Planet Topers

Model

Model – Tracing the Crust

- Different compositions:
  - black = mantle
  - blue = basaltic
  - green = felsic
  - red = continental
- New crust forms above a melt region (white)

1
00:00:13,590 --> 00:00:11,340
so when I talked about earlier I don't

2
00:00:16,140 --> 00:00:13,600
mean that because you know that's like

3
00:00:18,720 --> 00:00:16,150
help you would like to live here when I

4
00:00:21,029 --> 00:00:18,730
mean earlier for me something more like

5
00:00:23,370 --> 00:00:21,039
this so the surface temperature cool

6
00:00:28,860 --> 00:00:23,380
down already it's nice and comfortable

7
00:00:31,890 --> 00:00:28,870
up there maybe like 30 40 degrees okay

8
00:00:33,630 --> 00:00:31,900
can you hear me better now and not

9
00:00:35,940 --> 00:00:33,640
really I have to speak a little bit loud

10
00:00:40,380 --> 00:00:35,950
and scream a little bit okay no problem

11
00:00:42,360 --> 00:00:40,390
I can do that so as I said before when i

12
00:00:45,330 --> 00:00:42,370
think about earlier i do not think about

13
00:00:47,430 --> 00:00:45,340

this hellish earliest earth but i rather

14
00:00:49,890 --> 00:00:47,440
think about the time when the surface

15
00:00:51,510 --> 00:00:49,900
temperature cool down when he had oceans

16
00:00:55,319 --> 00:00:51,520
at the surface and it was becoming too

17
00:00:58,920 --> 00:00:55,329
nice and comfortable and then you have

18
00:01:01,950 --> 00:00:58,930
volcanism and first volcanic islands

19
00:01:05,639 --> 00:01:01,960
that soak up the water the oceanic water

20
00:01:07,740 --> 00:01:05,649
and at some point magically you turn

21
00:01:11,250 --> 00:01:07,750
them two continents and this is exactly

22
00:01:13,440 --> 00:01:11,260
what I'm trying to investigate how we

23
00:01:16,020 --> 00:01:13,450
can actually come from this point to

24
00:01:20,240 --> 00:01:16,030
that point where we see humans and it

25
00:01:31,109 --> 00:01:27,990
sure no problem so yes no let's go to

26
00:01:33,240 --> 00:01:31,119
the next slide already so coming back to

27
00:01:35,880 --> 00:01:33,250
the question of habitability what's the

28
00:01:37,679 --> 00:01:35,890
motivation of the study for those who

29
00:01:40,590 --> 00:01:37,689
have not been there yesterday for the

30
00:01:42,570 --> 00:01:40,600
estimize speaks competition plate

31
00:01:45,600 --> 00:01:42,580
tectonics seems to be very important for

32
00:01:48,120 --> 00:01:45,610
habitability of a planet or at least for

33
00:01:50,100 --> 00:01:48,130
earth seems to be very important so on

34
00:01:52,140 --> 00:01:50,110
the one hand plate tectonics itself

35
00:01:55,370 --> 00:01:52,150
leads to the regulation of the

36
00:01:57,840 --> 00:01:55,380
atmosphere on large global timescales

37
00:01:59,910 --> 00:01:57,850
because we all know this you to cycle

38
00:02:04,140 --> 00:01:59,920

from the news from the last ten years or

39
00:02:06,690 --> 00:02:04,150
something like that and the cabinet in

40
00:02:09,990 --> 00:02:06,700
the sediment basins abducted by plate

41
00:02:12,119 --> 00:02:10,000
tectonics into the mantle and nutrients

42
00:02:14,880 --> 00:02:12,129
are replenished by wrkn ism and this way

43
00:02:16,350 --> 00:02:14,890
you can regulate the atmosphere and the

44
00:02:17,740 --> 00:02:16,360
amount of carbon in the atmosphere on

45
00:02:21,460 --> 00:02:17,750
large timescale

46
00:02:24,970 --> 00:02:21,470
so we speak about several millions of

47
00:02:27,550 --> 00:02:24,980
years hundreds of million years on the

48
00:02:29,500 --> 00:02:27,560
other hand at the plate boundaries to

49
00:02:33,220 --> 00:02:29,510
the plate pounds like helium it was rich

50
00:02:34,870 --> 00:02:33,230
for example years rich days which there

51
00:02:37,270 --> 00:02:34,880
is a hydrothermal vents that we already

52
00:02:39,910 --> 00:02:37,280
heard about this morning and people

53
00:02:42,370 --> 00:02:39,920
speculate that life may have originated

