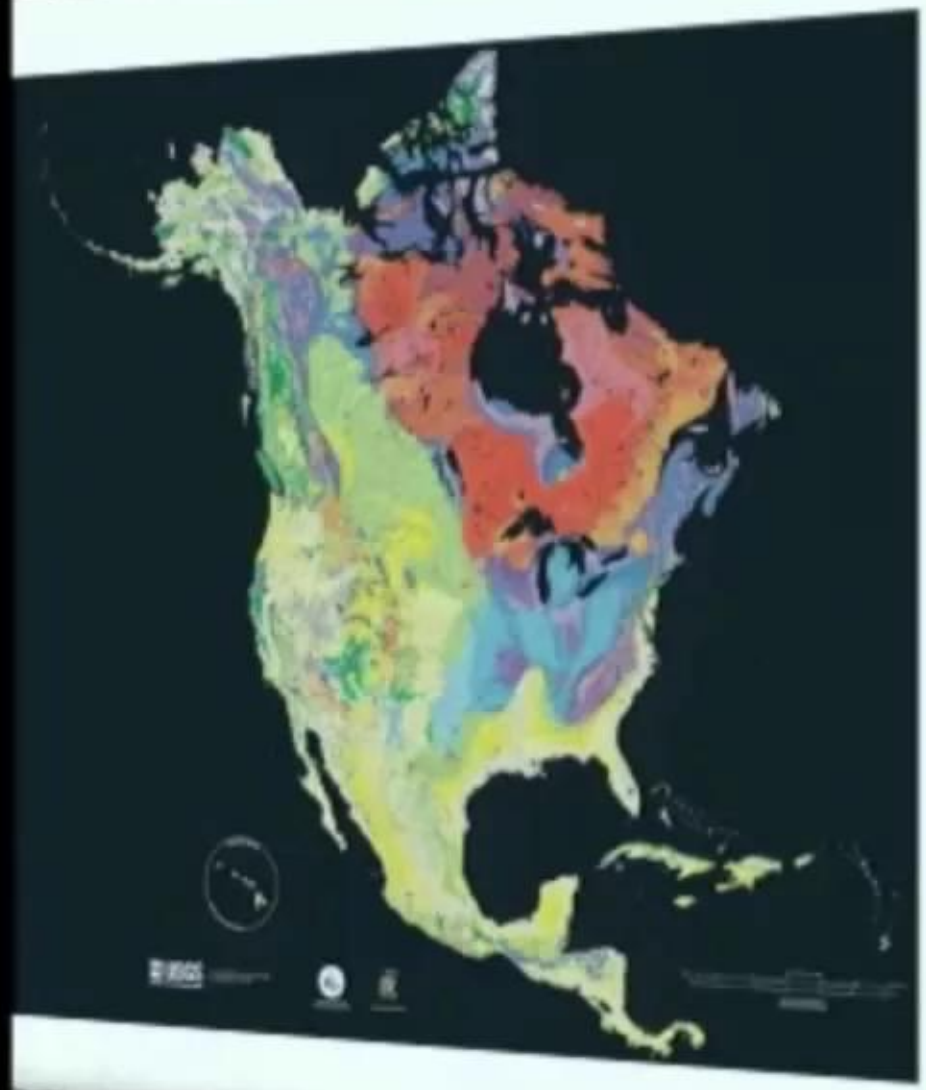

- Reds and pinks = Archaean rocks

1
00:00:10,700 --> 00:00:08,510
you get to hear me talk all over again

2
00:00:14,060 --> 00:00:10,710
but this time about early is geobiology

3
00:00:15,500 --> 00:00:14,070
the topic of today's session so first

4
00:00:19,640 --> 00:00:15,510
off I want to talk about what we mean by

5
00:00:21,109 --> 00:00:19,650
the early is so this is a diagram of the

6
00:00:23,720 --> 00:00:21,119
time scale of the entire Earth

7
00:00:26,120 --> 00:00:23,730
everything that's ever happened and and

8
00:00:28,340 --> 00:00:26,130
when we say early Earth and geology in

9
00:00:29,870 --> 00:00:28,350
geobiology what we really mean is pretty

10
00:00:32,420 --> 00:00:29,880
much everything that happens from here

11
00:00:35,119 --> 00:00:32,430
where the earth is formed really right

12
00:00:36,950 --> 00:00:35,129
up to about here which is where

13
00:00:40,819 --> 00:00:36,960

multicellular life really starts to take

14
00:00:42,650 --> 00:00:40,829
off so you can also think of it as

15
00:00:45,350 --> 00:00:42,660
everything that happens before the great

16
00:00:47,060 --> 00:00:45,360
oxidation event and the ikea and had ian

17
00:00:49,729 --> 00:00:47,070
but everything that happens in the

18
00:00:52,010 --> 00:00:49,739
proterozoic is generally included too so

19
00:00:53,870 --> 00:00:52,020
essentially the early Earth geology that

20
00:00:55,690 --> 00:00:53,880
sounds like not a lot of its history

21
00:00:59,030 --> 00:00:55,700
right but we're actually thinking about

22
00:01:00,860 --> 00:00:59,040
3.5 or four billion years of this four

23
00:01:03,340 --> 00:01:00,870
and a half billion year history so this

24
00:01:06,770 --> 00:01:03,350
is clearly a lot of territory to cover

25
00:01:09,380 --> 00:01:06,780
so what about geobiology well and its

26
00:01:13,190 --> 00:01:09,390
simplest form geology is where geology

27
00:01:15,139 --> 00:01:13,200
meets biology in terms of geology what

28
00:01:17,510 --> 00:01:15,149
we do is we look at rocks and we want to

29
00:01:19,940 --> 00:01:17,520
know what can they tell us about life in

30
00:01:21,499 --> 00:01:19,950
the past so this picture up here this is

31
00:01:24,199 --> 00:01:21,509
a picture of a formation known as the

32
00:01:26,330 --> 00:01:24,209
gunflint shirt and it's really important

33
00:01:28,580 --> 00:01:26,340
it was discovered in the 60s because all

34
00:01:30,739 --> 00:01:28,590
these things here you think wow that

35
00:01:32,929 --> 00:01:30,749
really looks like a close-up on a

36
00:01:35,419 --> 00:01:32,939
microscope photo / microbial mat and

37
00:01:37,789 --> 00:01:35,429
you'd be right this is a 1.9 belen

38
00:01:40,010 --> 00:01:37,799

year-old microbial med so right away

39
00:01:42,169 --> 00:01:40,020
this rock is telling us something about

40
00:01:44,419 --> 00:01:42,179
the organisms that were living 1.9

41
00:01:47,480 --> 00:01:44,429
billion years ago but there's another

42
00:01:49,399 --> 00:01:47,490
part to geobiology and that is asking

43
00:01:51,889 --> 00:01:49,409
what life in the prison can tell us

44
00:01:54,230 --> 00:01:51,899
about the rot record so this picture

45
00:01:55,550 --> 00:01:54,240
this is of a stromatolite which some of

46
00:01:57,469 --> 00:01:55,560
you have probably heard of their

47
00:01:59,330 --> 00:01:57,479
structures found in the rock record that

48
00:02:01,849 --> 00:01:59,340
we think indicate microbial life but

49
00:02:03,620 --> 00:02:01,859
this stromatolite is really cool because

50
00:02:06,019 --> 00:02:03,630
this stromatolite isn't to the lean

