
AbSciCon
2017
MESA, ARIZONA

1
00:00:12,250 --> 00:00:06,150
you

2
00:00:18,340 --> 00:00:14,160
[Music]

3
00:00:21,100 --> 00:00:18,350
hello everyone can you hear me alright

4
00:00:22,359 --> 00:00:21,110
perfect so my name is mama monster I'm a

5
00:00:23,769 --> 00:00:22,369
graduate student from Penn State

6
00:00:25,690 --> 00:00:23,779
University and I'm going to talk about

7
00:00:29,310 --> 00:00:25,700
malignant and nitrogen column addition

8
00:00:32,530 --> 00:00:29,320
to ecosystems in the Pacific Ocean and

9
00:00:35,200 --> 00:00:32,540
so as astrobiologists we are interested

10
00:00:36,790 --> 00:00:35,210
in finding life in the universe one of

11
00:00:38,680 --> 00:00:36,800
the places that we have added identify

12
00:00:41,290 --> 00:00:38,690
to be too hard where life might be

13
00:00:43,509 --> 00:00:41,300

earth-like planets but women think of

14
00:00:45,850 --> 00:00:43,519
like planets what type of life forms do

15
00:00:48,970 --> 00:00:45,860
we expect to find there we expect to

16
00:00:51,580 --> 00:00:48,980
find simple life that that can perhaps

17
00:00:54,340 --> 00:00:51,590
evolved complex lives and to intelligent

18
00:00:55,510 --> 00:00:54,350
life is this evolutionary transition

19
00:00:57,400 --> 00:00:55,520
inevitable

20
00:00:58,630 --> 00:00:57,410
while some suggest that there are

21
00:01:01,630 --> 00:00:58,640
barriers that would prevent this

22
00:01:03,160 --> 00:01:01,640
evolution and in order to start

23
00:01:05,400 --> 00:01:03,170
answering this question we can look at

24
00:01:08,590 --> 00:01:05,410
to its surface trees as a case study

25
00:01:10,359 --> 00:01:08,600
deals over a period of 4.5 billion years

26
00:01:13,779 --> 00:01:10,369
have changed has undergone dramatic

27
00:01:16,420 --> 00:01:13,789
changes from an possibly ion which ocean

28
00:01:18,880 --> 00:01:16,430
in our Qian to a sulfinic ocean in the

29
00:01:21,719 --> 00:01:18,890
protozoic and to an oxygen which of and

30
00:01:23,950 --> 00:01:21,729
in the world that we live in today and

31
00:01:26,380 --> 00:01:23,960
it was thought that the earliest

32
00:01:29,469 --> 00:01:26,390
microbes were speedily on around four

33
00:01:32,440 --> 00:01:29,479
billion years ago this followed a period

34
00:01:34,330 --> 00:01:32,450
of where where major UK TWC

35
00:01:35,980 --> 00:01:34,340
diversification happens around 500

36
00:01:37,719 --> 00:01:35,990
million years ago and there seems to be

37
00:01:40,960 --> 00:01:37,729
a long period about four billion years

38
00:01:44,620 --> 00:01:40,970

where simple life where it took from

39
00:01:46,300 --> 00:01:44,630
simple life to complex life and I'm

40
00:01:48,730 --> 00:01:46,310
finally intelligent life I was pretty

41
00:01:51,270 --> 00:01:48,740
pretty rapidly after the major UK a feat

42
00:01:53,499 --> 00:01:51,280
of diversification and so my project

43
00:01:55,630 --> 00:01:53,509
involves looking at this long period of

44
00:01:57,999 --> 00:01:55,640
seemingly evolution interfaces from

45
00:01:59,830 --> 00:01:58,009
microbes to eukaryotes transition while

46
00:02:02,319 --> 00:01:59,840
the barriers that depth even this

47
00:02:05,940 --> 00:02:02,329
transition attendez transition happening

48
00:02:09,310 --> 00:02:05,950
early on earlier on in Earth history and

49
00:02:12,100 --> 00:02:09,320
so one idea was proposed by as far as I

50
00:02:14,020 --> 00:02:12,110
know by in 2002 by Avalon by Andrew nor

