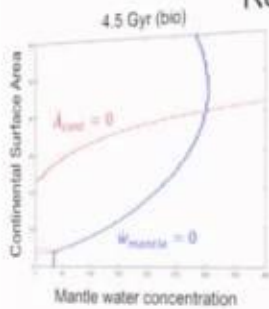


Results



1
00:00:11,699 --> 00:00:08,820
okay yesterday we had this nice panel

2
00:00:14,940 --> 00:00:11,709
discussion and this question came up

3
00:00:17,999 --> 00:00:14,950
what may I study if I want to become an

4
00:00:21,900 --> 00:00:18,009
astrobiologist so we mentioned several

5
00:00:25,740 --> 00:00:21,910
fields like biology chemistry geology

6
00:00:28,109 --> 00:00:25,750
and engineering science but one field

7
00:00:32,940 --> 00:00:28,119
was missing and this is actually my

8
00:00:34,650 --> 00:00:32,950
field so geophysics and so I think I

9
00:00:38,700 --> 00:00:34,660
have to advertise a little bit for

10
00:00:41,880 --> 00:00:38,710
geophysics in this field as a

11
00:00:46,020 --> 00:00:41,890
geophysicist you can basically come from

12
00:00:48,630 --> 00:00:46,030
two directions to astrobiology and the

13
00:00:52,680 --> 00:00:48,640

one direction is the big topic

14

00:00:55,350 --> 00:00:52,690

habitability so what does a geophysicist

15

00:00:57,180 --> 00:00:55,360

have to do with habitability for example

16

00:01:01,650 --> 00:00:57,190

if you look at plate tectonics you can

17

00:01:03,540 --> 00:01:01,660

decide or you can find out y 0 SS plate

18

00:01:05,280 --> 00:01:03,550

tectonics and why other planets do not

19

00:01:08,399 --> 00:01:05,290

have plate tectonics what about

20

00:01:10,950 --> 00:01:08,409

exoplanets what about big size planets

21

00:01:13,520 --> 00:01:10,960

about five earth masses also does five

22

00:01:16,559 --> 00:01:13,530

earth-mass planet low plate tectonics

23

00:01:20,149 --> 00:01:16,569

what about volcanism is it more likely

24

00:01:23,249 --> 00:01:20,159

on bigger planets on smaller planets and

25

00:01:26,879 --> 00:01:23,259

is there enough outgassing for example

26
00:01:29,099 --> 00:01:26,889
to maintain an atmosphere at smaller

27
00:01:31,559 --> 00:01:29,109
sized planets like Mars like or even

28
00:01:34,679 --> 00:01:31,569
smaller so this is all about the

29
00:01:39,029 --> 00:01:34,689
habitability but you and we also saw a

30
00:01:41,849 --> 00:01:39,039
nice talk by lena a few minutes ago in

31
00:01:44,190 --> 00:01:41,859
this direction but it's not all about

32
00:01:46,230 --> 00:01:44,200
habitability you also can go from

33
00:01:51,059 --> 00:01:46,240
another direction and i will talk a

34
00:01:53,550 --> 00:01:51,069
little bit about it so if you have your

35
00:01:56,219 --> 00:01:53,560
model how's yours evolves with time

36
00:02:00,599 --> 00:01:56,229
starting with the origin of the earth

37
00:02:03,209 --> 00:02:00,609
and then you you put in all the

38
00:02:07,080 --> 00:02:03,219

parameters and you start your in your

39

00:02:12,570 --> 00:02:07,090

model z us to evolve and you end up at

40

00:02:15,390 --> 00:02:12,580

present day earth and so all is nice but

41

00:02:18,360 --> 00:02:15,400

if you know do the same thing again but

42

00:02:19,180 --> 00:02:18,370

switch some parameter off and you can

43

00:02:23,110 --> 00:02:19,190

have

44

00:02:26,200 --> 00:02:23,120

this parameter you may find some

45

00:02:30,100 --> 00:02:26,210

parameter which is related to life so

46

00:02:33,610 --> 00:02:30,110

you may switch life off and you can find

47

00:02:35,920 --> 00:02:33,620

out how the planet evolves and if you

48

00:02:40,360 --> 00:02:35,930

now observe some exoplanets you can

49

00:02:44,230 --> 00:02:40,370

basically look at these differences and

50

00:02:46,900 --> 00:02:44,240

may distinguish if it's related of life

51
00:02:49,840 --> 00:02:46,910
is there life present or not and my talk

52
00:02:52,330 --> 00:02:49,850
