to be very clear what

389

00:17:56,680 --> 00:17:53,630

types of questions absolutely require

390

00:18:00,789 --> 00:17:56,690

this and and what and what those

391

00:18:02,500 --> 00:18:00,799

questions are thank you Dan we're going

392

00:18:04,360 --> 00:18:02,510

to move on to another question surely

393

00:18:08,680 --> 00:18:04,370

but before we do so Dave did you have a

394

00:18:10,270 --> 00:18:08,690

comment on our first question here yeah

395

00:18:11,860 --> 00:18:10,280

I just wanted to follow up briefly on

396

00:18:13,779 --> 00:18:11,870

some of the chatter that's going on in

397

00:18:16,149 --> 00:18:13,789

the open chat as well so one of the

398

00:18:17,980 --> 00:18:16,159

things that that I think that's a harder

399

00:18:19,870 --> 00:18:17,990

book with Diana thing and Dominic's

400

00:18:21,640 --> 00:18:19,880

point is that we have these micro scales

401
00:18:24,100 --> 00:18:21,650
of analysis that are now available to us

402
00:18:25,899 --> 00:18:24,110
and one of the things that I I struggled

403
00:18:28,450 --> 00:18:25,909
with and I'm curious the community feel

404
00:18:30,279 --> 00:18:28,460
similarly is that we often take an

405
00:18:32,169 --> 00:18:30,289
interpretive framework based on a whole

406
00:18:34,390 --> 00:18:32,179
rock or hand sample size sample and

407
00:18:37,000 --> 00:18:34,400
apply it to these very very small scale

408
00:18:39,970 --> 00:18:37,010
measurement it's called kind of such of

409
00:18:41,649 --> 00:18:39,980
a comment day I believe has made that

410
00:18:44,140 --> 00:18:41,659
modeling or having some quantitative

411
00:18:46,440 --> 00:18:44,150
framework to bridge measuring something

412
00:18:48,909 --> 00:18:46,450
on the net us can help to a

413
00:18:51,610 --> 00:18:48,919

process-oriented interpretation of the

414

00:18:55,600 --> 00:18:51,620

emotions gallery a specific sales seems

415

00:18:57,039 --> 00:18:55,610

like Mary of opportunity and so that's

416

00:18:58,810 --> 00:18:57,049

kind of my notes and I'm curious if

417

00:19:02,850 --> 00:18:58,820

others feel the same way we move on to

418

00:19:06,880 --> 00:19:05,440

thank you very much I see that oma has

419

00:19:08,500 --> 00:19:06,890

use hand up but oh my if you could just

420

00:19:10,779 --> 00:19:08,510

bear with us for a moment will come to

421

00:19:13,080 --> 00:19:10,789

an open mic in a short while I'd like to

422

00:19:16,570 --> 00:19:13,090

move the conversation to our second

423

00:19:18,399 --> 00:19:16,580

second open panel question are there

424

00:19:20,080 --> 00:19:18,409

problems you think that a vital to

425

00:19:23,080 --> 00:19:20,090

understanding the early evolution of

426

00:19:25,659 --> 00:19:23,090

life and the biosphere that have not yet

427

00:19:27,610 --> 00:19:25,669

been articulated by NASA I'm wondering

428

00:19:30,159 --> 00:19:27,620

Tim produced arms off why you think this

429

00:19:30,940 --> 00:19:30,169

is an important question yeah and I

430

00:19:33,160 --> 00:19:30,950

think it sort of

431

00:19:35,710 --> 00:19:33,170

follows up on the previous question I

432

00:19:37,060 --> 00:19:35,720

die to think that this it's I for me

433

00:19:40,300 --> 00:19:37,070

there's really been a renaissance it

434

00:19:43,290 --> 00:19:40,310

started in the in the late 90s and I

435

00:19:45,550 --> 00:19:43,300

think it that was motivated in part by a

436

00:19:47,320 --> 00:19:45,560

evolving array of proxies that were

437

00:19:49,210 --> 00:19:47,330

addressing fundamental questions about

438

00:19:50,800 --> 00:19:49,220

early Earth's oxygen evolution a

439

00:19:52,690 --> 00:19:50,810

particular but tied to that are methane

440

00:19:54,340 --> 00:19:52,700

and many other components of the

441

00:19:56,740 --> 00:19:54,350

atmosphere that plays central roles and

442

00:19:58,750 --> 00:19:56,750

maintaining habitability and so there

443

00:20:00,220 --> 00:19:58,760

was there was instrumentation but there

444

00:20:02,110 --> 00:20:00,230

was also a lot of coupling to

445

00:20:05,200 --> 00:20:02,120

experimental work and so I worry a

446

00:20:07,080 --> 00:20:05,210

little bit I the micro analytical

447

00:20:09,340 --> 00:20:07,090

obviously is essential and the scale of

448

00:20:12,220 --> 00:20:09,350

observation is essential and a lot of

449

00:20:13,960 --> 00:20:12,230

those those approaches are motivated by

450

00:20:15,570 --> 00:20:13,970

rover technology and things we might be

451
00:20:17,770 --> 00:20:15,580
able to do institute on another planet

452
00:20:19,450 --> 00:20:17,780
but I also worry a little bit about

453
00:20:22,390 --> 00:20:19,460
forest for trees and so many of the

454
00:20:24,790 --> 00:20:22,400
answers that have come so far have have

455
00:20:27,850 --> 00:20:24,800
not just been in many cases have not

456
00:20:29,530 --> 00:20:27,860
been the advances have not come from my

457
00:20:31,540 --> 00:20:29,540
core analytical techniques but simply

458
00:20:32,920 --> 00:20:31,550
new ways of trying to quantify with the

459
00:20:34,450 --> 00:20:32,930
ocean and atmospheric chemistry were

460
00:20:36,760 --> 00:20:34,460
including Dominus dependent sulfur

461
00:20:38,350 --> 00:20:36,770
fractionations and metal mass balances

462
00:20:39,670 --> 00:20:38,360
in some cases relatively simple

463
00:20:43,300 --> 00:20:39,680

approaches that have been taken in new

464

00:20:45,040 --> 00:20:43,310

directions to try and quantify so the

465

00:20:46,150 --> 00:20:45,050

biggest question in earlier studies is

466

00:20:48,010 --> 00:20:46,160

not measuring presence or absence

467

00:20:49,630 --> 00:20:48,020

anymore but try to quantify what the

468

00:20:52,990 --> 00:20:49,640

composition of the ocean and atmosphere

469

00:20:55,060 --> 00:20:53,000

were and so I continue to think that

470

00:20:57,430 --> 00:20:55,070

fundamental questions that we have are

471

00:20:58,990 --> 00:20:57,440

our about when did oxygen first appear

472

00:21:02,080 --> 00:20:59,000

we've been asking those questions but we

473

00:21:04,270 --> 00:21:02,090

need to continue to do that and and I

474

00:21:07,060 --> 00:21:04,280

think also proxies that allow us to

475

00:21:08,560 --> 00:21:07,070

better understand what the more

476
00:21:10,510 --> 00:21:08,570
comprehensive composition of the

477
00:21:12,820 --> 00:21:10,520
atmosphere was as we try and understand

478
00:21:15,100 --> 00:21:12,830
greenhouse warming capabilities of the

479
00:21:19,150 --> 00:21:15,110
atmosphere and so forth or are really

480
00:21:20,800 --> 00:21:19,160
essential here and I also I worry a

481
00:21:22,840 --> 00:21:20,810
little bit if we steer that the

482
00:21:24,370 --> 00:21:22,850
conversation too much towards Mars and

483
00:21:26,230 --> 00:21:24,380
sample return I personally am very

484
00:21:28,150 --> 00:21:26,240
interested in icy moons as I know many

485
00:21:29,950 --> 00:21:28,160
other people are and the last question

486
00:21:32,950 --> 00:21:29,960
will address this but I'm also very very

487
00:21:34,420 --> 00:21:32,960
interested in exoplanets and so the the

488
00:21:36,940 --> 00:21:34,430

early Earth provides a wonderful

489

00:21:38,890 --> 00:21:36,950

experiment and in the face of a faint

490

00:21:40,720 --> 00:21:38,900

Sun and understanding and an evolving

491

00:21:43,389 --> 00:21:40,730

same Sun so it gives us a range of

492

00:21:45,009 --> 00:21:43,399

conditions over which we can understand

493

00:21:46,899 --> 00:21:45,019

liquid water was maintained to tell life

494

00:21:48,459 --> 00:21:46,909