51
00:02:15,850 --> 00:02:14,030
is that there were molybdenum and

52
00:02:18,640 --> 00:02:15,860
nitrogen coal imitation to porters a

53
00:02:20,559 --> 00:02:18,650
proto ZOA ecosystem and so in order to

54
00:02:22,900 --> 00:02:20,569
understand it I policies we must first

55
00:02:25,960 --> 00:02:22,910
understand the molybdenum cycling in the

56
00:02:26,350 --> 00:02:25,970
modern modern ocean today molybdenum is

57
00:02:28,510 --> 00:02:26,360
supply

58
00:02:30,460 --> 00:02:28,520
primarily to oxidative we're doing a

59
00:02:33,210 --> 00:02:30,470
continence to the modern ocean with

60
00:02:35,530 --> 00:02:33,220
concentrations of about 100 nano molar

61
00:02:37,510 --> 00:02:35,540
molybdenum is also removed from the

62
00:02:40,510 --> 00:02:37,520
ocean will have its primary sinks being

63
00:02:42,610 --> 00:02:40,520

fulfilling regions and because the earth

64
00:02:45,100 --> 00:02:42,620
has undergone dramatic geochemical

65
00:02:46,570 --> 00:02:45,110
changes to our history and because our

66
00:02:48,850 --> 00:02:46,580
multi-layered supplies to oxidative

67
00:02:50,110 --> 00:02:48,860
we're doing let's start that emotional

68
00:02:51,910 --> 00:02:50,120
considerations when the ocean will

69
00:02:54,280 --> 00:02:51,920
change as a function of oxygen

70
00:02:56,949 --> 00:02:54,290
concentration so here we can see the

71
00:02:58,750 --> 00:02:56,959
oxygen evolution where it increased

72
00:03:00,490 --> 00:02:58,760
after the great oxidation event and then

73
00:03:02,980 --> 00:03:00,500
followed up there by a second oxidation

74
00:03:05,290 --> 00:03:02,990
event multi known concentrations are

75
00:03:06,430 --> 00:03:05,300
also part to change over time being

76
00:03:08,080 --> 00:03:06,440
pretty low in the alkyne

77
00:03:10,479 --> 00:03:08,090
and an increasing slightly in the

78
00:03:12,780 --> 00:03:10,489
Pacific and finally increasing by a lot

79
00:03:15,010 --> 00:03:12,790
during the kind of a fan of every

80
00:03:18,060 --> 00:03:15,020
molybdenum as it turns out it's a pretty

81
00:03:20,590 --> 00:03:18,070
important cofactor in nitrogen fixation

82
00:03:23,680 --> 00:03:20,600
fixing enzymes such as nitrogenous and

83
00:03:26,080 --> 00:03:23,690
here we can superimpose an experimental

84
00:03:28,449 --> 00:03:26,090
nitrogen fixation limit to laboratory

85
00:03:30,550 --> 00:03:28,459
cultures and here this is so below this

86
00:03:33,340 --> 00:03:30,560
period Molina is limiting to nitrogen

87
00:03:35,229 --> 00:03:33,350
fixation and thus there potentially like

88
00:03:37,840 --> 00:03:35,239

nutrients to support the transition to a

89
00:03:40,690 --> 00:03:37,850
eukaryotic world and so the question

90
00:03:42,310 --> 00:03:40,700
here is so to judge biogeochemical

91
00:03:45,130 --> 00:03:42,320
modeling people have suggested that

92
00:03:47,800 --> 00:03:45,140
marginal constituents are about one nano

93
00:03:49,660 --> 00:03:47,810
molar in the alkene and then it

94
00:03:52,030 --> 00:03:49,670
increased about 10 nano molar in the

95
00:03:53,860 --> 00:03:52,040
Proterozoic but especially in the

96
00:03:55,090 --> 00:03:53,870
purchase order answered there are huge

97
00:03:56,979 --> 00:03:55,100
answers these with marginal

98
00:03:59,020 --> 00:03:56,989
concentrations because we don't know

99
00:04:01,420 --> 00:03:59,030
what the whether the ocean was really

100
00:04:03,250 --> 00:04:01,430