51
00:02:08,600 --> 00:02:06,029
years old this stromatolite was found in

52
00:02:10,580 --> 00:02:08,610
a yellow stone hot spring about five six

53
00:02:12,110 --> 00:02:10,590
years ago that it looks exactly like a

54
00:02:14,330 --> 00:02:12,120
whole bunch of strata lights from the

55
00:02:16,850 --> 00:02:14,340
rock record so by studying things like

56
00:02:17,600 --> 00:02:16,860
this that exists in the prison day we

57
00:02:19,040 --> 00:02:17,610
can understand

58
00:02:21,560 --> 00:02:19,050
what the structure that structures in

59
00:02:24,830 --> 00:02:21,570
the rock record actually are and what

60
00:02:26,480 --> 00:02:24,840
might have been going on back then so

61
00:02:28,610 --> 00:02:26,490
let's just go back to this kind of

62
00:02:29,900 --> 00:02:28,620
diagram of the time scale of the earth

63
00:02:31,670 --> 00:02:29,910

for a minute and I want to go through

64
00:02:33,950 --> 00:02:31,680
some of the key events in early Earth

65
00:02:35,660 --> 00:02:33,960
history to give you a good idea of what

66
00:02:37,220 --> 00:02:35,670
was going on at different times and the

67
00:02:40,310 --> 00:02:37,230
kinds of topics that our speakers today

68
00:02:43,010 --> 00:02:40,320
we'll be talking about so we really kick

69
00:02:44,570 --> 00:02:43,020
off in terms of geobiology roughly four

70
00:02:46,550 --> 00:02:44,580
billion years ago which is when the

71
00:02:49,730 --> 00:02:46,560
oldest known rocks that we can access

72
00:02:51,199 --> 00:02:49,740
some were being formed so anything that

73
00:02:53,030 --> 00:02:51,209
happened before four billion years ago

74
00:02:54,590 --> 00:02:53,040
we don't know about from the rock record

75
00:02:58,070 --> 00:02:54,600
on earth because those rocks aren't

76
00:03:00,050 --> 00:02:58,080
there anymore dig on about 3.5 billion

77
00:03:02,180 --> 00:03:00,060
years ago at the oldest stromatolite so

78
00:03:04,280 --> 00:03:02,190
oldest probably microbially formed

79
00:03:06,650 --> 00:03:04,290
structures so that's the first point of

80
00:03:08,330 --> 00:03:06,660
which we can look at on these things and

81
00:03:10,280 --> 00:03:08,340
say this is probably life and we're

82
00:03:12,290 --> 00:03:10,290
seeing evidence already in the rock

83
00:03:15,620 --> 00:03:12,300
record as a structure just not in terms

84
00:03:17,330 --> 00:03:15,630
of our predictions about 2.3 million

85
00:03:19,250 --> 00:03:17,340
years ago came the great oxygen

86
00:03:21,080 --> 00:03:19,260
oxygenation of in and this is when we

87
00:03:23,180 --> 00:03:21,090
can say okay there's not just life on

88
00:03:24,560 --> 00:03:23,190

the planet it's creating so much oxygen

89
00:03:26,720 --> 00:03:24,570
that it's getting into the atmosphere

90
00:03:28,970 --> 00:03:26,730
and fundamentally changing how our

91
00:03:30,620 --> 00:03:28,980
planet is this is the point in which the

92
00:03:33,530 --> 00:03:30,630
early Earth changes from being in a

93
00:03:35,810 --> 00:03:33,540
primarily anaerobic world to a not as

94
00:03:37,610 --> 00:03:35,820
arabic world as today as we were told

95
00:03:39,770 --> 00:03:37,620
about last night but still a world where

96
00:03:41,840 --> 00:03:39,780
oxygen is playing a major chemical role

97
00:03:46,910 --> 00:03:41,850
so this is a really crucial change over

98
00:03:48,470 --> 00:03:46,920
in our early Earth time period about 1.9

99
00:03:50,090 --> 00:03:48,480
billion years ago that's the gunflint

100
00:03:52,460 --> 00:03:50,100
should I was showing you this is when we

101
00:03:54,229 --> 00:03:52,470
have the oldest microfossils so we can