evolves and co evolve and drove our

495

00:21:50,320 --> 00:21:48,469

environmental change and this incredible

496

00:21:52,299 --> 00:21:50,330

array of feedbacks that we had the earth

497

00:21:54,909 --> 00:21:52,309

history that allowed the earth to mate

498

00:21:58,359 --> 00:21:54,919

maintain a very special place in its

499

00:22:00,639 --> 00:21:58,369

history for the history of life and so I

500

00:22:02,619 --> 00:22:00,649

guess I ask as people address the second

501
00:22:04,239 --> 00:22:02,629
question to think to think broadly and

502
00:22:10,089 --> 00:22:04,249
not get too narrow towards Mars and

503
00:22:18,039 --> 00:22:10,099
microanalysis stop there thank you

504
00:22:19,959 --> 00:22:18,049
beyond it I see you nodding there yes I

505
00:22:22,959 --> 00:22:19,969
support what Tim said I think it's

506
00:22:27,329 --> 00:22:22,969
important that we try to be you know

507
00:22:31,329 --> 00:22:27,339
broad in our thinking about questions

508
00:22:35,589 --> 00:22:31,339
and take a view for you know the sake of

509
00:22:37,509 --> 00:22:35,599
a funding regime right now where we're

510
00:22:39,669 --> 00:22:37,519
quite limited we want as a community to

511
00:22:42,459 --> 00:22:39,679
try to collectively agree on things that

512
00:22:45,999 --> 00:22:42,469
are actually important and not get too

513
00:22:47,739 --> 00:22:46,009

parochial in in how we we think about

514

00:22:49,959 --> 00:22:47,749

these questions so that's just

515

00:22:51,820 --> 00:22:49,969

encouragement to give us your best ideas

516

00:22:53,769 --> 00:22:51,830

whether it's you know within your

517

00:22:56,889 --> 00:22:53,779

particular domain of what you've been

518

00:22:58,779 --> 00:22:56,899

doing or even better you know you know

519

00:23:00,940 --> 00:22:58,789

being broad and thinking about what's

520

00:23:02,469 --> 00:23:00,950

going to be exciting intellectually

521

00:23:09,899 --> 00:23:02,479

going forward for the next decade or

522

00:23:16,589 --> 00:23:12,339

think my co-leaders hit the nail on the

523

00:23:21,009 --> 00:23:19,029

purpose well in that case let's let's

524

00:23:22,389 --> 00:23:21,019

not press on through because we can come

525

00:23:24,519 --> 00:23:22,399

back to these in a short while ago from

526

00:23:27,779 --> 00:23:24,529

lights from other people our third

527

00:23:30,159 --> 00:23:27,789

question here how has exponential growth

528

00:23:33,969 --> 00:23:30,169

discovery of the study of extra players

529

00:23:35,859 --> 00:23:33,979

impacted um can we give you can we give

530

00:23:37,570 --> 00:23:35,869

people time to respond i think that

531

00:23:39,519 --> 00:23:37,580

we're you know plowing through these

532

00:23:41,469 --> 00:23:39,529

questions and sometimes it takes people

533

00:23:43,959 --> 00:23:41,479

a little while to collect their thoughts

534

00:23:49,060 --> 00:23:43,969

so can we just wait for 30 seconds and

535

00:23:50,859 --> 00:23:49,070

have somebody put something out most

536

00:23:53,259 --> 00:23:50,869

certainly there are plenty of questions

537

00:24:15,890 --> 00:23:53,269

coming through and some of them being

538

00:24:21,900 --> 00:24:18,840

so this is just encouragement maybe Jake

539

00:24:24,900 --> 00:24:21,910

Bailey can you pick up your mic and talk

540

00:24:26,400 --> 00:24:24,910

or anyone else that would be great if we

541

00:24:29,310 --> 00:24:26,410

could hear you I think it's harder for

542

00:24:30,210 --> 00:24:29,320

everybody to focus on the open chats at

543

00:24:32,760 --> 00:24:30,220

the same time we're having a

544

00:24:34,380 --> 00:24:32,770

conversation so anybody who wants to

545

00:24:36,390 --> 00:24:34,390

take what you're writing in chat and

546

00:24:40,560 --> 00:24:36,400

speak that would be really helpful thank

547

00:24:42,600 --> 00:24:40,570

you just a quick follow-up on that this

548

00:24:45,060 --> 00:24:42,610

is Mike you can use the raise hand

549

00:24:46,680 --> 00:24:45,070

feature to let us know you want to speak

550

00:24:48,120 --> 00:24:46,690

and that's located at the top of the

551
00:24:49,950 --> 00:24:48,130
screen there's an icon of a person

552
00:24:51,720 --> 00:24:49,960
raising their hand just click that

553
00:24:59,159 --> 00:24:51,730
select raise hand and then we will open

554
00:25:05,039 --> 00:24:59,169
up the telecom line Thanks all right

555
00:25:07,230 --> 00:25:05,049
let's take lipstick chick then I I just

556
00:25:09,570 --> 00:25:07,240
wanted to make the point that the early

557
00:25:11,460 --> 00:25:09,580
carbon oxygen and sulfur has really been

558
00:25:13,169 --> 00:25:11,470
a focus and lots of great work has been

559
00:25:16,320 --> 00:25:13,179
done on that but not so much has been

560
00:25:17,970 --> 00:25:16,330
done on phosphorus and nitrogen in part

561
00:25:20,399 --> 00:25:17,980
because nitrogen is difficult to

562
00:25:23,010 --> 00:25:20,409
preserve but I think potentially as a

563
00:25:25,770 --> 00:25:23,020

community we can somehow focus more on

564

00:25:27,510 --> 00:25:25,780

may be developing an interest in

565

00:25:34,430 --> 00:25:27,520

nitrogen and maybe technology that can

566

00:25:38,940 --> 00:25:36,720

maybe I can just expand on that I

567

00:25:41,130 --> 00:25:38,950

wholeheartedly agree and I think many

568

00:25:43,190 --> 00:25:41,140

other the models for understanding that

569

00:25:45,570 --> 00:25:43,200

steps and oxygenation in the early Earth

570

00:25:48,240 --> 00:25:45,580

require a deep understanding of nutrient

571

00:25:49,890 --> 00:25:48,250

cycling and protracted nutrient

572

00:25:51,930 --> 00:25:49,900

limitations that may shift in their

573

00:25:53,520 --> 00:25:51,940

nature through time and the tipping

574

00:25:55,620 --> 00:25:53,530

points that are required to get from one

575

00:25:57,360 --> 00:25:55,630

regime to another I think most famously

576

00:25:59,700 --> 00:25:57,370

of getting from the mid proterozoic to

577

00:26:01,500 --> 00:25:59,710

the neoproterozoic and so i guess i

578

00:26:02,850 --> 00:26:01,510

would i would go beyond just nitrogen

579

00:26:05,190 --> 00:26:02,860

and phosphorus and i would talk a lot

580

00:26:07,110 --> 00:26:05,200

about micro nutrients as well that made

581

00:26:09,000 --> 00:26:07,120

for example drive the nitrogen cycle and

582

00:26:12,600 --> 00:26:09,010

so we and many other people are involved

583

00:26:14,700 --> 00:26:12,610

in trying to glean quantitatively upon

584

00:26:17,159 --> 00:26:14,710

as as much as possible the metal

585

00:26:19,560 --> 00:26:17,169

distributions to earth history and so

586

00:26:22,259 --> 00:26:19,570

that those questions of nutrients s has

587

00:26:24,060 --> 00:26:22,269

tied to carbon and oxygen and sulfur

588

00:26:26,070 --> 00:26:24,070

they're all intricately linked obviously

589

00:26:28,409 --> 00:26:26,080

it's really essential and there's

590

00:26:30,359 --> 00:26:28,419

there's been correspondingly little I

591

00:26:31,739 --> 00:26:30,369

think work done on phosphorus in

592

00:26:33,299 --> 00:26:31,749

particular a lot of people are thinking

593

00:26:34,859 --> 00:26:33,309

about controls on nitrogen but

594

00:26:42,389 --> 00:26:34,869

phosphorus maybe fall into the cracks

595

00:26:46,649 --> 00:26:42,399

event thank you Jim and dominic has a

596

00:26:50,729 --> 00:26:46,659

question as well oh yeah can you hear me

597

00:26:53,729 --> 00:26:50,739

can you hear me ok so I'm lowering my

598

00:26:57,149 --> 00:26:53,739

hand I just wanted to comment on Tim's