54
00:02:44,710 --> 00:02:42,380
at these hydrothermal vents or at least

55
00:02:47,770 --> 00:02:44,720
have been frozen developed at these

56
00:02:50,320 --> 00:02:47,780
points so the question is if you

57
00:02:51,580 --> 00:02:50,330
wouldn't have plate tectonics and if you

58
00:02:52,930 --> 00:02:51,590
wouldn't have played down where it's

59
00:02:55,060 --> 00:02:52,940
what we actually do have this

60
00:02:56,830 --> 00:02:55,070
hydrothermal vents or not or what they

61
00:02:59,890 --> 00:02:56,840
look different so there might be some

62
00:03:02,590 --> 00:02:59,900
kind of a connection also another thing

63
00:03:05,110 --> 00:03:02,600

which we should be very thankful for is

64
00:03:07,690 --> 00:03:05,120
that plate tectonics helps to maintain a

65
00:03:10,690 --> 00:03:07,700
magnetic dynamo so this dynamism

66
00:03:14,229 --> 00:03:10,700
magnetosphere keeps the atmosphere from

67
00:03:17,250 --> 00:03:14,239
erosion by solar wind and therefore

68
00:03:19,510 --> 00:03:17,260
makes earth even more comfortable for us

69
00:03:21,400 --> 00:03:19,520
so but this is just about plate

70
00:03:24,759 --> 00:03:21,410
tectonics what's now about countenance

71
00:03:27,820 --> 00:03:24,769
while on the one hand continents helped

72
00:03:32,229 --> 00:03:27,830
on earth to have an enhanced land-based

73
00:03:34,060 --> 00:03:32,239
evolution so ours and to have larger

74
00:03:36,550 --> 00:03:34,070
biodiversity and if you wouldn't have

75
00:03:38,320 --> 00:03:36,560
had continents and on the other hand

76
00:03:40,270 --> 00:03:38,330
there could be some kind of a relation

77
00:03:43,390 --> 00:03:40,280
between continents and plate tectonics

78
00:03:47,710 --> 00:03:43,400
and therefore an indirect factor for the

79
00:03:49,750 --> 00:03:47,720
habitability so when did continents

80
00:03:52,330 --> 00:03:49,760
formal herbs or some kind of pre

81
00:03:54,130 --> 00:03:52,340
continent and plate tectonics what do we

82
00:03:56,110 --> 00:03:54,140
actually know well we did learn this

83
00:03:58,930 --> 00:03:56,120
morning already that we don't know that

84
00:04:00,789 --> 00:03:58,940
much actually but we already heard about

85
00:04:03,430 --> 00:04:00,799
a teaser cones which are very stable

86
00:04:05,140 --> 00:04:03,440
crystals and the oldest one that have

87
00:04:07,960 --> 00:04:05,150
been found so fine with Jack hills in

88
00:04:10,660 --> 00:04:07,970

Western Australia are 4.4 billion years

89
00:04:12,009 --> 00:04:10,670
old so this is really ought is like 100

90
00:04:15,880 --> 00:04:12,019
million years after the moon-forming

91
00:04:17,560 --> 00:04:15,890
impact and the interesting thing about

92
00:04:20,080 --> 00:04:17,570
it is that they formed together with

93
00:04:21,969 --> 00:04:20,090
granite so it's more fun as a quest

94
00:04:25,300 --> 00:04:21,979
almost 20 net across you could call it

95
00:04:29,140 --> 00:04:25,310
and it forms when hydrated pizzetta

96
00:04:31,570 --> 00:04:29,150
crust is somehow recycled reloading in

97
00:04:35,409 --> 00:04:31,580
which kind however

98
00:04:38,710 --> 00:04:35,419
so at this time 4.4 billion years ago

99
00:04:41,149 --> 00:04:38,720
oceans and some kind of crust to

100
00:04:43,279 --> 00:04:41,159
recycling was present at this time I

101
00:04:46,879 --> 00:04:43,289
won't say that it's plate tectonics but

102
00:04:49,040 --> 00:04:46,889
something was going on at the time so

103
00:04:50,960 --> 00:04:49,050
here you can see the timeline of what

104
00:04:52,879 --> 00:04:50,970
people think different people think when

105
00:04:56,149 --> 00:04:52,889
continents did form on earth and how

106
00:04:58,040 --> 00:04:56,159
much coordinates formed when so some

107
00:05:00,619 --> 00:04:58,050
people argue that the first continents

108
00:05:03,740 --> 00:05:00,629
formed actually really 4.4 billion years

109
00:05:07,399 --> 00:05:03,750
ago some argue that took like six 600