sulfide rich and how much of the ocean

101
00:04:07,720 --> 00:04:03,260
was subjected to software the conditions

102
00:04:09,820 --> 00:04:07,730
and so this is and so one proxied has

103
00:04:11,470 --> 00:04:09,830
been suggested to be useful in order to

104
00:04:13,750 --> 00:04:11,480
reconstruct seawater molybdenum

105
00:04:16,390 --> 00:04:13,760
12 time is the melindam content in

106
00:04:18,759 --> 00:04:16,400
pyrite pyrite is an iron disulfide

107
00:04:20,740 --> 00:04:18,769
mineral doing its precipitation

108
00:04:22,540 --> 00:04:20,750
molybdenum in seawater can be

109
00:04:24,850 --> 00:04:22,550
incorporated into pyrite crystal

110
00:04:26,650 --> 00:04:24,860
structure as impurities and this is

111
00:04:28,960 --> 00:04:26,660
thought this has been suggested by Ross

112
00:04:30,550 --> 00:04:28,970
Lodge and others that it can be used as

113
00:04:33,760 --> 00:04:30,560

a proxy for see what promotional

114
00:04:36,370 --> 00:04:33,770
consideration both large and I just

115
00:04:38,170 --> 00:04:36,380
produce a data set where the modern

116
00:04:40,210 --> 00:04:38,180
content of pyrite the analyzed modem

117
00:04:42,370 --> 00:04:40,220
contemporize - laser ablation

118
00:04:44,740 --> 00:04:42,380
and shown it as a function of time and

119
00:04:47,740 --> 00:04:44,750
we can see that in terms of relative

120
00:04:50,020 --> 00:04:47,750
amount that's a very low modern content

121
00:04:52,210 --> 00:04:50,030
in polite Indian with a slight increase

122
00:04:56,350 --> 00:04:52,220
in protozoic and finally a huge increase

123
00:04:59,550 --> 00:04:56,360
in the phanerozoic however there is no

124
00:05:02,140 --> 00:04:59,560
quantitative constraints on these values

125
00:05:04,930 --> 00:05:02,150
currently we are only concentrated

126
00:05:08,710 --> 00:05:04,940
considering them as relative and so what

127
00:05:10,090 --> 00:05:08,720
I want to do I wanted to do is to do

128
00:05:12,070 --> 00:05:10,100
experiments in order to devise a

129
00:05:14,080 --> 00:05:12,080
relationship between the modern content

130
00:05:16,300 --> 00:05:14,090
of pyrite and actual modern

131
00:05:18,070 --> 00:05:16,310
concentrations in water so that we can

132
00:05:19,920 --> 00:05:18,080
get quantitative quantitative

133
00:05:23,830 --> 00:05:19,930
constraints that we can compare to

134
00:05:26,500 --> 00:05:23,840
actual biological limit and so we set

135
00:05:28,030 --> 00:05:26,510
out to do this in the laboratory and to

136
00:05:30,310 --> 00:05:28,040
grow pyrite under control

137
00:05:32,500 --> 00:05:30,320
experimental conditions so we

138
00:05:35,110 --> 00:05:32,510

precipitate pyrite in this reactors that

139
00:05:37,270 --> 00:05:35,120
contain a baseline of 10 nano molar moly

140
00:05:40,150 --> 00:05:37,280
molybdenum as in the form of molybdate

141
00:05:42,970 --> 00:05:40,160
ion we added iron and sulfite together

142
00:05:45,310 --> 00:05:42,980
we tested several different conditions

143
00:05:47,650 --> 00:05:45,320
variable initial dissolve Maldon 'm as

144
00:05:50,280 --> 00:05:47,660
well as the effects of precipitation

145
00:05:52,990 --> 00:05:50,290
rate and pH - multi no content in pyrite

146
00:05:54,940 --> 00:05:53,000
pyrite was separated from the reactors

147
00:05:56,920 --> 00:05:54,950
using a sequential acid extraction I

148
00:05:58,500 --> 00:05:56,930
will measure the muslim continent pyrite

149
00:06:01,120 --> 00:05:58,510
using icp-ms

150