599

00:27:00,029 --> 00:26:57,159

previous comment that we should steer

600

00:27:02,699 --> 00:27:00,039

away from Mars because the other solar

601
00:27:05,009 --> 00:27:02,709
planet Terra satellites are also

602
00:27:06,539 --> 00:27:05,019
interesting I don't deny that but i

603
00:27:08,669 --> 00:27:06,549
think that to answer the most

604
00:27:10,769 --> 00:27:08,679
fundamental and central questions with

605
00:27:13,349 --> 00:27:10,779
astrobiology and probably of all human

606
00:27:15,060 --> 00:27:13,359
time has been is there life outside

607
00:27:17,099 --> 00:27:15,070
earth elsewhere in the universe and the

608
00:27:20,099 --> 00:27:17,109
way to answer that is wait for steady

609
00:27:23,129 --> 00:27:20,109
contact us or that they come here which

610
00:27:25,319 --> 00:27:23,139
is not good idea and then or that we go

611
00:27:27,209 --> 00:27:25,329
and try to find it and Mars turns out to

612
00:27:29,549 --> 00:27:27,219
be the closest target with the highest

613
00:27:33,919 --> 00:27:29,559

potential and it is the closest target

614

00:27:36,419 --> 00:27:33,929

both timewise and financial wise so I I

615

00:27:38,849 --> 00:27:36,429

just think it would be a mistake to new

616

00:27:40,199 --> 00:27:38,859

astrobiology away from Mars and go in

617

00:27:42,029 --> 00:27:40,209

the outer solar system and we know very

618

00:27:44,310 --> 00:27:42,039

well in am are several times ten years

619

00:27:46,079 --> 00:27:44,320

ago was maybe four or five billion and

620

00:27:49,199 --> 00:27:46,089

now it's probably increase to 15 12

621

00:27:51,449 --> 00:27:49,209

billion and today's money first it's a

622

00:27:53,249 --> 00:27:51,459

huge undertaking for NASA but over the

623

00:27:55,769 --> 00:27:53,259

years the money can be spent lawton

624

00:27:58,139 --> 00:27:55,779

wisely and a facility like what I'm

625

00:28:00,419 --> 00:27:58,149

proposing that p vol facility that would

626
00:28:03,719 --> 00:28:00,429
house the instrument I numerated before

627
00:28:05,909 --> 00:28:03,729
would enable a lot of the analyses that

628
00:28:08,339 --> 00:28:05,919
are being discussed right now and open

629
00:28:11,009 --> 00:28:08,349
new field and thinking of one of our

630
00:28:13,259 --> 00:28:11,019
pioneer founders are very Bloomberg the

631
00:28:18,989 --> 00:28:13,269
biology has been underrepresented since

632
00:28:21,359 --> 00:28:18,999
his his passing and he contributed

633
00:28:22,949 --> 00:28:21,369
immensely to the field of medicine and i

634
00:28:24,930 --> 00:28:22,959
think that there's also significant

635
00:28:27,449 --> 00:28:24,940
contributions to be made to the field of

636
00:28:30,089 --> 00:28:27,459
medicine but also public health with a p

637
00:28:32,459 --> 00:28:30,099
4 biosafety planetary biosafety

638
00:28:33,620 --> 00:28:32,469

microanalysis laboratory because we

639

00:28:36,530 --> 00:28:33,630

don't really know a woman

640

00:28:39,020 --> 00:28:36,540

antigen many viruses have but for

641

00:28:41,990 --> 00:28:39,030

biomarkers that can be detected by the

642

00:28:44,540 --> 00:28:42,000

tech annoyed set that I intrusion yeah

643

00:28:46,610 --> 00:28:44,550

go ahead I just like Tim can I can I

644

00:28:48,410 --> 00:28:46,620

since coming he didn't has hey I just

645

00:28:50,240 --> 00:28:48,420

want to respond i certainly am NOT

646

00:28:52,400 --> 00:28:50,250

trying to steer anything away from Mars

647

00:28:54,530 --> 00:28:52,410

on Mars friendly as much as anyone I

648

00:28:56,330 --> 00:28:54,540

just think that we need to cast a big

649

00:28:57,800 --> 00:28:56,340

net especially early on in these

650

00:28:59,930 --> 00:28:57,810

discussions and one of the points of

651

00:29:03,260 --> 00:28:59,940

defining a roadmap is to laying a

652

00:29:05,060 --> 00:29:03,270

framework of questions that may may

653

00:29:07,100 --> 00:29:05,070

precipitate questions that we can't even

654

00:29:08,330 --> 00:29:07,110

think about asking now so if you keep it

655

00:29:11,210 --> 00:29:08,340

general I think what are the fundamental

656

00:29:12,920 --> 00:29:11,220

things that we need to know about not

657

00:29:14,990 --> 00:29:12,930

only history on earth that obviously how

658

00:29:17,210 --> 00:29:15,000

that allows us to inform exploration for

659

00:29:20,330 --> 00:29:17,220

life on Mars in many other places and so

660

00:29:21,980 --> 00:29:20,340

I just I just caution it's my personal

661

00:29:24,770 --> 00:29:21,990

perspective the caution us all not to

662

00:29:27,230 --> 00:29:24,780

focus too much on small analyses on one

663

00:29:28,790 --> 00:29:27,240

planet and and I think whatever we talk

664

00:29:30,410 --> 00:29:28,800

about speaks to Mars and we could

665

00:29:33,050 --> 00:29:30,420

certainly steer the conversation towards

666

00:29:34,400 --> 00:29:33,060

Mars but I personally again speaking for

667

00:29:36,230 --> 00:29:34,410

myself would like to hear a lot of

668

00:29:39,890 --> 00:29:36,240

clever things that maybe I've never

669

00:29:41,720 --> 00:29:39,900

heard before and and absolutely

670

00:29:44,030 --> 00:29:41,730

everything you said about Mars is true

671

00:29:45,830 --> 00:29:44,040

and and that may be the next time in 10

672

00:29:48,380 --> 00:29:45,840

years and whatever many years and that

673

00:29:50,270 --> 00:29:48,390

may remain the essential priority but it

674

00:29:52,010 --> 00:29:50,280

may not also and the part of the goal

675

00:29:57,110 --> 00:29:52,020

here is to find out what those things

676

00:29:59,690 --> 00:29:57,120

should be I'll leave it there thank you

677

00:30:03,320 --> 00:29:59,700

Tim did you have some new insight into a

678

00:30:05,660 --> 00:30:03,330

Johnson I was actually just going to

679

00:30:07,250 --> 00:30:05,670

circle back around to where this portion

680

00:30:08,900 --> 00:30:07,260

of the conversation started with looking

681

00:30:10,840 --> 00:30:08,910

at nutrient cycles and things like that

682

00:30:13,430 --> 00:30:10,850

and you know our understanding is lean

683

00:30:15,110 --> 00:30:13,440

because these are tough systems to try

684

00:30:16,910 --> 00:30:15,120

to sort out how to quantify or how to

685

00:30:19,850 --> 00:30:16,920

get at and so I just posed the question

686

00:30:21,920 --> 00:30:19,860

in the open chat as to whether people

687

00:30:23,630 --> 00:30:21,930

think it we just need to keep hammering

688

00:30:25,820 --> 00:30:23,640

on the geologic record in making

689

00:30:27,620 --> 00:30:25,830

measurements or it is it are we missing

690

00:30:29,270 --> 00:30:27,630

missing the mark all together and we

691

00:30:31,250 --> 00:30:29,280

need new approaches or are their ideas

692

00:30:33,530 --> 00:30:31,260

for how we can go about trying to access

693

00:30:35,360 --> 00:30:33,540

some of these more cryptic element

694

00:30:38,270 --> 00:30:35,370

cycles in the are keen in particular

695

00:30:40,550 --> 00:30:38,280

that we know are hugely important but a

696

00:30:42,980 --> 00:30:40,560

little bit less tractable in terms of a

697

00:30:47,330 --> 00:30:42,990

classic sediment geochemistry context so

698

00:30:51,380 --> 00:30:49,460

thank you and there are lots of

699

00:30:53,750 --> 00:30:51,390

questions coming through on the open

700

00:30:56,000 --> 00:30:53,760

chat here I don't know if it's sir if we

701
00:30:57,800 --> 00:30:56,010
wanted a dress that is directing now I I

702
00:30:59,330 --> 00:30:57,810
want to make sure we don't miss our last

703