110
00:05:09,409 --> 00:05:07,409
500 600 more million years and then we

111
00:05:11,930 --> 00:05:09,419
have several different models and

112
00:05:14,899 --> 00:05:11,940
observations depending on continents

113
00:05:16,600 --> 00:05:14,909

should it right up we had already four

114
00:05:19,700 --> 00:05:16,610
by four billion years ago as many

115
00:05:22,909 --> 00:05:19,710
continents as today or actually took a

116
00:05:26,719 --> 00:05:22,919
long time and gradually increase the

117
00:05:28,760 --> 00:05:26,729
mass of the continents so the data point

118
00:05:30,649 --> 00:05:28,770
that we do have like right in the

119
00:05:34,279 --> 00:05:30,659
beginning something has been there

120
00:05:38,180 --> 00:05:34,289
because we do have the circles and in

121
00:05:41,300 --> 00:05:38,190
the last 300 400 years 500 years we

122
00:05:44,629 --> 00:05:41,310
don't know roughly what the amount of

123
00:05:46,939 --> 00:05:44,639
continents but that's actually problem

124
00:05:48,260 --> 00:05:46,949
if you want to simulate continents and

125
00:05:51,620 --> 00:05:48,270
against continents and plate tectonics

126
00:05:53,600 --> 00:05:51,630
and our models because if we run models

127
00:05:56,659 --> 00:05:53,610
we see heat that we did have at the

128
00:05:59,809 --> 00:05:56,669
beginning of zeros in the interior of

129
00:06:02,089 --> 00:05:59,819
mental we should actually end up with a

130
00:06:05,149 --> 00:06:02,099
stagnant little planet so we heard

131
00:06:07,879 --> 00:06:05,159
yesterday again already about technip

132
00:06:09,260 --> 00:06:07,889
planets versus play tektronix planets so

133
00:06:13,249 --> 00:06:09,270
this would be like Mars this would be

134
00:06:16,189 --> 00:06:13,259
like Earth and if the amount is very

135
00:06:19,610 --> 00:06:16,199
very hot and warm you were most likely

136
00:06:22,040 --> 00:06:19,620
not have plate tectonics and first the

137
00:06:25,070 --> 00:06:22,050
planet has to cool going rather than to

138
00:06:29,059 --> 00:06:25,080

this age to be able to have plate

139
00:06:31,730 --> 00:06:29,069
tectonics so that's why we model it and

140
00:06:34,100 --> 00:06:31,740
try to see what happens when we can

141
00:06:36,740 --> 00:06:34,110
actually form continents and how long it

142
00:06:39,860 --> 00:06:36,750
takes and which processes can be used to

143
00:06:41,629 --> 00:06:39,870
get continent so this kind of picture

144
00:06:44,370 --> 00:06:41,639
you will see now in the next slide tues

145
00:06:46,710 --> 00:06:44,380
well i will explain it a little bit

146
00:06:48,180 --> 00:06:46,720
and you can see several different colors

147
00:06:51,480 --> 00:06:48,190
here in this picture and they are

148
00:06:54,030 --> 00:06:51,490
tracing the composition there is a black

149
00:06:57,060 --> 00:06:54,040
color like here for example is like

150
00:07:00,570 --> 00:06:57,070
mantle material non depleted by

151
00:07:03,570 --> 00:07:00,580
monumental silicates the blue collar is

152
00:07:08,570 --> 00:07:03,580
bizarre d crust the Flexi primordial

153
00:07:14,330 --> 00:07:08,580
crust has produced by mult green or like

154
00:07:17,490 --> 00:07:14,340
housing or less a thick crust is what

155
00:07:20,100 --> 00:07:17,500
could have been at the time and we found

156
00:07:21,900 --> 00:07:20,110
the circles first circle hmmm and the

157
00:07:24,630 --> 00:07:21,910
red color means that we really have

158
00:07:28,140 --> 00:07:24,640
granites continental crust like we see

159
00:07:30,050 --> 00:07:28,150
you today as continents and these white

160
00:07:33,540 --> 00:07:30,060
regions are always melt regions and

161
00:07:39,180 --> 00:07:33,550
above melt regions continental crust is

162
00:07:41,280 --> 00:07:39,190
formed and to actually come from besadii

163
00:07:44,040 --> 00:07:41,290

quest to continental crust you have to

164
00:07:46,980 --> 00:07:44,050
subtract the vet Posada quest we made it