00:06:03,219 --> 00:06:01,130
in our baseline condition where we only

151
00:06:05,350 --> 00:06:03,229
added ferrous iron and sodium sulphide

152
00:06:07,630 --> 00:06:05,360
at pH 7 we found that the reaction was

153
00:06:10,030 --> 00:06:07,640
very slow and it never of each

154
00:06:12,370 --> 00:06:10,040
completion so you modify the baseline

155
00:06:14,590 --> 00:06:12,380
condition by adding elemental sulfur and

156
00:06:16,469 --> 00:06:14,600
by adding elemental software we actually

157
00:06:19,930 --> 00:06:16,479
increase the precipitation rate for

158
00:06:22,330 --> 00:06:19,940
precipitation rate for pyrite from we

159
00:06:26,200 --> 00:06:22,340
and we also the reaction complete

160
00:06:27,700 --> 00:06:26,210
obvious to completion we can also test

161
00:06:30,010 --> 00:06:27,710
at different multi known concentrations

162
00:06:33,760 --> 00:06:30,020
now so we tested Constitution between 10

163
00:06:35,650 --> 00:06:33,770

to about 10,000 nano molar molybdenum we

164
00:06:37,960 --> 00:06:35,660
also tested different pH so all these

165
00:06:41,200 --> 00:06:37,970
experiments were done at page 7 and this

166
00:06:44,530 --> 00:06:41,210
were done at pH 9 interestingly we found

167
00:06:46,120 --> 00:06:44,540
that pH causes and in fact the

168
00:06:47,950 --> 00:06:46,130
dissipation rate so there were slower

169
00:06:51,310 --> 00:06:47,960
precipitation at pH 9 relative to

170
00:06:53,680 --> 00:06:51,320
comparable condition at pH 7 we also

171
00:06:53,990 --> 00:06:53,690
found out that when we added hi mama

172
00:06:56,360 --> 00:06:54,000
listener

173
00:06:58,850 --> 00:06:56,370
into experiments a th9 millennium

174
00:07:01,100 --> 00:06:58,860
precipitates out in a mineral phase that

175
00:07:03,830 --> 00:07:01,110
was not associated of pyrite so we

176
00:07:07,340 --> 00:07:03,840
didn't consider this data in our in our

177
00:07:08,810 --> 00:07:07,350
study in our interpretation the

178
00:07:11,330 --> 00:07:08,820
preliminary results were very

179
00:07:13,490 --> 00:07:11,340
encouraging and that we found that the

180
00:07:15,230 --> 00:07:13,500
modern content in pyrite correlates very

181
00:07:17,810 --> 00:07:15,240
well with the initial dissolve modern

182
00:07:20,900 --> 00:07:17,820
concentration in our reactors we get an

183
00:07:22,700 --> 00:07:20,910
r-squared value of point eight three we

184
00:07:24,170 --> 00:07:22,710
did not find any significant difference

185
00:07:25,760 --> 00:07:24,180
which either precipitation rate or

186
00:07:28,600 --> 00:07:25,770
between different pH or between

187
00:07:31,340 --> 00:07:28,610
different amounts of elemental sulphur

188
00:07:32,990 --> 00:07:31,350

we do see this huge scatter which seems

189
00:07:35,120 --> 00:07:33,000
to be correlated with the amount of

190
00:07:37,400 --> 00:07:35,130
pyrite that we make in the in our ESS so

191
00:07:39,770 --> 00:07:37,410
as we make more pyrite we decrease the

192
00:07:43,909 --> 00:07:39,780
emotional content and pyrite our

193
00:07:44,900 --> 00:07:43,919
demonium iron ratio and pyrite so now

194
00:07:47,810 --> 00:07:44,910
that we have this interesting

195
00:07:50,180 --> 00:07:47,820
correlation to experimental conditions

196
00:07:52,040 --> 00:07:50,190
we wanted to see whether we can apply

197
00:07:54,380 --> 00:07:52,050
this with whether we can actually use

198
00:07:56,900 --> 00:07:54,390
this in natural system so this is the