00:31:01,340 --> 00:30:59,340
question and then have an open

704
00:31:03,500 --> 00:31:01,350
discussion at the end of this so if you

705
00:31:07,010 --> 00:31:03,510
don't mind maybe we could look to our

706
00:31:09,410 --> 00:31:07,020
third question in our list of points

707
00:31:11,390 --> 00:31:09,420
that we drew out earlier how has the

708
00:31:13,790 --> 00:31:11,400
exponential growth in our discovery and

709
00:31:15,530 --> 00:31:13,800
understanding exoplanets impacted the

710
00:31:18,800 --> 00:31:15,540
kinds of questions and informational

711
00:31:20,300 --> 00:31:18,810
extract from early Earth record can

712
00:31:27,980 --> 00:31:20,310
someone on our panel started off with

713
00:31:31,310 --> 00:31:27,990

that like I'll say are just a few things

714

00:31:32,660 --> 00:31:31,320

um I'm sure like like many of you I get

715

00:31:35,180 --> 00:31:32,670

excited every time there's a new

716

00:31:38,030 --> 00:31:35,190

discovery and they happen and they

717

00:31:39,650 --> 00:31:38,040

happen fast and I even with exponential

718

00:31:42,230 --> 00:31:39,660

growth phase in our understanding of

719

00:31:44,170 --> 00:31:42,240

these systems and so I find out very

720

00:31:47,420 --> 00:31:44,180

exciting i also think that it resonates

721

00:31:49,430 --> 00:31:47,430

really well with the public might my

722

00:31:51,650 --> 00:31:49,440

computer opens to the NPR web page like

723

00:31:53,600 --> 00:31:51,660

I'm sure manatee Avenger and I'm very

724

00:31:55,910 --> 00:31:53,610

often see the latest exoplanet

725

00:31:59,600 --> 00:31:55,920

announcements highlighted on the MTR web

726

00:32:01,160 --> 00:31:59,610

page and so I think that you know one of

727

00:32:02,570 --> 00:32:01,170

the fundamental frontiers is

728

00:32:04,880 --> 00:32:02,580

understanding obviously the zone of

729

00:32:07,490 --> 00:32:04,890

habitability and obviously we've gone

730

00:32:10,430 --> 00:32:07,500

far beyond just needing to to infer the

731

00:32:11,870 --> 00:32:10,440

distance from a planet sun but it's

732

00:32:13,430 --> 00:32:11,880

become so essential to try and

733

00:32:15,440 --> 00:32:13,440

understand the associated atmospheres

734

00:32:17,200 --> 00:32:15,450

and some of the most exciting work in

735

00:32:19,160 --> 00:32:17,210

earlier studies is not just

736

00:32:21,500 --> 00:32:19,170

understanding when oxygen was first

737

00:32:23,570 --> 00:32:21,510

produced in her first accumulators and

738

00:32:25,280 --> 00:32:23,580

and then inhale it grew further to

739

00:32:27,710 --> 00:32:25,290

support different kinds of rice but what

740

00:32:30,530 --> 00:32:27,720

the associated loss of other gases for

741

00:32:32,180 --> 00:32:30,540

example methane were in parallel without

742

00:32:35,030 --> 00:32:32,190

in this huge part nautic attacks that

743

00:32:37,550 --> 00:32:35,040

happened likely in association with with

744

00:32:40,340 --> 00:32:37,560

shifting fundamentally redox and and so

745

00:32:44,150 --> 00:32:40,350

as we understand these these greenhouse

746

00:32:45,770 --> 00:32:44,160

climates and and the feedback in essence

747

00:32:47,150 --> 00:32:45,780

what happens is we've developed an

748

00:32:48,830 --> 00:32:47,160

atmosphere that was less favorable of

749

00:32:50,340 --> 00:32:48,840

methane well happily our son was

750

00:32:52,860 --> 00:32:50,350

becoming brighter and so

751
00:32:55,110 --> 00:32:52,870
offsetting effect and sometimes those

752
00:32:56,909 --> 00:32:55,120
are really interesting scenarios that's

753
00:32:59,490 --> 00:32:56,919
a that need to be fully understand

754
00:33:02,310 --> 00:32:59,500
understood as we think about the broad

755
00:33:04,289 --> 00:33:02,320
range of habitability for for any planet

756
00:33:11,390 --> 00:33:04,299
including ours but any exoplanet in

757
00:33:23,430 --> 00:33:22,049
thank you Tim damn Dave well maybe it's

758
00:33:25,350 --> 00:33:23,440
the key things rolling one of the things

759
00:33:27,299 --> 00:33:25,360
that I've been thinking about recently

760
00:33:29,370 --> 00:33:27,309
it's just what we can do beyond looking

761
00:33:31,049 --> 00:33:29,380
for biogenic trace gases are kind of

762
00:33:32,669 --> 00:33:31,059
observing atmospheres if there are other

763
00:33:34,919 --> 00:33:32,679

thought experiments that we can run to

764

00:33:36,810 --> 00:33:34,929

try to better bring the sort of early

765

00:33:39,919 --> 00:33:36,820

Earth questions that we think about most

766

00:33:42,810 --> 00:33:39,929

often to this expanding catalogue of

767

00:33:44,100 --> 00:33:42,820

exoplanets that certainly place a lot of

768

00:33:45,330 --> 00:33:44,110

excitement right now so if we could

769

00:33:46,710 --> 00:33:45,340

build those bridges in ways with

770

00:33:50,760 --> 00:33:46,720

meaningful and thoughtful i think that

771

00:33:52,890 --> 00:33:50,770

there's a lot to making i would just say

772

00:33:55,409 --> 00:33:52,900

that the wonderful thing about the

773

00:33:57,390 --> 00:33:55,419

exoplanets is that it forces us to go

774

00:34:00,270 --> 00:33:57,400

back to basic principles regarding what

775

00:34:04,440 --> 00:34:00,280

is life and to think through sources for

776

00:34:06,960 --> 00:34:04,450

both energy generation and also what

777

00:34:10,500 --> 00:34:06,970

would be needed to build biomass in a

778

00:34:15,200 --> 00:34:10,510

way that isn't biased but sort of comes

779

00:34:19,379 --> 00:34:15,210

at it you know from a very open-minded

780

00:34:22,980 --> 00:34:19,389

perspective and i'm looking at the

781

00:34:25,020 --> 00:34:22,990

online chat in real time as we're having

782

00:34:26,639 --> 00:34:25,030

this discussion and I I notice that

783

00:34:29,070 --> 00:34:26,649

there are a lot of people chiming in

784

00:34:32,879 --> 00:34:29,080

regarding the importance of doing work

785

00:34:35,430 --> 00:34:32,889

with modern organisms to understand for

786

00:34:39,690 --> 00:34:35,440

example trace elements that are key

787

00:34:41,669 --> 00:34:39,700

micro nutrients and enzymes well they're

788

00:34:44,700 --> 00:34:41,679

micronutrients because they they go into

789

00:34:46,859 --> 00:34:44,710

enzymes as as metal cofactors for

790

00:34:49,649 --> 00:34:46,869

example and that when we're talking

791

00:34:51,740 --> 00:34:49,659

about exoplanets or life wherever it is

792

00:34:54,950 --> 00:34:51,750

be it on the early Earth or an exoplanet

793

00:34:58,710 --> 00:34:54,960

again it comes back to having a very

794

00:35:00,390 --> 00:34:58,720

precise and well-informed understanding

795

00:35:02,579 --> 00:35:00,400

of what life is about today and what

796

00:35:05,640 --> 00:35:02,589

types of things are possible

797

00:35:08,849 --> 00:35:05,650

and I guess I would invite anybody who

798

00:35:12,209 --> 00:35:08,859

is typing these comments to also get on

799

00:35:19,950 --> 00:35:12,219

the phone and expand upon what your your

800

00:35:21,749 --> 00:35:19,960

typing so everybody can hear and if I

801
00:35:24,150 --> 00:35:21,759
could just build on that these

802
00:35:27,539 --> 00:35:24,160
conversations these questions will be on

803
00:35:30,209 --> 00:35:27,549
the website the astrobiology future dog

804
00:35:33,690 --> 00:35:30,219
website and so we encourage everybody to

805
00:35:36,140 --> 00:35:33,700
as many people as we can to get involved

806
00:35:40,009 --> 00:35:36,150
in those conversations on the website

807
00:35:43,589 --> 00:35:40,019
now and after this event the trans trans

808
00:35:46,589 --> 00:35:43,599