102
00:03:55,970 --> 00:03:54,239
undo min on a rock and actually see

103
00:03:58,039 --> 00:03:55,980
organisms preserved in the rock it's

104
00:04:01,009 --> 00:03:58,049
also when we have the oldest eukaryote

105
00:04:02,390 --> 00:04:01,019
fossil so we don't just have prokaryotes

106
00:04:05,390 --> 00:04:02,400
we've got eukaryotes and we have

107
00:04:07,699 --> 00:04:05,400
evidence of them about 1.2 billion years

108
00:04:09,259 --> 00:04:07,709
ago we have the oldest identifiable

109
00:04:10,789 --> 00:04:09,269
fossils and what I mean by that a

110
00:04:12,890 --> 00:04:10,799
fossils where we can look at them and

111
00:04:14,900 --> 00:04:12,900
say in the case of these particular

112
00:04:15,979 --> 00:04:14,910
fossils these are red algae so we're not

113
00:04:18,199 --> 00:04:15,989

just saying these are microorganisms

114
00:04:21,800 --> 00:04:18,209
these are members of the clave that

115
00:04:24,440 --> 00:04:21,810
exists today that we know about but I'm

116
00:04:26,150 --> 00:04:24,450
half billion years ago so that's 600

117
00:04:27,890 --> 00:04:26,160
million years ago we have the oldest

118
00:04:29,659 --> 00:04:27,900
multicellular fossils and I'm going to

119
00:04:30,510 --> 00:04:29,669
zoom in a bit on the time scale just to

120
00:04:33,240 --> 00:04:30,520
bring you up to speed

121
00:04:35,430 --> 00:04:33,250
on where we hit the modern period and so

122
00:04:37,200 --> 00:04:35,440
this has really really zoomed in but

123
00:04:38,640 --> 00:04:37,210
this is this is everything going back to

124
00:04:40,800 --> 00:04:38,650
600 million years so this is the

125
00:04:42,180 --> 00:04:40,810
dinosaurs this is us and it's a tiny

126
00:04:44,939 --> 00:04:42,190
fraction of the whole history of the

127
00:04:47,249 --> 00:04:44,949
earth so about 600 million years ago we

128
00:04:49,140 --> 00:04:47,259
have spanish fossils that when you spot

129
00:04:51,480 --> 00:04:49,150
alive sponges what you most again at

130
00:04:53,460 --> 00:04:51,490
least tiny little silica glass spec you

131
00:04:55,320 --> 00:04:53,470
look like a whole sponge but the

132
00:04:59,309 --> 00:04:55,330
evidence that some silica forming

133
00:05:01,589 --> 00:04:59,319
sponges were around that 550 million

134
00:05:02,730 --> 00:05:01,599
years ago maybe 600 to get small Shelly

135
00:05:04,320 --> 00:05:02,740
fossils and these are the first

136
00:05:06,270 --> 00:05:04,330
organisms that were forming actual

137
00:05:08,129 --> 00:05:06,280
shells and then you get the Cambrian

138
00:05:09,719 --> 00:05:08,139

explosion or the major animal phyla

139
00:05:11,879 --> 00:05:09,729
appear in the rock record and we're off

140
00:05:13,680 --> 00:05:11,889
to the races with multicellular life but

141
00:05:15,270 --> 00:05:13,690
what we really care about is the first

142
00:05:16,770 --> 00:05:15,280
three and a half four billion years

143
00:05:18,779 --> 00:05:16,780
before that when multicellular life

144
00:05:20,640 --> 00:05:18,789
wasn't around so when you don't have

145
00:05:22,110 --> 00:05:20,650
fossils in the rock record when you

146
00:05:24,390 --> 00:05:22,120
don't have your bones and your

147
00:05:25,830 --> 00:05:24,400
coprolites and your trace fossils what

148
00:05:29,550 --> 00:05:25,840
are you looking at to tell what was

149
00:05:31,920 --> 00:05:29,560
going on with life so back to our

150
00:05:33,959 --> 00:05:31,930
diagram and you can note that on this

151
00:05:36,420 --> 00:05:33,969
diagram the Hadean and the archaean the

152
00:05:37,830 --> 00:05:36,430
early anaerobic curator and read and