is about this direction and basically

53
00:02:59,170 --> 00:02:52,340
it's about a continental crust

54
00:03:02,920 --> 00:02:59,180
production so so I start with a with the

55
00:03:04,450 --> 00:03:02,930
approach to form continental crust

56
00:03:07,840 --> 00:03:04,460
continents are formed in subduction

57
00:03:09,700 --> 00:03:07,850
zones point is here yep continents are

58
00:03:12,490 --> 00:03:09,710
formed in subduction zones over here

59
00:03:15,580 --> 00:03:12,500
when water is present at depths and this

60
00:03:18,190 --> 00:03:15,590
is very important because it's not very

61
00:03:21,850 --> 00:03:18,200
clear how you can get water very deep

62
00:03:24,130 --> 00:03:21,860
and we have this oceanic crust which is

63
00:03:27,610 --> 00:03:24,140

abducted beneath the continental crust

64

00:03:36,010 --> 00:03:27,620

we have sediments which are subducted

65

00:03:38,050 --> 00:03:36,020

and now I can yeah and now how do you

66

00:03:40,570 --> 00:03:38,060

get this sediment the sediments are

67

00:03:44,320 --> 00:03:40,580

basically from the continent by erosion

68

00:03:48,280 --> 00:03:44,330

and there are several effects while life

69

00:03:51,970 --> 00:03:48,290

could affect this continental erosion

70

00:03:55,060 --> 00:03:51,980

rate by weathering processes and so you

71

00:03:56,770 --> 00:03:55,070

form the sedimentary layer and if you

72

00:03:59,470 --> 00:03:56,780

know look at very shallow depths the

73

00:04:03,310 --> 00:03:59,480

first few kilometers and before the

74

00:04:05,710 --> 00:04:03,320

metamorphic reaction take place you you

75

00:04:08,790 --> 00:04:05,720

have shallow dewatering and you will

76
00:04:12,009 --> 00:04:08,800
lose a lot of your water but if you have

77
00:04:13,990 --> 00:04:12,019
sufficient amounts of clays in the

78
00:04:17,800 --> 00:04:14,000
sediments which have low permeability

79
00:04:22,750 --> 00:04:17,810
you you can suppress some of these

80
00:04:25,540 --> 00:04:22,760
shallow dewatering and this will lead to

81
00:04:27,909 --> 00:04:25,550
a more available water in greater depth

82
00:04:31,300 --> 00:04:27,919
and it will enhance your continental

83
00:04:32,980 --> 00:04:31,310
production rate and also the mental

84
00:04:38,400 --> 00:04:32,990
water regarding rate

85
00:04:41,980 --> 00:04:38,410
now as a geophysicist this in turn

86
00:04:44,950 --> 00:04:41,990
impacts the model because a mentor in

87
00:04:49,060 --> 00:04:44,960
the water in the mental reduces the

88
00:04:55,050 --> 00:04:49,070

viscosity of of the mantle convection

89

00:04:57,580 --> 00:04:55,060

and stuff like this so I sketched I I

90

00:05:00,340 --> 00:04:57,590

did not include any formulas in this

91

00:05:03,490 --> 00:05:00,350

presentation to not bore you with but i

92

00:05:05,800 --> 00:05:03,500

just want to mention is a key link again

93

00:05:07,830 --> 00:05:05,810

so was increasing by bioactivity you

94

00:05:10,480 --> 00:05:07,840

increase the continental erosion rate

95

00:05:14,170 --> 00:05:10,490

the thickness of the sedimentary layer

96

00:05:16,840 --> 00:05:14,180

also the shallow dewatering decreases

97

00:05:19,420 --> 00:05:16,850

you have more water available in greater

98

00:05:21,580 --> 00:05:19,430

depth and it's enhanced the continental

99

00:05:24,910 --> 00:05:21,590

production and mentor gassing great so I

100

00:05:28,060 --> 00:05:24,920

just skip the rest of the model how I do

101

00:05:31,810 --> 00:05:28,070

it mathematically but show the results

102

00:05:33,340 --> 00:05:31,820

and what you see here is a face plan

103

00:05:35,410 --> 00:05:33,350