transpose of this open chat will be on

809
00:35:58,350 --> 00:35:46,599
that site as soon as this conference is

810
00:36:03,210 --> 00:36:01,500
I see one comment I would like to call

811
00:36:06,360 --> 00:36:03,220
out that I think is interesting where

812
00:36:08,580 --> 00:36:06,370
there isn't as much emphasis at least as

813
00:36:11,370 --> 00:36:08,590

as far as I'm aware and that is

814

00:36:14,160 --> 00:36:11,380

experimental taphonomy so much of what

815

00:36:16,280 --> 00:36:14,170

we do is look at ancient biosignatures

816

00:36:18,750 --> 00:36:16,290

and we often make a jump from

817

00:36:20,010 --> 00:36:18,760

experiments we do in the modern two

818

00:36:22,770 --> 00:36:20,020

things that occurred billions of years

819

00:36:26,310 --> 00:36:22,780

ago without a lot of understanding how

820

00:36:31,920 --> 00:36:26,320

we get from now to then and so I'm

821

00:36:34,950 --> 00:36:31,930

curious what type of work would fall

822

00:36:36,720 --> 00:36:34,960

underneath that umbrella that is the

823

00:36:39,720 --> 00:36:36,730

umbrella of experimental taphonomy what

824

00:36:42,420 --> 00:36:39,730

are people thinking would be useful for

825

00:36:43,950 --> 00:36:42,430

NASA to support in order for us to gain

826

00:36:49,170 --> 00:36:43,960

a deeper understanding of ancient

827

00:36:51,090 --> 00:36:49,180

biomarkers okay we have a couple of

828

00:36:52,860 --> 00:36:51,100

hands up us or kids you want to respond

829

00:36:54,720 --> 00:36:52,870

to that first let me just very quickly

830

00:36:56,580 --> 00:36:54,730

or while people are thinking and typing

831

00:36:58,560 --> 00:36:56,590

I was going to follow up before it

832

00:37:00,630 --> 00:36:58,570

Scrolls too far up another soccer I've

833

00:37:02,400 --> 00:37:00,640

got the comment about plate tectonics is

834

00:37:03,930 --> 00:37:02,410

also really really essential and it's

835

00:37:05,040 --> 00:37:03,940

something we barely ever think about if

836

00:37:07,500 --> 00:37:05,050

you look at the earth as a habitable

837

00:37:09,480 --> 00:37:07,510

planet may be the single most essential

838

00:37:11,310 --> 00:37:09,490

partners plate tectonics in terms of

839

00:37:13,710 --> 00:37:11,320

gases that come out and buffer oxygen or

840

00:37:15,240 --> 00:37:13,720

don't and also the essential recycling

841

00:37:17,610 --> 00:37:15,250

of nutrients we wouldn't be who we are

842

00:37:20,250 --> 00:37:17,620

today if it won't plate tectonics and so

843

00:37:23,070 --> 00:37:20,260

any diet ideas of how to explore the

844

00:37:24,450 --> 00:37:23,080

possibility of that further obviously

845

00:37:26,100 --> 00:37:24,460

people are looking at within our solar

846

00:37:31,410 --> 00:37:26,110

system picking art would be incredibly

847

00:37:33,930 --> 00:37:31,420

intriguing i'll be there thank you can

848

00:37:37,760 --> 00:37:33,940

we ask mike tice to switch his mic on

849

00:37:40,920 --> 00:37:37,770

and and speak please his hand is raised

850

00:37:43,800 --> 00:37:40,930

okay well first of all just briefly i'll

851

00:37:47,190 --> 00:37:43,810

say ah men to what tim just said but

852

00:37:48,930 --> 00:37:47,200

then I just had a comment about using

853

00:37:52,050 --> 00:37:48,940

modern microorganisms to understand

854

00:37:54,180 --> 00:37:52,060

constraints and other things and I think

855

00:37:58,340 --> 00:37:54,190

this is wonderful and necessary the

856

00:38:02,090 --> 00:37:58,350

thing that that constantly scares me is

857

00:38:05,340 --> 00:38:02,100

how little we may know or not know about

858

00:38:08,280 --> 00:38:05,350

what modern micro organisms on Earth do

859

00:38:09,960 --> 00:38:08,290

as a matter of biological necessity and

860

00:38:12,670 --> 00:38:09,970

how much as a matter of

861

00:38:15,160 --> 00:38:12,680

historical contingency boats for

862

00:38:16,720 --> 00:38:15,170

unpacking the early geologic record of

863

00:38:20,609 --> 00:38:16,730

life and for understanding life on other

864

00:38:24,609 --> 00:38:20,619

planets potentially and yeah certainly

865

00:38:28,150 --> 00:38:24,619

you can imagine ways to work on that

866

00:38:32,020 --> 00:38:28,160

type of a problem but you know i'd like

867

00:38:34,210 --> 00:38:32,030

to maybe think a bit about how to how to

868

00:38:35,349 --> 00:38:34,220

go into the geologic record a nascar

869

00:38:38,530 --> 00:38:35,359

they're fundamentally different ways

870

00:38:40,750 --> 00:38:38,540

that organism big things than what we

871

00:38:46,569 --> 00:38:40,760

see in modern the modern successful

872

00:38:52,290 --> 00:38:46,579

preserve descendants how do we approach

873

00:38:55,109 --> 00:38:52,300

that Mike what I'm raising that as a

874

00:38:57,160 --> 00:38:55,119

something I think is important questions

875

00:39:00,069 --> 00:38:57,170

I'm not saying that there's necessarily

876

00:39:02,589 --> 00:39:00,079

an easy solutions that maybe Robbie

877

00:39:05,650 --> 00:39:02,599

funneling dollars into at the moment but

878

00:39:07,240 --> 00:39:05,660

certainly you know we need to be very

879

00:39:09,910 --> 00:39:07,250

careful when we approach the geologic

880

00:39:12,849 --> 00:39:09,920

record that we understand what is a

881

00:39:15,520 --> 00:39:12,859

signal of the desert black box process

882

00:39:17,230 --> 00:39:15,530

that we're interested in and what is

883

00:39:19,329 --> 00:39:17,240

telling us about how the organism

884

00:39:23,260 --> 00:39:19,339

actually accomplished it yeah that makes

885

00:39:28,390 --> 00:39:23,270

sense but does that get what you're

886

00:39:30,520 --> 00:39:28,400

asking Dan I've sorta I realize it's a

887

00:39:33,370 --> 00:39:30,530

very hard question and I think your

888

00:39:35,440 --> 00:39:33,380

points very good but I guess where I'm

889

00:39:39,640 --> 00:39:35,450

trying to push you is a little bit more

890

00:39:41,710 --> 00:39:39,650

specific in how one can deal with that

891

00:39:44,650 --> 00:39:41,720

problem if you have any specific

892

00:39:46,660 --> 00:39:44,660

thoughts if not we can you know think

893

00:39:50,470 --> 00:39:46,670

you think harder about it and give input

894

00:39:53,770 --> 00:39:50,480

at a later time does it means to me just

895

00:39:55,780 --> 00:39:53,780

some analogies here um yeah sure with

896

00:39:57,220 --> 00:39:55,790

McIlroy dances is fairly easy we can

897

00:39:59,140 --> 00:39:57,230

look into the record and key things that

898

00:40:02,950 --> 00:39:59,150

didn't have for instance five digits

899

00:40:06,430 --> 00:40:02,960

hands Wow with my quarry insensitive a

900

00:40:08,680 --> 00:40:06,440

bit more complex and then there we can

901
00:40:10,390 --> 00:40:08,690
you know with with posters we're

902
00:40:13,569 --> 00:40:10,400
starting to do this where we go and look

903
00:40:15,010 --> 00:40:13,579
for central place where words where we

904
00:40:18,030 --> 00:40:15,020
using say different collect ronic

905
00:40:23,650 --> 00:40:18,040
scepters actually the electron donors

906
00:40:26,109 --> 00:40:23,660
purposes um no I

907
00:40:28,539 --> 00:40:26,119
I think probably mostly about the

908
00:40:29,890 --> 00:40:28,549
geologic record and so I come to see a

909
00:40:32,440 --> 00:40:29,900
lot of the challenges there i'm

910
00:40:35,260 --> 00:40:32,450
wondering if maybe some cokes you who

911
00:40:44,010 --> 00:40:35,270
think in the lab and think molecular Lee

912
00:40:46,569 --> 00:40:44,020
went also have some insight at all can I