199
00:07:59,870 --> 00:07:56,910
same plot as before our muslim continent

200
00:08:02,000 --> 00:07:59,880
pyrite versus concentration and this is

201
00:08:03,860 --> 00:08:02,010
the experimental line and so we want to

202
00:08:06,080 --> 00:08:03,870
compare this with modern pyrite where we

203
00:08:08,390 --> 00:08:06,090
have data of the whole genome content as

204
00:08:11,420 --> 00:08:08,400
well as the modern constitution in the

205
00:08:13,190 --> 00:08:11,430
water above them pyrite is one of those

206
00:08:15,950 --> 00:08:13,200
complex minerals that can form under a

207
00:08:17,450 --> 00:08:15,960
variety of conditions so the first one

208
00:08:19,490 --> 00:08:17,460
that we looked at was there isn't a

209
00:08:21,920 --> 00:08:19,500
pyrite that forms under toxic to the

210
00:08:24,620 --> 00:08:21,930
coccyx water columns this pyrite are

211
00:08:28,070 --> 00:08:24,630
formed in sediments and if all right

212
00:08:30,590 --> 00:08:28,080
somewhere along this line we also look

213
00:08:33,770 --> 00:08:30,600

at genetic pyrite by whatever form in

214
00:08:35,600 --> 00:08:33,780
the water column so this pyrite in this

215
00:08:37,490 --> 00:08:35,610
water column there can be certification

216
00:08:40,040 --> 00:08:37,500
with surface water that contains high

217
00:08:41,570 --> 00:08:40,050
marginal content and a sofa dick bottom

218
00:08:44,209 --> 00:08:41,580
water that contains lower marginal

219
00:08:45,890 --> 00:08:44,219
concentration and so that's the best

220
00:08:48,140 --> 00:08:45,900
reason for this line here this is from

221
00:08:50,900 --> 00:08:48,150
the black sea where the concentration of

222
00:08:54,110 --> 00:08:50,910
the water can change can vary between

223
00:08:57,200 --> 00:08:54,120
the bottom and surface water we also

224
00:08:59,000 --> 00:08:57,210
look at biofilm associated pyrite today

225
00:09:00,260 --> 00:08:59,010
this mode of formation of pyrite is

226
00:09:03,590 --> 00:09:00,270
where but it could have been more

227
00:09:05,690 --> 00:09:03,600
important on the early Earth so a few

228
00:09:07,600 --> 00:09:05,700
things are pop out here the first one

229
00:09:09,160 --> 00:09:07,610
being that the experimental diversity

230
00:09:11,920 --> 00:09:09,170
relationship kind of works for that

231
00:09:13,960 --> 00:09:11,930
genetic pyrite but we can see that

232
00:09:15,430 --> 00:09:13,970
there's clear overestimation there's a

233
00:09:18,190 --> 00:09:15,440
clear bias to its higher value

234
00:09:20,820 --> 00:09:18,200
especially for us in genetic and biofilm

235
00:09:23,740 --> 00:09:20,830
associated pyrite so we cannot use this

236
00:09:25,510 --> 00:09:23,750
instrument aligned directly we have to

237
00:09:27,430 --> 00:09:25,520
account for this complications access it

238
00:09:32,680 --> 00:09:27,440

in other two because we construct skew

239
00:09:34,750 --> 00:09:32,690
optimism over history and so we propose

240
00:09:36,310 --> 00:09:34,760
a couple of strategies in order to

241
00:09:39,370 --> 00:09:36,320
reconstruct see what they more than them

242
00:09:42,280 --> 00:09:39,380
so this is the modern content this is

243
00:09:44,530 --> 00:09:42,290
the data of marginal content in private

244
00:09:46,570 --> 00:09:44,540
collected to collected to later

245
00:09:49,900 --> 00:09:46,580
ablations compiled some literature's

246
00:09:52,180 --> 00:09:49,910
blew up highlights on black shales while