153
00:05:39,899 --> 00:05:37,840
tank and this is important because i'm

154
00:05:41,670 --> 00:05:39,909
going to show you this map and the

155
00:05:42,990 --> 00:05:41,680
archaean rocks and which also

156
00:05:44,879 --> 00:05:43,000
encompasses the hoodie and for these

157
00:05:46,890 --> 00:05:44,889
purposes also read in Peng so right away

158
00:05:48,510 --> 00:05:46,900
you can see when we go looking for rocks

159
00:05:50,790 --> 00:05:48,520
to find out about life from the early

160
00:05:52,230 --> 00:05:50,800
Earth we don't have a lot of rocks to go

161
00:05:53,730 --> 00:05:52,240
look at because not all of these are

162
00:05:55,769 --> 00:05:53,740
going to tell us about life life is

163
00:05:57,450 --> 00:05:55,779

primarily preserved in the sedimentary

164
00:05:59,550 --> 00:05:57,460
rock record not the igneous or the

165
00:06:01,110 --> 00:05:59,560
metamorphic because that's where life

166
00:06:03,209 --> 00:06:01,120
tends to live life isn't living and

167
00:06:05,670 --> 00:06:03,219
basalts and volcanoes it's living in the

168
00:06:07,260 --> 00:06:05,680
soil it's living in the sea floor so we

169
00:06:09,149 --> 00:06:07,270
have to find sedimentary rocks and they

170
00:06:11,339 --> 00:06:09,159
just started that many of them apart

171
00:06:13,379 --> 00:06:11,349
from the very top of North America most

172
00:06:15,779 --> 00:06:13,389
people also study Western Australia

173
00:06:17,370 --> 00:06:15,789
South Africa and the archaean rocks in

174
00:06:18,749 --> 00:06:17,380
India but not a lot was done with them

175
00:06:20,279 --> 00:06:18,759
so there's really only these two or

176
00:06:21,809 --> 00:06:20,289
three areas in the world where you can

177
00:06:23,399 --> 00:06:21,819
go to find these rocks and find out

178
00:06:26,760 --> 00:06:23,409
about the earlier so we have to work

179
00:06:28,260 --> 00:06:26,770
really hard with what we've got so what

180
00:06:29,640 --> 00:06:28,270
are we looking for in these rocks ins we

181
00:06:31,830 --> 00:06:29,650
don't have the bones and the coprolites

182
00:06:33,300 --> 00:06:31,840
and all that sort of thing and we're

183
00:06:35,219 --> 00:06:33,310
looking for evidence the life was there

184
00:06:37,230 --> 00:06:35,229
which can be microfossils although again

185
00:06:38,790 --> 00:06:37,240
we don't have a lot of microfossils for

186
00:06:40,110 --> 00:06:38,800
the early early Earth they start to

187
00:06:42,990 --> 00:06:40,120
emerge sort of two billion years ago

188
00:06:44,380 --> 00:06:43,000

really post grade oxidation event we're

189
00:06:46,600 --> 00:06:44,390
looking for evidence that life

190
00:06:48,760 --> 00:06:46,610
have been there we're looking for

191
00:06:50,950 --> 00:06:48,770
evidence that life could not have been

192
00:06:52,840 --> 00:06:50,960
there and if this is starting to sound

193
00:06:54,160 --> 00:06:52,850
like astrobiology you'd be right because

194
00:06:56,650 --> 00:06:54,170
this is the thing about early Earth

195
00:06:58,420 --> 00:06:56,660
geobiology for us the earliest is

196
00:07:00,790 --> 00:06:58,430
basically an alien planet it's this

197
00:07:02,500 --> 00:07:00,800
anaerobic world filled with prokaryotes

198
00:07:04,780 --> 00:07:02,510
where life as we know it doesn't really

199
00:07:06,760 --> 00:07:04,790
exist and the only way we can look at it

200
00:07:08,380 --> 00:07:06,770
is to study rocks and there's only a

201
00:07:09,970 --> 00:07:08,390
very few of these rocks because most of

202
00:07:11,680 --> 00:07:09,980
them have been destroyed so it's pretty

203