913
00:40:49,539 --> 00:40:46,579

thank you Mike and I got Rick Jake into

914

00:40:50,980 --> 00:40:49,549

the conversation he has his arm raised

915

00:40:57,220 --> 00:40:50,990

might you put your arm down now if you

916

00:41:00,099 --> 00:40:57,230

want thank you hello I just want to make

917

00:41:03,789 --> 00:41:00,109

the point that that before we can sort

918

00:41:05,349 --> 00:41:03,799

of apply biasing materials to ancient

919

00:41:07,839 --> 00:41:05,359

system of either on earth or on other

920

00:41:10,329 --> 00:41:07,849

planets we need to kind of subject those

921

00:41:12,370 --> 00:41:10,339

those potential but earns modern

922

00:41:14,200 --> 00:41:12,380

biosignatures to the kind of pressure

923

00:41:16,900 --> 00:41:14,210

and temperature conditions that they

924

00:41:19,120 --> 00:41:16,910

would experience after burial and so

925

00:41:21,339 --> 00:41:19,130

this might involve some use of either

926
00:41:24,099 --> 00:41:21,349
high temperature or pressure experiments

927
00:41:25,720 --> 00:41:24,109
to try to subject you know our modern

928
00:41:27,370 --> 00:41:25,730
signatures to the kind of conditions

929
00:41:29,680 --> 00:41:27,380
that they that they were experienced

930
00:41:32,349 --> 00:41:29,690
before ultimately being preserved and

931
00:41:45,269 --> 00:41:32,359
either rocks on earth or Mars or other

932
00:41:52,390 --> 00:41:45,279
planet to potentially Thank You Jake

933
00:41:58,720 --> 00:41:52,400
bola you have your arm raised hello okay

934
00:42:01,120 --> 00:41:58,730
hear me okay so um expand on Jake's

935
00:42:04,299 --> 00:42:01,130
comment as a modern microbiologist I

936
00:42:05,680 --> 00:42:04,309
study a lot of microorganisms in the lab

937
00:42:07,510 --> 00:42:05,690
that have been cultured from the lab for

938
00:42:09,279 --> 00:42:07,520

many years and we look at the biomarkers

939

00:42:11,410 --> 00:42:09,289

and what their function might be and a

940

00:42:13,359 --> 00:42:11,420

question that I often get a lot of times

941

00:42:14,769 --> 00:42:13,369

from students is is how do we correlate

942

00:42:18,039 --> 00:42:14,779

that to the past and I think this gets

943

00:42:20,049 --> 00:42:18,049

to what Diane was saying and my thinking

944

00:42:22,720 --> 00:42:20,059

has always been that if we can if we

945

00:42:26,289 --> 00:42:22,730

first determine what these molecules are

946

00:42:28,630 --> 00:42:26,299

doing in an organism and in the lab we

947

00:42:31,660 --> 00:42:28,640

can expand out into environment that we

948

00:42:33,260 --> 00:42:31,670

consider analogs for sister and as an

949

00:42:35,210 --> 00:42:33,270

example and then ask

950

00:42:38,180 --> 00:42:35,220

annually culture organisms that an

951
00:42:40,370 --> 00:42:38,190
environment are these molecules being

952
00:42:42,530 --> 00:42:40,380
used in the same way and that brings us

953
00:42:44,630 --> 00:42:42,540
a connection from the lab into the

954
00:42:47,170 --> 00:42:44,640
environment and then we can even use

955
00:42:49,670 --> 00:42:47,180
more modern molecular techniques such as

956
00:42:51,410 --> 00:42:49,680
transcriptomic to see how their

957
00:42:53,150 --> 00:42:51,420
expression is an actual environment

958
00:42:55,880 --> 00:42:53,160
where we see the pressures of say if

959
00:42:59,060 --> 00:42:55,890
there's pressure from pH changes or

960
00:43:00,860 --> 00:42:59,070
different environmental facts so that's

961
00:43:03,680 --> 00:43:00,870
kind of my comment as kind of a way to

962
00:43:10,670 --> 00:43:03,690
get from the labs who eventually the

963
00:43:18,820 --> 00:43:10,680

rock record and I think that's it thank

964

00:43:24,800 --> 00:43:22,160

throughout a lot of this discussion it

965

00:43:26,270 --> 00:43:24,810

seems like we we kind of are coming down

966

00:43:29,180 --> 00:43:26,280

on two different sorts of proxies

967

00:43:30,650 --> 00:43:29,190

there's those that are struggling major

968

00:43:32,840 --> 00:43:30,660

element Michaels that you actually try

969

00:43:35,420 --> 00:43:32,850

to look at abundance and or metrics for

970

00:43:36,770 --> 00:43:35,430

abundance I'm say using isotopes to back

971

00:43:39,950 --> 00:43:36,780

out the size of a particular reservoir

972

00:43:42,260 --> 00:43:39,960

and then there are some that are more so

973

00:43:44,000 --> 00:43:42,270

we're interested in biogenesis intifada

974

00:43:45,830 --> 00:43:44,010

me because just the simple presence of a

975

00:43:48,080 --> 00:43:45,840

certain Connor molecule is hugely

976
00:43:51,050 --> 00:43:48,090
informative and both of us and wanted to

977
00:43:54,590 --> 00:43:51,060
share that is this aspect of biogenesis

978
00:43:56,990 --> 00:43:54,600
that the open chat we've had a script

979
00:43:58,580 --> 00:43:57,000
going on but curious if there are folks

980
00:44:00,050 --> 00:43:58,590
in particular I know Frank Crosetti is

981
00:44:03,320 --> 00:44:00,060
contributing a lot to this this

982
00:44:05,660 --> 00:44:03,330
discussion wanna chime in is to turn

983
00:44:07,190 --> 00:44:05,670
their aspects of to fajn autonomy or

984
00:44:08,750 --> 00:44:07,200
preservation that we're missing are

985
00:44:10,280 --> 00:44:08,760
there they're simple things that we can

986
00:44:13,040 --> 00:44:10,290
do I'm obviously pressure and

987
00:44:16,340 --> 00:44:13,050
temperature the things the most obvious

988
00:44:25,040 --> 00:44:16,350

targets for knowledge to turn but is

989

00:44:28,070 --> 00:44:25,050

anything else maybe well he strike is is

990

00:44:30,440 --> 00:44:28,080

thinking let me follow up on that so I

991

00:44:32,000 --> 00:44:30,450

Harry Elderfield famously talked about

992

00:44:34,100 --> 00:44:32,010

the lifespan of a proxy and he talked

993

00:44:36,260 --> 00:44:34,110

about early on the honeymoon periods

994

00:44:37,610 --> 00:44:36,270

when everyone was very excited and you

995

00:44:39,770 --> 00:44:37,620

could do almost anything you want it

996

00:44:41,190 --> 00:44:39,780

with it and then it hit what I call the

997

00:44:42,660 --> 00:44:41,200

pit of despair where everyone

998

00:44:44,970 --> 00:44:42,670

but it's not going to be quite as simple

999

00:44:46,590 --> 00:44:44,980

as we initially imagined and then

1000

00:44:48,060 --> 00:44:46,600

eventually you climb out of that for an

1001
00:44:49,860 --> 00:44:48,070
individual proxy in front where the

1002
00:44:51,420 --> 00:44:49,870
utility lies and there's always some but

1003
00:44:53,880 --> 00:44:51,430
it's never what you imagined initially

1004
00:44:55,860 --> 00:44:53,890
and I think that's happening I referred

1005
00:44:57,240 --> 00:44:55,870
earlier to their to the Renaissance that

1006
00:45:00,420 --> 00:44:57,250
I think began in there in the late

1007
00:45:02,520 --> 00:45:00,430
nineteen 1990s with precambrian studies

1008
00:45:05,610 --> 00:45:02,530
and part of that was motivated by very

1009
00:45:06,930 --> 00:45:05,620
important 1999 biomarker paper and a

1010
00:45:09,360 --> 00:45:06,940
number of other things that came out

1011
00:45:12,000 --> 00:45:09,370
following that and so I think we're

1012
00:45:13,740 --> 00:45:12,010
facing that a bit right now where we had

1013
00:45:15,210 --> 00:45:13,750

new tools that were development and

1014

00:45:17,280 --> 00:45:15,220

validated and developed in modern

1015

00:45:18,780 --> 00:45:17,290

systems and experimental systems and

1016

00:45:20,430 --> 00:45:18,790

everyone got very excited we were able

1017

00:45:23,250 --> 00:45:20,440

to say a lot of things and I think we're