which is spent by the mental water

104

00:05:38,670 --> 00:05:35,420

concentration in the continental surface

105

00:05:41,110 --> 00:05:38,680

area and each dot in this phase plane is

106

00:05:43,390 --> 00:05:41,120

representative for one state where the

107

00:05:46,360 --> 00:05:43,400

earth basically could be for example if

108

00:05:49,020 --> 00:05:46,370

you are here then your earth have a very

109

00:05:54,070 --> 00:05:49,030

wet mental and no continents at all and

110

00:05:56,740 --> 00:05:54,080

each point or in this red line shows a

111

00:05:58,540 --> 00:05:56,750

point where the continental surface area

112

00:06:01,390 --> 00:05:58,550

does not change with time anymore and

113

00:06:03,190 --> 00:06:01,400

the blue line shows each value whether a

114

00:06:05,290 --> 00:06:03,200

mental water concentration does not

115

00:06:08,740 --> 00:06:05,300

change with time so you got one point

116

00:06:10,750 --> 00:06:08,750

basically where two lines cross so you

117

00:06:12,880 --> 00:06:10,760

got a stable fixed point over there and

118

00:06:14,680 --> 00:06:12,890

now independently from where you start

119

00:06:17,860 --> 00:06:14,690

in the neighborhood you always will run

120

00:06:21,370 --> 00:06:17,870

into the stable fixed point about forty

121

00:06:24,070 --> 00:06:21,380

percent continental coverage as we are

122

00:06:28,300 --> 00:06:24,080

also observe them on earth and this self

123

00:06:33,250 --> 00:06:28,310

consistent result of the model and now

124

00:06:36,850 --> 00:06:33,260

you can have three fourths that is not a

125

00:06:41,560 --> 00:06:36,860

nice table because the transition to

126

00:06:46,000 --> 00:06:41,570

this neck but you can see we are here so

127

00:06:46,719 --> 00:06:46,010

we have 4.5 billions of years and we are

128

00:06:49,480 --> 00:06:46,729

by

129

00:06:54,459 --> 00:06:49,490

we have a biotic continental Rosen rate

130

00:06:58,540 --> 00:06:54,469

and now I can just go from from this to

131

00:07:00,850 --> 00:06:58,550

here to to go to an abiotic planet and

132

00:07:05,200 --> 00:07:00,860

you can see how the face plant shifts

133

00:07:07,209 --> 00:07:05,210

and first of all you see that the the

134

00:07:09,339 --> 00:07:07,219

stable fixed point moves up because the

135

00:07:11,619 --> 00:07:09,349

continental erosion rate decreases and

136

00:07:14,769 --> 00:07:11,629

so you can end up with more continents

137

00:07:17,890 --> 00:07:14,779

but at the same time you see that the

138

00:07:22,089 --> 00:07:17,900

second stable fixed point evolves with

139

00:07:24,129 --> 00:07:22,099

very tiny continent and a very low

140

00:07:26,170 --> 00:07:24,139

mentor water concentration and now

141

00:07:28,779 --> 00:07:26,180

suddenly depends where you start because

142

00:07:30,579 --> 00:07:28,789

you can also run into this stable fixed

143

00:07:32,799 --> 00:07:30,589

point with very low meant for water

144

00:07:35,519 --> 00:07:32,809

concentration and continents and so

145

00:07:42,249 --> 00:07:35,529

where did you end up and this is why I

146

00:07:45,309 --> 00:07:42,259

started at zero Giga years so just

147

00:07:47,950 --> 00:07:45,319

videos developed and how the phase plane

148

00:07:52,480 --> 00:07:47,960

looks like for an abiotic earth and I

149

00:07:54,129 --> 00:07:52,490

just move up and I start with 300 ppm

150

00:07:56,050 --> 00:07:54,139

enter water concentration and without

151

00:07:58,149 --> 00:07:56,060

continents and here you see all the

152

00:08:02,829 --> 00:07:58,159

continental growth rate evolves with

153

00:08:04,420 --> 00:08:02,839