00:07:13,270 --> 00:07:11,690
much exactly like looking for life on

204
00:07:15,070 --> 00:07:13,280
Mars you're looking at the few rocks you

205
00:07:18,160 --> 00:07:15,080
can get hold of for a totally alien

206
00:07:20,170 --> 00:07:18,170
world so this is an alias geobiology

207
00:07:21,850 --> 00:07:20,180
isn't just important because it tells us

208
00:07:23,530 --> 00:07:21,860
thing about what alien wills might be

209
00:07:26,920 --> 00:07:23,540
like it is telling us about an alien

210
00:07:28,750 --> 00:07:26,930
world the beginning of their own so

211
00:07:30,280 --> 00:07:28,760
these are some of the kinds of things

212
00:07:32,440 --> 00:07:30,290
you look at when you're looking for

213
00:07:34,080 --> 00:07:32,450

evidence in the rocks microbial

214
00:07:36,040 --> 00:07:34,090
structures so not necessarily

215
00:07:37,330 --> 00:07:36,050
microfossils were you looking them under

216
00:07:39,460 --> 00:07:37,340
a microscope and seeing the actual

217
00:07:41,410 --> 00:07:39,470
microbes but structures created by

218
00:07:42,730 --> 00:07:41,420
microbes and some of you who are not

219
00:07:44,530 --> 00:07:42,740
geologists are probably looking at that

220
00:07:46,030 --> 00:07:44,540
and thinking the only structure I Syria

221
00:07:49,990 --> 00:07:46,040
there is a rock hammer and that's fair

222
00:07:51,850 --> 00:07:50,000
enough but this is a stromatolite this

223
00:07:53,680 --> 00:07:51,860
term stromatolite actually means a

224
00:07:56,320 --> 00:07:53,690
mattress rock because you have layers

225
00:07:58,150 --> 00:07:56,330
like mattresses and that create this

226
00:07:59,680 --> 00:07:58,160
structure I don't look a lot like

227
00:08:01,270 --> 00:07:59,690
matrices to me but clearly they look

228
00:08:03,730 --> 00:08:01,280
like mattresses to someone so that's

229
00:08:06,580 --> 00:08:03,740
what we're going with and if we zoom in

230
00:08:08,560 --> 00:08:06,590
close this is a pre-cambrian so not like

231
00:08:09,850 --> 00:08:08,570
super super early earth that like around

232
00:08:12,220 --> 00:08:09,860
the time of were just before the

233
00:08:14,080 --> 00:08:12,230
Cambrian extrusion stromatolite it's at

234
00:08:15,460 --> 00:08:14,090
Mount Dunphy and Nevada I was there a

235
00:08:17,560 --> 00:08:15,470
couple of months ago where I took this

236
00:08:19,060 --> 00:08:17,570
photo and you can see that there's all

237
00:08:20,950 --> 00:08:19,070
these fine fine layers and this

238
00:08:22,420 --> 00:08:20,960

fine-grained sandstone and we think

239
00:08:25,300 --> 00:08:22,430
these are being caused by little

240
00:08:27,220 --> 00:08:25,310
microbes growing and mounds and then the

241
00:08:28,510 --> 00:08:27,230
trapper trapping sediment some hair and

242
00:08:31,060 --> 00:08:28,520
it forms layers and these are then

243
00:08:32,830 --> 00:08:31,070
preserved in the rock record you also

244
00:08:35,469 --> 00:08:32,840
get going back to the gunflint should

245
00:08:37,480 --> 00:08:35,479
axle microfossils normally not for the

246
00:08:39,310 --> 00:08:37,490
very very early earth and there are some

247
00:08:40,690 --> 00:08:39,320
examples like that apex to it which we

248
00:08:42,580 --> 00:08:40,700
mentioned last night which are very

249
00:08:45,400 --> 00:08:42,590
hotly debated because they're kind of

250
00:08:48,820 --> 00:08:45,410
like um the Martian meteorite found in

251
00:08:51,010 --> 00:08:48,830
Antarctica they look like microbes but

252
00:08:54,280 --> 00:08:51,020
it's so long ago and the rocks so

253
00:08:56,000 --> 00:08:54,290
screwed up that are they microbes maybe