1018

00:45:25,290 --> 00:45:23,260

now going through some reality checks

1019

00:45:26,670 --> 00:45:25,300

about certainly with organic biomarkers

1020

00:45:28,770 --> 00:45:26,680

going through checks about what these

1021

00:45:30,240 --> 00:45:28,780

things really are telling us and and how

1022

00:45:32,460 --> 00:45:30,250

they can be sustained and preserved

1023

00:45:33,810 --> 00:45:32,470

under a variety of conditions and so I

1024

00:45:35,190 --> 00:45:33,820

think we're a little bit in the pit of

1025

00:45:37,500 --> 00:45:35,200

despair for a number of these things

1026

00:45:39,960 --> 00:45:37,510

it's probably unfairly deep and so it's

1027

00:45:42,000 --> 00:45:39,970

an exciting time to to come out with a

1028

00:45:43,740 --> 00:45:42,010

lot of these things too but to get out

1029

00:45:45,480 --> 00:45:43,750

of that pit but I think importantly it's

1030

00:45:48,000 --> 00:45:45,490

really essential as many people are

1031

00:45:50,040 --> 00:45:48,010

typing along that's and saying that we

1032

00:45:51,990 --> 00:45:50,050

need to really think about that we need

1033

00:45:53,670 --> 00:45:52,000

to revisit all of this with a much more

1034

00:45:55,560 --> 00:45:53,680

sophisticated view of the effects of

1035

00:45:57,000 --> 00:45:55,570

burial history and certainly we always

1036

00:45:58,830 --> 00:45:57,010

did that they're probably not well

1037

00:46:08,790 --> 00:45:58,840

enough so it's there's lots of

1038

00:46:10,230 --> 00:46:08,800

opportunity for thank you Tim I'm just

1039

00:46:13,440 --> 00:46:10,240

wondering for those of you who think

1040

00:46:15,930 --> 00:46:13,450

about experimental diagenesis or

1041

00:46:17,760 --> 00:46:15,940

taphonomy and I see there's some

1042

00:46:23,160 --> 00:46:17,770

discussion now getting more precise

1043

00:46:25,550 --> 00:46:23,170

about a problem with time scales and

1044

00:46:28,100 --> 00:46:25,560

just scaling in general if there are

1045

00:46:31,050 --> 00:46:28,110

disciplines that are not typically

1046

00:46:34,830 --> 00:46:31,060

included within the NASA umbrella that

1047

00:46:38,790 --> 00:46:34,840

could be recruited to help us tackle

1048

00:46:41,400 --> 00:46:38,800

these type of scaling issues that would

1049

00:46:44,250 --> 00:46:41,410

bring thoughts from another disciplinary

1050

00:46:46,140 --> 00:46:44,260

community that would would be helpful if

1051
00:46:50,850 --> 00:46:46,150
any of you work with these people are

1052
00:46:53,140 --> 00:46:50,860
even aware of the fact that these type

1053
00:47:01,359 --> 00:46:53,150
of individuals who may

1054
00:47:06,809 --> 00:47:01,369
may exist thank you damn well people are

1055
00:47:12,789 --> 00:47:09,819
yeah Diane speaking about you know who

1056
00:47:15,670 --> 00:47:12,799
else could we draw in food I've been

1057
00:47:19,630 --> 00:47:15,680
making overtures to the dental school at

1058
00:47:22,210 --> 00:47:19,640
USC because think about a lot of what

1059
00:47:24,339 --> 00:47:22,220
they do they work on both films that you

1060
00:47:25,839 --> 00:47:24,349
know calcify on your teeth and how to

1061
00:47:27,970 --> 00:47:25,849
get rid of those and how that process

1062
00:47:30,099 --> 00:47:27,980
works and they think about a lot of

1063
00:47:31,839 --> 00:47:30,109

things that are very different from what

1064

00:47:33,670 --> 00:47:31,849

we think about but ultimately we're kind

1065

00:47:35,980 --> 00:47:33,680

of looking at a similar thing you know

1066

00:47:39,010 --> 00:47:35,990

we end up with this crusty thing that we

1067

00:47:42,160 --> 00:47:39,020

wonder you know how do microbes interact

1068

00:47:43,900 --> 00:47:42,170

with that so that's another area I think

1069

00:47:46,390 --> 00:47:43,910

you know that we could potentially

1070

00:47:48,130 --> 00:47:46,400

explore just talk to these other people

1071

00:47:49,930 --> 00:47:48,140

that have a vastly different interest

1072

00:47:55,329 --> 00:47:49,940

and maybe something they've discovered

1073

00:48:03,490 --> 00:47:55,339

can help us and vice versa you know so

1074

00:48:06,640 --> 00:48:03,500

anyway there you go thank you have about

1075

00:48:09,279 --> 00:48:06,650

eight minutes remaining we this

1076

00:48:11,970 --> 00:48:09,289

conversation will as I say will be

1077

00:48:14,410 --> 00:48:11,980

transcribed and put onto the website

1078

00:48:17,500 --> 00:48:14,420

straight after this event so we would

1079

00:48:20,380 --> 00:48:17,510

like the conversation to continue please

1080

00:48:24,519 --> 00:48:20,390

on the website but in our last eight

1081

00:48:27,220 --> 00:48:24,529

minutes any other questions that NASA

1082

00:48:29,079 --> 00:48:27,230

should be considering as important

1083

00:48:52,710 --> 00:48:29,089

questions to support the astrobiology

1084

00:48:57,780 --> 00:48:54,940

there was some early discussion in the

1085

00:48:59,830 --> 00:48:57,790

online open chat about different

1086

00:49:01,330 --> 00:48:59,840

environmental targets different extreme

1087

00:49:04,750 --> 00:49:01,340

environments or potential analog

1088

00:49:07,510 --> 00:49:04,760

habitats no beyond the ones that we

1089

00:49:08,920 --> 00:49:07,520

naturally flock to most quickly which

1090

00:49:10,210 --> 00:49:08,930

are kind of hydrothermal systems and

1091

00:49:12,790 --> 00:49:10,220

stuff like that are there other places

1092

00:49:15,370 --> 00:49:12,800

that we should be looking today you know

1093

00:49:17,980 --> 00:49:15,380

employing a lot of modern molecular and

1094

00:49:32,270 --> 00:49:17,990

microbial techniques and things that we

1095

00:49:44,820 --> 00:49:40,890

go ahead run I I just like to chime in

1096

00:49:46,860 --> 00:49:44,830

on that even though i work on saline

1097

00:49:49,820 --> 00:49:46,870

alkaline Lakes those are pretty good

1098

00:49:53,150 --> 00:49:49,830

analogies for what we might encounter

1099

00:49:57,290 --> 00:49:53,160

under the regolith of Mars or in the

1100

00:50:01,770 --> 00:49:57,300

moons of the outer planets hyper saline

1101

00:50:03,780 --> 00:50:01,780

Brian's uh in a beneath the ice for

1102

00:50:06,510 --> 00:50:03,790

example due to cry out concentration I

1103

00:50:08,520 --> 00:50:06,520

think though it's these various alien

1104

00:50:11,100 --> 00:50:08,530

environments are worth looking at in

1105

00:50:28,230 --> 00:50:11,110

addition to the spreading centers okay

1106

00:50:30,270 --> 00:50:28,240

bye thank you other questions raise your

1107

00:50:37,530 --> 00:50:30,280

hand we can drag you into the

1108

00:50:40,140 --> 00:50:37,540

conversation um I have a question I'd

1109

00:50:42,470 --> 00:50:40,150

like to throw out there how do people

1110

00:50:47,640 --> 00:50:42,480

feel about NASA investing more in

1111

00:50:51,960 --> 00:50:47,650

development of violent 4matic platforms

1112

00:50:55,800 --> 00:50:51,970

that the community could use to you know

1113

00:50:58,980 --> 00:50:55,810

really be able to effectively parse the

1114

00:51:01,320 --> 00:50:58,990

wealth of sequence data that is now

1115

00:51:03,690 --> 00:51:01,330

becoming ever more readily available to

1116

00:51:06,600 --> 00:51:03,700

us you know within the next five years

1117

00:51:09,210 --> 00:51:06,610

the sequencing of single cells is likely

1118

00:51:12,000 --> 00:51:09,220

to become very easy and what I'm

1119

00:51:13,890 --> 00:51:12,010

wondering is if this is something that

1120

00:51:16,200 --> 00:51:13,900

the community feels they're going to be