247
00:09:55,090 --> 00:09:52,190
original from shallow microbial cabinets

248
00:09:58,000 --> 00:09:55,100
and we have actually notice here we have

249
00:10:02,170 --> 00:09:58,010
put the marginal concentration data on

250
00:10:04,960 --> 00:10:02,180
the axis on the right and so if we use

251
00:10:07,030 --> 00:10:04,970
the data directly mol genome

252
00:10:09,340 --> 00:10:07,040
constellations in the modern ocean can

253
00:10:11,230 --> 00:10:09,350
predict it to be as high as 10,000 nano

254
00:10:13,120 --> 00:10:11,240
molar which doesn't seem to be accurate

255
00:10:15,420 --> 00:10:13,130
at all that is there is no place that

256
00:10:19,480 --> 00:10:15,430
currently has 10,000 animala molybdenum

257
00:10:22,090 --> 00:10:19,490
but one way we can try to remove this

258
00:10:24,100 --> 00:10:22,100
bias to a higher value value is to

259
00:10:25,600 --> 00:10:24,110
remove this data from sin genetic pyrite

260
00:10:27,730 --> 00:10:25,610
which which can be identified through

261
00:10:29,650 --> 00:10:27,740
the use of several geochemical proxies

262
00:10:32,080 --> 00:10:29,660
one of them being the degree of

263
00:10:34,900 --> 00:10:32,090

civilization another thing that we did

264
00:10:36,550 --> 00:10:34,910
was to use the median as the upper limit

265
00:10:38,890 --> 00:10:36,560
instead of the maximum and use the

266
00:10:40,810 --> 00:10:38,900
minimum as the lower limit so we can put

267
00:10:43,330 --> 00:10:40,820
constraints in order to try to reduce

268
00:10:46,420 --> 00:10:43,340
the bias to a higher values and so this

269
00:10:47,140 --> 00:10:46,430
is what we did so this is the median for

270
00:10:49,390 --> 00:10:47,150
the black shales

271
00:10:51,340 --> 00:10:49,400
followed by the minimum and we can

272
00:10:52,870 --> 00:10:51,350
collapse this data in order to get some

273
00:10:56,080 --> 00:10:52,880
constraints on see what the moles in

274
00:11:00,490 --> 00:10:56,090
them over time we can do the same thing

275
00:11:02,110 --> 00:11:00,500
for cabinets and we get this trend this

276
00:11:04,150 --> 00:11:02,120
trend for see what ammonium over time

277
00:11:08,590 --> 00:11:04,160
based on black shales and cognates

278
00:11:10,500 --> 00:11:08,600
and so if you look here this did so this

279
00:11:13,240 --> 00:11:10,510
the data is pretty interesting in that

280
00:11:15,250 --> 00:11:13,250
so we can also impose superimpose the

281
00:11:17,650 --> 00:11:15,260
nitrogen fixation limit which is about 5

282
00:11:19,900 --> 00:11:17,660
nano molar around here and so as you can

283
00:11:20,950 --> 00:11:19,910
see the data from the Archie and suggest

284
00:11:22,900 --> 00:11:20,960
that multi necrosis

285
00:11:25,330 --> 00:11:22,910
were below the nitrogen fixation remain

286
00:11:28,330 --> 00:11:25,340
as predicted by biochemical biochemical

287
00:11:30,850 --> 00:11:28,340
models and in a modern ocean the values

288
00:11:32,620 --> 00:11:30,860

some is somewhere between 50 to 100 nano

289
00:11:36,340 --> 00:11:32,630
molar so that gave me some confidence

290
00:11:39,130 --> 00:11:36,350
that this approach might work and then

291
00:11:42,240 --> 00:11:39,140
we can compare the data to what happens

292
00:11:44,860 --> 00:11:42,250
in the Proterozoic so we get a value of

293
00:11:46,630 --> 00:11:44,870
between 5 to 50 nano molar with an

294
00:11:50,290 --> 00:11:46,640
average value of 20 nano molar

295
00:11:52,960 --> 00:11:50,300