254
00:08:58,190 --> 00:08:56,010
maybe not but these are definitely

255
00:08:59,510 --> 00:08:58,200
so for the later early Earth we're

256
00:09:02,660 --> 00:08:59,520
really lucky we can actually see

257
00:09:04,400 --> 00:09:02,670
microbes in the rock but without these

258
00:09:06,260 --> 00:09:04,410
larger microbial structures and the

259
00:09:07,670 --> 00:09:06,270
microfossils what are we left with for

260
00:09:09,680 --> 00:09:07,680
these really old rocks that we don't

261
00:09:11,300 --> 00:09:09,690
have many of well there's a few proxies

262
00:09:12,590 --> 00:09:11,310
we can look at to think about life too

263
00:09:14,750 --> 00:09:12,600

and you'll hear about some of them today

264
00:09:16,250 --> 00:09:14,760
these isotopes which you're going to

265
00:09:17,690 --> 00:09:16,260
hear a lot more about from Bradley in

266
00:09:19,580 --> 00:09:17,700
just a few minutes and from speakers

267
00:09:21,710 --> 00:09:19,590
speakers later on this afternoon but

268
00:09:23,780 --> 00:09:21,720
essentially isotopes like carbon oxygen

269
00:09:25,730 --> 00:09:23,790
and sulfur can tell us things about the

270
00:09:27,350 --> 00:09:25,740
chemistry of the early Earth which can

271
00:09:28,760 --> 00:09:27,360
give us ideas about what sort of life

272
00:09:30,530 --> 00:09:28,770
could have been there and especially in

273
00:09:32,150 --> 00:09:30,540
terms of oxygen whether life was

274
00:09:34,700 --> 00:09:32,160
producing oxygen and what it was

275
00:09:37,070 --> 00:09:34,710
interacting with you have lipids and

276
00:09:38,930 --> 00:09:37,080
organic molecules things like DNA don't

277
00:09:41,360 --> 00:09:38,940
survive that long the oldest ancient DNA

278
00:09:43,700 --> 00:09:41,370
that we've managed to sequences maybe 30

279
00:09:45,440 --> 00:09:43,710
40 50 thousand years old these claims of

280
00:09:47,480 --> 00:09:45,450
all the stuff that it's pretty broken up

281
00:09:50,180 --> 00:09:47,490
but things like lipids can survive a

282
00:09:51,680 --> 00:09:50,190
really really long time again this isn't

283
00:09:53,840 --> 00:09:51,690
really relevant for the early early

284
00:09:56,090 --> 00:09:53,850
Earth and the best examples actually

285
00:09:58,640 --> 00:09:56,100
probably from the phanerozoic which is

286
00:10:00,200 --> 00:09:58,650
the modern earth i'll post the Cambrian

287
00:10:01,790 --> 00:10:00,210
explosion but you can get the

288
00:10:03,710 --> 00:10:01,800

preservation of lipids and the rock

289
00:10:06,200 --> 00:10:03,720
record and you can look at the lipids

290
00:10:08,300 --> 00:10:06,210
and think about the kind of things in

291
00:10:10,190 --> 00:10:08,310
the modern world that have those lipids

292
00:10:11,450 --> 00:10:10,200
and their name raves and so what it

293
00:10:14,240 --> 00:10:11,460
could mean about the life that could

294
00:10:20,450 --> 00:10:14,250
have been there and finally and kiefer

295
00:10:22,820 --> 00:10:20,460
geobiology there are minerals hooray so

296
00:10:24,890 --> 00:10:22,830
this is an example of a banded iron

297
00:10:26,870 --> 00:10:24,900
formation I'm sure a lot of you heard of

298
00:10:28,460 --> 00:10:26,880
these this is where in the great oaks

299
00:10:30,290 --> 00:10:28,470
around the time of the great oxidation

300
00:10:32,630 --> 00:10:30,300
event you had tons and tons of iron

301
00:10:34,700 --> 00:10:32,640
being laid down as the iron rusted with

302
00:10:37,820 --> 00:10:34,710
oxygen a man was laid down on these

303
00:10:39,830 --> 00:10:37,830
beautiful red layers and so these

304
00:10:41,210 --> 00:10:39,840