1121

00:51:18,830 --> 00:51:16,210

using in their research and if so are

1122

00:51:22,050 --> 00:51:18,840

they well equipped to do it and if not

1123

00:51:34,350 --> 00:51:22,060

what would be needed in order to make

1124

00:51:40,800 --> 00:51:37,180

Chad would you like to join in quickly

1125

00:51:44,440 --> 00:51:40,810

the last few minutes yes can you hear me

1126
00:51:46,570 --> 00:51:44,450
hello yes all right i said yeah i was

1127
00:51:48,190 --> 00:51:46,580
going to answer two ants question you

1128
00:51:50,890 --> 00:51:48,200
know the biologist you know we're

1129
00:51:53,410 --> 00:51:50,900
challenged with the ease of getting

1130
00:51:54,970 --> 00:51:53,420
sequence data now it's relatively easy

1131
00:51:57,370 --> 00:51:54,980
in the costs are coming down but it's

1132
00:51:59,770 --> 00:51:57,380
our problem is dealing with how do you

1133
00:52:01,570 --> 00:51:59,780
actually manage and analyze all the

1134
00:52:03,670 --> 00:52:01,580
sequence data I mean we can't do that on

1135
00:52:07,090 --> 00:52:03,680
our laptops and an external hard drive

1136
00:52:09,370 --> 00:52:07,100
so I think you know there's lots of talk

1137
00:52:12,160 --> 00:52:09,380
about using like amazon cloud computing

1138
00:52:14,320 --> 00:52:12,170

and calling up like massive parallel

1139

00:52:17,530 --> 00:52:14,330

computers and just for like hourly

1140

00:52:20,860 --> 00:52:17,540

purposes but you know obviously we need

1141

00:52:22,390 --> 00:52:20,870

to have collaborations with bayern

1142

00:52:24,850 --> 00:52:22,400

format assists who really know what

1143

00:52:28,780 --> 00:52:24,860

they're doing so I think you know having

1144

00:52:31,450 --> 00:52:28,790

investment in computational biology and

1145

00:52:32,710 --> 00:52:31,460

and funding those projects that do have

1146

00:52:35,260 --> 00:52:32,720

collaborations I think would be really

1147

00:52:37,960 --> 00:52:35,270

valuable I don't know about investing in

1148

00:52:39,700 --> 00:52:37,970

NASA supercomputers but you know that

1149

00:52:43,690 --> 00:52:39,710

that might be possibility as well as

1150

00:52:45,730 --> 00:52:43,700

it's just eating biologists who have the

1151

00:52:48,940 --> 00:52:45,740

desire to do these massive you know

1152

00:52:51,370 --> 00:52:48,950

sequencing projects but you need the

1153

00:52:59,470 --> 00:52:51,380

computational power to get it done the

1154

00:53:02,670 --> 00:52:59,480

analyses part Thanks I see that there's

1155

00:53:05,770 --> 00:53:02,680

some interesting comments coming on now

1156

00:53:07,540 --> 00:53:05,780

about going beyond sequencing Jake

1157

00:53:09,430 --> 00:53:07,550

Bailey and Paula we lender and our

1158

00:53:12,250 --> 00:53:09,440

Buddha boys have just chimed in on the

1159

00:53:16,120 --> 00:53:12,260

importance of funding to culture bugs

1160

00:53:22,460 --> 00:53:16,130

and do genetics in in them maybe could

1161

00:53:22,470 --> 00:53:29,630

you

1162

00:53:35,250 --> 00:53:32,100

bearing in mind we have two more minutes

1163

00:53:39,780 --> 00:53:35,260

left Paul has his head Paula have you

1164

00:53:44,040 --> 00:53:39,790

signed up ok I'm here sorry very quickly

1165

00:53:46,170 --> 00:53:44,050

just to you know rear date with Jake

1166

00:53:48,180 --> 00:53:46,180

just said on the chat is that all this

1167

00:53:50,130 --> 00:53:48,190

information mathematics data that we get

1168

00:53:51,660 --> 00:53:50,140

is huge and we have a lot of it and I

1169

00:53:53,520 --> 00:53:51,670

agree that we need some way to really

1170

00:53:55,110 --> 00:53:53,530

process it all together because right

1171

00:53:56,520 --> 00:53:55,120

now I find myself using hodgepodge of

1172

00:53:57,660 --> 00:53:56,530

program from here and a program from

1173

00:54:00,240 --> 00:53:57,670

there and figuring out how to do it

1174

00:54:01,680 --> 00:54:00,250

myself there was more of a central way

1175

00:54:03,120 --> 00:54:01,690

of doing that be great but we also need

1176

00:54:05,130 --> 00:54:03,130

to expand that and beyond that we get

1177

00:54:06,900 --> 00:54:05,140

all this data what do we do with it and

1178

00:54:08,820 --> 00:54:06,910

I think it brings us back to classic

1179

00:54:10,110 --> 00:54:08,830

genetics classic microbiology we need to

1180

00:54:11,910 --> 00:54:10,120

go back and understand what these

1181

00:54:14,400 --> 00:54:11,920

unknown seas are doing and that requires

1182

00:54:15,960 --> 00:54:14,410

funding more microbial geneticist and

1183

00:54:20,700 --> 00:54:15,970

molecular biologists to really get at

1184

00:54:22,650 --> 00:54:20,710

that question thank you can I just throw

1185

00:54:23,880 --> 00:54:22,660

it one other thing is people are sitting

1186

00:54:25,770 --> 00:54:23,890

and thinking and continuing this

1187

00:54:26,790 --> 00:54:25,780

discussion which I hope they will one

1188

00:54:28,380 --> 00:54:26,800

thing that we haven't really talked

1189

00:54:30,180 --> 00:54:28,390

about at all for those of us who work in

1190

00:54:32,160 --> 00:54:30,190

the earlier the ultimate limitation most

1191

00:54:34,230 --> 00:54:32,170

of the things that we do is

1192

00:54:36,540 --> 00:54:34,240

accessibility to good material that's

1193

00:54:37,620 --> 00:54:36,550

well dated and so one thing that we all

1194

00:54:39,930 --> 00:54:37,630

might think about or what our

1195

00:54:43,110 --> 00:54:39,940

limitations are in terms of those things

1196

00:54:45,690 --> 00:54:43,120

including the access to good cleanly

1197

00:54:47,190 --> 00:54:45,700

drilled material and there certainly is

1198

00:54:48,690 --> 00:54:47,200

a lot of activity happening but much

1199

00:54:51,600 --> 00:54:48,700

more could happen in that regard and

1200

00:54:53,280 --> 00:54:51,610

also working in new innovative ways to

1201

00:54:54,930 --> 00:54:53,290

think with the geochronology community

1202

00:54:56,250 --> 00:54:54,940

to try and better better date those

1203

00:54:58,470 --> 00:54:56,260

things especially as we get deeper and

1204

00:55:00,900 --> 00:54:58,480

deeper into time so that's another topic

1205

00:55:02,610 --> 00:55:00,910

I think and think generally about what

1206

00:55:07,740 --> 00:55:02,620

we don't have now that we would would

1207

00:55:10,770 --> 00:55:07,750

like to have more of Tim thank you very

1208

00:55:13,980 --> 00:55:10,780

much indeed we by my calculation we are

1209

00:55:16,740 --> 00:55:13,990

now to the end of the this conference we

1210

00:55:19,140 --> 00:55:16,750

want this conversation to continue so

1211

00:55:22,140 --> 00:55:19,150

again we encourage everybody to go to

1212

00:55:23,220 --> 00:55:22,150

the website as soon as this event is

1213

00:55:26,700 --> 00:55:23,230

over and look at some of the other

1214

00:55:30,470 --> 00:55:26,710

themes a transcription of this chat will

1215

00:55:32,640 --> 00:55:30,480

be up on library shortly and we will

1216

00:55:34,920 --> 00:55:32,650

we'll be seeing you soon am I seeing

1217

00:55:39,840 --> 00:55:34,930

missing Mary there's Mary wanting to say

1218

00:55:42,560 --> 00:55:39,850

something good all right in that rich

1219

00:55:48,300 --> 00:55:46,260

say that once again Mary please I had to

1220

00:55:50,840 --> 00:55:48,310

step out and I was off camera so I just

1221

00:55:58,730 --> 00:55:50,850

decided to step in they hide everyone

1222

00:56:03,420 --> 00:56:01,560

thank you very much everybody we'll see

1223

00:56:04,830 --> 00:56:03,430

you again in the next conference in a