molybdenum and so based on this simple

296
00:11:54,670 --> 00:11:52,970
of the construction well it seems that

297
00:11:57,070 --> 00:11:54,680
see what ammonium concession in the

298
00:12:00,610 --> 00:11:57,080
bottle protozoic is above the nitrogen

299
00:12:02,230 --> 00:12:00,620
fixation limit and so it cannot it may

300
00:12:04,870 --> 00:12:02,240
not be the barrier for you guys the

301
00:12:06,220 --> 00:12:04,880
evolution during this time period but of

302
00:12:08,950 --> 00:12:06,230
course we have to use the data with

303
00:12:10,810 --> 00:12:08,960
caution there's clear over estimation

304
00:12:13,510 --> 00:12:10,820
from Cincinnati and biofilm pyrite which

305
00:12:16,300 --> 00:12:13,520
we haven't fully removed because we like

306
00:12:19,120 --> 00:12:16,310
geochemical toxic data that to identify

307
00:12:20,950 --> 00:12:19,130
either both of this type of pyrite so

308
00:12:23,680 --> 00:12:20,960
perhaps uranium isotope can help us with

309
00:12:29,230 --> 00:12:23,690
some of that I and some other vbeq

310
00:12:31,240 --> 00:12:29,240
isotopes and so in summary we were

311
00:12:33,280 --> 00:12:31,250
wondering if Magnum and nitrogen

312
00:12:36,700 --> 00:12:33,290
colonization can act as a barrier to do

313
00:12:38,290 --> 00:12:36,710

to eukaryotic diversification we have

314
00:12:40,090 --> 00:12:38,300
conducted experiments in the laboratory

315
00:12:42,370 --> 00:12:40,100
that shows that the muslim continent

316
00:12:44,740 --> 00:12:42,380
private college very well with dissolved

317
00:12:46,780 --> 00:12:44,750
marginal concentrations we use the

318
00:12:49,360 --> 00:12:46,790
experimentally divided line in order to

319
00:12:51,100 --> 00:12:49,370
reconstruct yatta-mole denim and show

320
00:12:53,170 --> 00:12:51,110
that the molybdenum constellation in the

321
00:12:55,390 --> 00:12:53,180
project is potentially not limiting

322
00:12:57,160 --> 00:12:55,400
nitrogen fixation and may not be the

323
00:13:00,760 --> 00:12:57,170
barrier for eukaryotic diversification

324
00:13:02,170 --> 00:13:00,770
and finally we need more proxy more

325
00:13:04,420 --> 00:13:02,180
development of process in order to

326
00:13:05,440 --> 00:13:04,430
identify some genetic pyrite and biofilm

327
00:13:07,810 --> 00:13:05,450
associated pyrite

328
00:13:14,509 --> 00:13:07,820
so that we can use this technique more

329
00:13:17,579 --> 00:13:16,410
thanks very much we have time for a

330
00:13:27,540 --> 00:13:17,589
quick question or two while we switch

331
00:13:30,269 --> 00:13:27,550
over just a usual way too low

332
00:13:32,579 --> 00:13:30,279
molybdenum concentrations for our heal a

333
00:13:35,670 --> 00:13:32,589
lot of very important enzymes are using

334
00:13:38,790 --> 00:13:35,680
molybdenum how do you there was life

335
00:13:41,550 --> 00:13:38,800
energy more shelter how you explain that

336
00:13:44,250 --> 00:13:41,560
how they were coping good so there are

337
00:13:46,590 --> 00:13:44,260
the nitrogenous for example can have

338
00:13:48,900 --> 00:13:46,600

other different cofactors millennium is

339
00:13:51,420 --> 00:13:48,910
not the only cofactors it is certainly

340
00:13:53,790 --> 00:13:51,430
the most efficient form but iron for

341
00:13:57,990 --> 00:13:53,800
example can be substituted in depth in

342
00:13:59,610 --> 00:13:58,000
place of Magnum but another question the

343
00:14:01,590 --> 00:13:59,620