minerals are telling us again something

305
00:10:42,830 --> 00:10:41,220
about life on the early Earth because

306
00:10:44,630 --> 00:10:42,840
they're telling us about the oxygen and

307
00:10:46,850 --> 00:10:44,640
you get other minerals you get iron

308
00:10:48,740 --> 00:10:46,860
minerals that can be created by microbes

309
00:10:51,620 --> 00:10:48,750
by microbes that reduce an oxidized iron

310
00:10:53,450 --> 00:10:51,630
you get minerals and like sulfur sulfur

311
00:10:55,580 --> 00:10:53,460
minerals some of which you biogenic

312
00:10:57,650 --> 00:10:55,590
later on in the Earth's history you get

313
00:10:59,840 --> 00:10:57,660

carbonate minerals by organisms that are

314
00:11:02,330 --> 00:10:59,850
forming carbonate either directly by or

315
00:11:04,820 --> 00:11:02,340
by the influence on the environment so

316
00:11:06,980 --> 00:11:04,830
rocks are affected by life it's

317
00:11:08,750 --> 00:11:06,990
geobiology because the biology can

318
00:11:11,380 --> 00:11:08,760
create the geology

319
00:11:14,390 --> 00:11:11,390
not just coexisting with it and

320
00:11:16,490 --> 00:11:14,400
furthermore in early Earth geobiology we

321
00:11:18,650 --> 00:11:16,500
also have modern-day analogs so these

322
00:11:20,930 --> 00:11:18,660
places like deep-sea hydrothermal vents

323
00:11:22,700 --> 00:11:20,940
which are very hot there anaerobic and

324
00:11:25,400 --> 00:11:22,710
organisms are existing with the rock

325
00:11:27,860 --> 00:11:25,410
there's no sunlight and they're creating

326
00:11:29,480 --> 00:11:27,870
their own biosphere down there you have

327
00:11:31,790 --> 00:11:29,490
places like Yellowstone where you've got

328
00:11:33,260 --> 00:11:31,800
these hot springs and stromatolite just

329
00:11:36,140 --> 00:11:33,270
like the ones we see in the rock record

330
00:11:38,960 --> 00:11:36,150
are being created right now by organisms

331
00:11:41,120 --> 00:11:38,970
existing in the present day you have

332
00:11:44,060 --> 00:11:41,130
places like the Black Sea where you have

333
00:11:46,460 --> 00:11:44,070
a huge anoxic fascia basin and this

334
00:11:48,350 --> 00:11:46,470
really quite large sea and where the

335
00:11:49,670 --> 00:11:48,360
ocean is anaerobic like we think it was

336
00:11:51,850 --> 00:11:49,680
in the early Earth now it's not a

337
00:11:53,810 --> 00:11:51,860
perfect analogue because our the

338
00:11:55,490 --> 00:11:53,820

concentrations of a lot of things like

339
00:11:57,800 --> 00:11:55,500
sulfur very different but it's still a

340
00:11:59,960 --> 00:11:57,810
hole in aerobic section of ocean that we

341
00:12:01,100 --> 00:11:59,970
can go look at to see how organisms are

342
00:12:03,770 --> 00:12:01,110
getting on because there ain't no fish

343
00:12:06,080 --> 00:12:03,780
down there it's just microbes just like

344
00:12:07,730 --> 00:12:06,090
we think it was on the early Earth but

345
00:12:10,370 --> 00:12:07,740
really the point of all this forces

346
00:12:12,770 --> 00:12:10,380
astrobiologists is that if we know what

347
00:12:15,920 --> 00:12:12,780
life looks like in the rock record here

348
00:12:17,930 --> 00:12:15,930
and the signs it leaves behind we can

349
00:12:19,670 --> 00:12:17,940
understand what it might leave behind on

350
00:12:22,100 --> 00:12:19,680
other planets and how we can really

351
00:12:23,750 --> 00:12:22,110
adequately go out to Mars and say and

352
00:12:25,820 --> 00:12:23,760
look at the rocks and say this is

353
00:12:28,010 --> 00:12:25,830
geobiology these are the signs of what

354
00:12:37,060 --> 00:12:28,020
life left behind there just like it did