165
00:07:49,620 --> 00:07:46,990
again to come to fair the quest Reese

166
00:07:55,160 --> 00:07:49,630
abducted again to come to real grenade

167
00:07:57,570 --> 00:07:55,170
for the crust so if you now just try to

168
00:07:58,950 --> 00:07:57,580
understand how continents actually

169
00:08:02,460 --> 00:07:58,960
influence a simulation of plate

170
00:08:04,500 --> 00:08:02,470
tectonics here we f or I've done seven

171
00:08:07,020 --> 00:08:04,510
models where is that with some kind of

172
00:08:10,290 --> 00:08:07,030
three continents so this fails across

173
00:08:14,070 --> 00:08:10,300
the screen quest to see if it can help

174
00:08:16,500 --> 00:08:14,080
to actually get plate tectonics and at

175
00:08:19,050 --> 00:08:16,510
this simulation you can see that at the

176
00:08:22,530 --> 00:08:19,060
boundaries of these three continents and

177
00:08:25,140 --> 00:08:22,540
the normal crust due to larger stresses

178
00:08:28,370 --> 00:08:25,150
clay tectonics initiate at this point

179
00:08:31,770 --> 00:08:28,380
and plates status abduct at these points

180
00:08:33,930 --> 00:08:31,780
so if you investigated over time you

181
00:08:36,900 --> 00:08:33,940
have more massive action new continent

182
00:08:39,000 --> 00:08:36,910
new physique fastest forming at some

183
00:08:41,730 --> 00:08:39,010
point as fairly classes also subtracted

184
00:08:44,330 --> 00:08:41,740
and then you can end up with the first

185
00:08:49,170 --> 00:08:44,340
countenance which are very very small

186
00:08:51,510 --> 00:08:49,180
but grow this time but the problem is

187
00:08:53,400 --> 00:08:51,520
that on earth we wouldn't start with his

188
00:08:55,440 --> 00:08:53,410

pre countenance we would start with a

189
00:08:57,870 --> 00:08:55,450
standard bizarre the crust that we also

190
00:08:59,550 --> 00:08:57,880
have it all other planets if you can

191
00:09:03,770 --> 00:08:59,560
investigates affirm or terrestrial

192
00:09:06,960 --> 00:09:03,780
planets I should say so then I started

193
00:09:09,240 --> 00:09:06,970
like an early Earth scenario so this

194
00:09:11,040 --> 00:09:09,250
deep data actually only for people that

195
00:09:13,020 --> 00:09:11,050
are mental conduction simulations that

196
00:09:16,310 --> 00:09:13,030
they believe me that I try to be as

197
00:09:19,650 --> 00:09:16,320
Earth's like or earlier like as possible

198
00:09:22,890 --> 00:09:19,660
using also present day or actually

199
00:09:26,160 --> 00:09:22,900
realistic yet stresses that you have to

200
00:09:28,980 --> 00:09:26,170
overcome to actually be able to break

201
00:09:33,240 --> 00:09:28,990
material to actually get weak sense to

202
00:09:36,900 --> 00:09:33,250
initiate plate tectonics and using

203
00:09:39,470 --> 00:09:36,910
peridotite med curves and they're

204
00:09:42,270 --> 00:09:39,480
already after very very short time

205
00:09:44,520 --> 00:09:42,280
services like 230 million years after

206
00:09:48,540 --> 00:09:44,530
the moon-forming impact so this starts

207
00:09:50,880 --> 00:09:48,550
at zero is the moon-forming impact we

208
00:09:53,460 --> 00:09:50,890
can see that we have a lot of convection

209
00:09:55,200 --> 00:09:53,470
going on in the mantle so the cause or

210
00:09:59,190 --> 00:09:55,210
basic North I only simulates a mantle

211
00:10:02,130 --> 00:09:59,200
and since we have so much heat in the

212
00:10:04,140 --> 00:10:02,140
mantle because planets start very hot we

213
00:10:07,050 --> 00:10:04,150

have very very a very silly little

214
00:10:10,020 --> 00:10:07,060
sphere and here you can see the

215
00:10:12,570 --> 00:10:10,030
different convection zone so why means

216
00:10:14,790 --> 00:10:12,580
that we have strong connection red means

217
00:10:16,320 --> 00:10:14,800
that we have V convection and black

218
00:10:18,980 --> 00:10:16,330
means that we have no connection at all

219
00:10:22,230 --> 00:10:18,990
so if this would be a mass picture