terrestrial volcanic systems that are

344
00:14:04,040 --> 00:14:01,600
producing a lot of molybdenum okay

345
00:14:07,259 --> 00:14:04,050
probably do you consider these

346
00:14:10,139 --> 00:14:07,269
molybdenum delivery in your conclusions

347
00:14:14,220 --> 00:14:10,149
or you just consider the ocean samples

348
00:14:17,400 --> 00:14:14,230
so we in this respect we apply right is

349
00:14:19,860 --> 00:14:17,410
a proxy for a seawater so we use so we

350
00:14:21,720 --> 00:14:19,870
only consider the oceanic system but not

351
00:14:26,220 --> 00:14:21,730
Dario but doesn't ya want to thank you

352
00:14:28,110 --> 00:14:26,230
thank you yep oh it's very interesting

353
00:14:30,150 --> 00:14:28,120
talk so my question is and does

354
00:14:32,579 --> 00:14:30,160
molybdenum actually sit in the lattice

355
00:14:34,560 --> 00:14:32,589
of the pirate or they the multiple

356
00:14:37,380 --> 00:14:34,570
actually present some nugget and this is

357
00:14:39,389 --> 00:14:37,390
trapped by the pirate so I think this is

358
00:14:42,569 --> 00:14:39,399
still an area of ongoing research but

359
00:14:43,050 --> 00:14:42,579
the Kevin consensus is that it is an a

360
00:14:45,750 --> 00:14:43,060
nano

361
00:14:49,040 --> 00:14:45,760
inclusion in pyrite okay yeah all right

362
00:14:55,760 --> 00:14:51,360
Brooke we have time for we're a group

363
00:14:58,350 --> 00:14:55,770

that was great talk thanks um so I

364
00:15:00,180 --> 00:14:58,360
honestly I kind of have a comment just

365
00:15:02,970 --> 00:15:00,190
to update it update the field with some

366
00:15:04,590 --> 00:15:02,980
unpublished research because it's

367
00:15:06,660 --> 00:15:04,600
interesting to me that this all kind of

368
00:15:08,970 --> 00:15:06,670
hinges around this 5-man animal are

369
00:15:11,639 --> 00:15:08,980
numbers that are you know are ales

370
00:15:14,220 --> 00:15:11,649
groups when I was a PhD student and also

371
00:15:15,240 --> 00:15:14,230
average circle came up with but but now

372
00:15:18,300 --> 00:15:15,250
that we've been doing more field

373
00:15:19,980 --> 00:15:18,310
research it's pretty hard to find a

374
00:15:21,930 --> 00:15:19,990
little bit of limited environments and I

375
00:15:24,480 --> 00:15:21,940
think some people have found them but

376
00:15:26,850 --> 00:15:24,490
they're pretty rare and most fresh

377
00:15:27,660 --> 00:15:26,860
waters have we're talking you know some

378
00:15:30,300 --> 00:15:27,670
animal

379
00:15:32,910 --> 00:15:30,310
or levels and so I just want to kind of

380
00:15:35,940 --> 00:15:32,920
I think there's a kind of caveat that

381
00:15:37,380 --> 00:15:35,950
they're not using so far we've not found

382
00:15:40,410 --> 00:15:37,390
an environment that's using an

383
00:15:42,140 --> 00:15:40,420
alternative nitrogenase so based on the

384
00:15:44,730 --> 00:15:42,150
modern we don't have evidence that

385
00:15:46,410 --> 00:15:44,740
alternative my tragedies is important

386
00:15:48,930 --> 00:15:46,420
everywhere so just when thinking about

387
00:15:50,460 --> 00:15:48,940
that vanadium question I think it's

388
00:15:53,910 --> 00:15:50,470

important to kind of constrain it with

389
00:15:56,370 --> 00:15:53,920
some some modern focus environments like

390
00:15:57,750 --> 00:15:56,380
I have to talk more yeah I agree with

391
00:15:59,610 --> 00:15:57,760
that that's what there's a lot of

392
00:16:03,480 --> 00:15:59,620
research going to at least have an