355
00:12:41,300 --> 00:12:39,020
so I'm going to be rude and take the

356
00:12:43,700 --> 00:12:41,310
first question myself I was intrigued by

357
00:12:45,530 --> 00:12:43,710
the rock distribution map that you put

358
00:12:48,950 --> 00:12:45,540
up at the beginning yep what is it about

359
00:12:50,630 --> 00:12:48,960
northern North America that is the sole

360
00:12:52,910 --> 00:12:50,640
source or primary source of that

361
00:12:54,650 --> 00:12:52,920
sedimentary stuff is it glaciers so it's

362
00:12:56,240 --> 00:12:54,660
not the primary source Western Australia

363
00:12:58,670 --> 00:12:56,250

and South Africa a little better that

364
00:13:00,290 --> 00:12:58,680
was the best picture I i had but the

365
00:13:02,270 --> 00:13:00,300
thing about North America as you have

366
00:13:04,280 --> 00:13:02,280
the sort of crate on which is the center

367
00:13:06,590 --> 00:13:04,290
of north america and it's like a

368
00:13:08,270 --> 00:13:06,600
continental the center of a continent

369
00:13:09,800 --> 00:13:08,280
that's head staff added on to it and

370
00:13:12,200 --> 00:13:09,810
stuff broken off of the edges but the

371
00:13:14,380 --> 00:13:12,210
center is really old and that's why you

372
00:13:30,890 --> 00:13:14,390
have all these old old rocks preserved

373
00:13:34,160 --> 00:13:30,900
any other questions yep so you showed

374
00:13:36,350 --> 00:13:34,170
this picture of a layered rock and you

375
00:13:38,300 --> 00:13:36,360
said that you think his layers are

376
00:13:40,610 --> 00:13:38,310
formed by bacteria I can't explain how

377
00:13:42,170 --> 00:13:40,620
you know that these layers are formed by

378
00:13:44,300 --> 00:13:42,180
bacteria so that's a great question

379
00:13:45,860 --> 00:13:44,310
because I'm the original thinking was

380
00:13:47,780 --> 00:13:45,870
that wall stromatolites were formed by

381
00:13:49,280 --> 00:13:47,790
bacteria and there's a growing idea that

382
00:13:51,980 --> 00:13:49,290
actually a lot of stromatolite X

383
00:13:54,020 --> 00:13:51,990
structures aren't necessarily microbial

384
00:13:56,030 --> 00:13:54,030
how you can usually tell as you have

385
00:13:58,280 --> 00:13:56,040
layers and they'll lay down flat to be

386
00:14:00,440 --> 00:13:58,290
laid up but the flat is along a cone

387
00:14:03,320 --> 00:14:00,450
shape and the grains are trapped in ways

388
00:14:04,790 --> 00:14:03,330

where if it was just dropping on there

389
00:14:06,590 --> 00:14:04,800
they would have rolled off if they were

390
00:14:07,880 --> 00:14:06,600
being trapped by something sticky and we

391
00:14:10,040 --> 00:14:07,890
think the most likely thing in those

392
00:14:11,450 --> 00:14:10,050
situations as there were organisms they

393
00:14:13,550 --> 00:14:11,460
were producing sticky extra

394
00:14:14,960 --> 00:14:13,560
polysaccharides or they actually fill

395
00:14:17,030 --> 00:14:14,970
them into scrolling around the grains

396
00:14:18,830 --> 00:14:17,040
and that's why they're being trapped you

397
00:14:20,420 --> 00:14:18,840
can certainly have structures that look

398
00:14:22,580 --> 00:14:20,430
like that but if you look at the

399
00:14:24,440 --> 00:14:22,590
microstructure it's hard to think of

400
00:14:26,060 --> 00:14:24,450
ways that biology could have been

401
00:14:28,400 --> 00:14:26,070
involved so there's definitely a range

402
00:14:33,230 --> 00:14:28,410
not all stromatolite say you know as are

403
00:14:34,550 --> 00:14:33,240
definitely biological but a lot are all

404
00:14:36,540 --> 00:14:34,560
right we need to move on so let's thank