220
00:10:25,440 --> 00:10:22,240
everything up here would be black on

221
00:10:27,300 --> 00:10:25,450
earth however since we have so much heat

222
00:10:29,190 --> 00:10:27,310
in the beginning everything's like

223
00:10:31,500 --> 00:10:29,200
moving around a little bit even the

224
00:10:33,960 --> 00:10:31,510
surface is locally mobilized at the

225
00:10:36,090 --> 00:10:33,970
surface but the problem is that Matt is

226
00:10:39,000 --> 00:10:36,100
really hot so the surface material

227
00:10:41,190 --> 00:10:39,010
cannot go down it's less dense and the

228
00:10:42,870 --> 00:10:41,200
material beneath and the mantle materia

229
00:10:48,420 --> 00:10:42,880
so the bizarre teclast always wants to

230
00:10:51,540 --> 00:10:48,430
somehow flow on top and only when demand

231
00:10:53,900 --> 00:10:51,550
is not that hot anymore plates can

232
00:10:57,800 --> 00:10:53,910
actually subtract into the mantle

233
00:11:01,080 --> 00:10:57,810
however after some time since this

234
00:11:03,840 --> 00:11:01,090
surface crust gets mobilized and pushed

235
00:11:06,120 --> 00:11:03,850
against each other surface crust this

236
00:11:09,990 --> 00:11:06,130
way can somehow recycle into the mantle

237
00:11:10,790 --> 00:11:10,000
because it's pushed together and this

238
00:11:14,780 --> 00:11:10,800

way you can

239
00:11:17,630 --> 00:11:14,790
have like melting right Vanessa crust so

240
00:11:20,530 --> 00:11:17,640
this quest then is remodel which is not

241
00:11:23,889 --> 00:11:20,540
play tectonics it's something different

242
00:11:26,840 --> 00:11:23,899
still have to find a name for that and

243
00:11:30,230 --> 00:11:26,850
this week you can actually form first

244
00:11:34,220 --> 00:11:30,240
first pair the crust and first

245
00:11:37,900 --> 00:11:34,230
continental crust and after 300 million

246
00:11:42,710 --> 00:11:37,910
years already have some larger

247
00:11:47,329 --> 00:11:42,720
continents / that have been produced at

248
00:11:50,410 --> 00:11:47,339
that time without static tonics so here

249
00:11:53,600 --> 00:11:50,420
you can see that the the crustal volume

250
00:11:56,960 --> 00:11:53,610
over time again he is moon-forming

251
00:11:59,840 --> 00:11:56,970
impact and you can see that after some

252
00:12:01,160 --> 00:11:59,850
time crust actually felt across and

253
00:12:03,530 --> 00:12:01,170
continental crust formed at the same

254
00:12:05,720 --> 00:12:03,540
time because just everything that's the

255
00:12:10,400 --> 00:12:05,730
surface some are pushed down at the same

256
00:12:12,740 --> 00:12:10,410
time very interestingly if you look at

257
00:12:15,769 --> 00:12:12,750
the arm stress field or the strain rate

258
00:12:18,500 --> 00:12:15,779
field we can see that again locally at

259
00:12:20,510 --> 00:12:18,510
these points where the first continents

260
00:12:23,540 --> 00:12:20,520
have formed we actually have rather

261
00:12:26,300 --> 00:12:23,550
large stressors so these are the points

262
00:12:28,850 --> 00:12:26,310
where later on during the evolution of

263
00:12:32,210 --> 00:12:28,860

the man to cool down plate tectonics can

264
00:12:35,930 --> 00:12:32,220
initiate again or actually can finally

265
00:12:38,180 --> 00:12:35,940
initiate and this now brings up a new

266
00:12:41,569 --> 00:12:38,190
idea of how actually continents and

267
00:12:43,280 --> 00:12:41,579
plate tectonics formed on earth there is

268
00:12:45,350 --> 00:12:43,290
a possible continent formation would be

269
00:12:46,430 --> 00:12:45,360
that in the beginning right here you

270
00:12:49,579 --> 00:12:46,440
would have some kind of service

271
00:12:52,280 --> 00:12:49,589
mobilization no subduction of the mantle

272
00:12:56,180 --> 00:12:52,290
material but rather pushing together of

273
00:13:00,439 --> 00:12:56,190
society crust this way pre continents

274
00:13:02,420 --> 00:13:00,449
can be formed very early in time but it

275
00:13:06,829 --> 00:13:02,430
takes a long time and dismantle actually

276
00:13:09,160 --> 00:13:06,839
cuts down that we have the initiation of

277
00:13:11,990 --> 00:13:09,170
plant economics attached at this point

278
00:13:14,030 --> 00:13:12,000
so if you look again at the warrior of

279
00:13:17,000 --> 00:13:14,040
the continental crust what my modest

280
00:13:18,439 --> 00:13:17,010
would predict is that we have some crust

281
00:13:20,449 --> 00:13:18,449
formation continental crust formation

282
00:13:22,569 --> 00:13:20,459
right in the beginning then more or less

283
00:13:25,869 --> 00:13:22,579
nothing is happening for a large time

284
00:13:28,569 --> 00:13:25,879
and then the formation of the present a

285
00:13:30,939 --> 00:13:28,579
countenance shoots and starts begin due

286
00:13:57,000 --> 00:13:30,949
to the initiation of plate tectonics so

287
00:14:04,030 --> 00:13:59,590
so in this model it's about volume of

288
00:14:06,370 --> 00:14:04,040

the continent so I don't have different

289
00:14:09,090 --> 00:14:06,380
heights of continents yet so they all

290
00:14:12,100 --> 00:14:09,100
have the same height of 20 kilometers

291
00:14:13,660 --> 00:14:12,110
yep so the area forms automatically this

292
00:14:16,780 --> 00:14:13,670
time and you can you build up new

293
00:14:18,370 --> 00:14:16,790
continents and also continents can

294
00:14:20,950 --> 00:14:18,380
converge together this way you get

295
00:14:23,080 --> 00:14:20,960
larger countenance but the volume is

296
00:14:27,100 --> 00:14:23,090
restricted in such a way that I cannot

297
00:14:31,870 --> 00:14:27,110
have mountains yet did we have another

298
00:14:35,380 --> 00:14:31,880
question so how long after Earth's

299
00:14:38,980 --> 00:14:35,390
formation would you put the start of

300
00:14:41,320 --> 00:14:38,990
plate tectonics that really depends on

301
00:14:43,480 --> 00:14:41,330
the parameters so that's also why didn't

302
00:14:45,160 --> 00:14:43,490
gave her real number so here you can see

303
00:14:47,430 --> 00:14:45,170
that at some point suddenly plate

304
00:14:51,510 --> 00:14:47,440
tectonics heads in but this depends on

305
00:14:54,130 --> 00:14:51,520
really it can be anywhere in this region

306
00:14:57,730 --> 00:14:54,140
depending on how fast the mantle really

307
00:15:01,150 --> 00:14:57,740
cool how strong connection was on the

308
00:15:04,060 --> 00:15:01,160
exact initial parameters but you're so

309
00:15:07,330 --> 00:15:04,070
your diagrams it essentially shows it

310
00:15:11,020 --> 00:15:07,340
about a billion years after life it

311
00:15:14,410 --> 00:15:11,030
after we have fossils after life began

312
00:15:17,800 --> 00:15:14,420
on this earth is that true or am I

313
00:15:19,630 --> 00:15:17,810

missing that or I can't see that you

314
00:15:21,100 --> 00:15:19,640
mean this point here all right there so

315
00:15:23,170 --> 00:15:21,110
there's a what is more just an

316
00:15:26,110 --> 00:15:23,180
indication of that it takes a long time

317
00:15:29,020 --> 00:15:26,120
or can take a long time at until actual

318
00:15:31,510 --> 00:15:29,030
a tectonic starts but you can have some

319
00:15:33,130 --> 00:15:31,520
kind of continuous continent formation

320
00:15:35,440 --> 00:15:33,140
even though its own unique formation

321
00:15:38,500 --> 00:15:35,450
before real plate tectonics or present

322
00:15:41,730 --> 00:15:38,510
day like data tonics energy is so it's

323
00:15:44,730 --> 00:15:41,740
not a problem with the fossils because

324
00:15:47,410 --> 00:15:44,740
you would have some kind of continental

325
00:15:51,760 --> 00:15:47,420
preserved material right in the

326
00:15:53,380 --> 00:15:51,770
beginning already I'm sorry we don't

327
00:15:54,580 --> 00:15:53,390
have any more questions time for any

328
00:15:56,380 --> 00:15:54,590
more questions right now if you could

329
00:15:59,470 --> 00:15:56,390
have addressed this to Lena after