time and I've I just go up and you see

154

00:08:06,399 --> 00:08:04,430

all the phase plane shifts and how the

155

00:08:09,969 --> 00:08:06,409

continental surface area of all this

156

00:08:12,670 --> 00:08:09,979

time and you see that you will end up or

157

00:08:15,429 --> 00:08:12,680

some terminate at this lower stable

158

00:08:20,199 --> 00:08:15,439

fixed point without your with a ten

159

00:08:29,649 --> 00:08:20,209

percent continent coverage and a more or

160

00:08:33,189 --> 00:08:29,659

less dry mental yeah but it's okay you

161

00:08:36,939 --> 00:08:33,199

can do the same again and suddenly you

162

00:08:40,180 --> 00:08:36,949

can for at one billions of years you can

163

00:08:46,120 --> 00:08:40,190

switch on life in the model and so you

164

00:08:49,240 --> 00:08:46,130

basically go from up to down by ya ever

165

00:08:51,009 --> 00:08:49,250

increasing the the continental Rosen

166

00:08:58,780 --> 00:08:51,019

rate and you see how the phase plane

167

00:09:00,700 --> 00:08:58,790

shift and then you you start your yeah

168

00:09:04,750 --> 00:09:00,710

you run your you continue to run your

169

00:09:09,820 --> 00:09:04,760

and you see how suddenly the whole

170

00:09:11,410 --> 00:09:09,830

system evolves into the this stable

171

00:09:13,660 --> 00:09:11,420

fixed point above there and you will

172

00:09:16,300 --> 00:09:13,670

also terminate there and you see how the

173

00:09:19,690 --> 00:09:16,310

continental surface area evolves with

174

00:09:22,660 --> 00:09:19,700

time and so this is my conclusion that

175

00:09:25,570 --> 00:09:22,670

life that there is our ways where life

176

00:09:28,750 --> 00:09:25,580

impact continental growth and we also

177

00:09:31,480 --> 00:09:28,760

find it founded transition that you may

178

00:09:33,970 --> 00:09:31,490

end up at this stable fixed point with

179

00:09:38,590 --> 00:09:33,980

low continental surface area and may

180

00:09:43,590 --> 00:09:38,600

evolve with the origin of life to thirty

181

00:09:46,840 --> 00:09:43,600

five percent and continents in turn

182

00:09:48,940 --> 00:09:46,850

helps life again because they have a

183

00:09:51,250 --> 00:09:48,950

solar energy as they helped us harvest

184

00:09:54,850 --> 00:09:51,260

solar energy because they got direct

185

00:09:57,490 --> 00:09:54,860

access to to this processor so there's a

186

00:09:59,710 --> 00:09:57,500

feedback again and we can ask ourselves

187

00:10:02,380 --> 00:09:59,720

whether our life always change the

188

00:10:06,010 --> 00:10:02,390

planet in this way that the amount of

189

00:10:14,980 --> 00:10:06,020

available energy is maximized and I want

190

00:10:33,940 --> 00:10:14,990

to end with the sexy do we have any

191

00:10:41,180 --> 00:10:38,780

no what I did take into account is that

192

00:10:44,780 --> 00:10:41,190

if you have a lot of water and you

193

00:10:48,340 --> 00:10:44,790

mentally or viscosity decreases and with

194

00:10:52,280 --> 00:10:48,350

decreasing viscosity your convection is

195

00:10:55,400 --> 00:10:52,290

faster and with faster convection also

196

00:10:59,840 --> 00:10:55,410

the subduction goes faster so and and

197

00:11:02,540 --> 00:10:59,850

this in turn also is rated that that the

198

00:11:04,970 --> 00:11:02,550

surface is that that you cannot lose so

199

00:11:09,530 --> 00:11:04,980

much water and so on and also the

200

00:11:11,090 --> 00:11:09,540

temperatures I am I included that at the

201
00:11:18,980 --> 00:11:11,100
beginning of the earth it's very hot and

202
00:11:21,500 --> 00:11:18,990
stuff it at how many points in time can

203
00:11:23,120 --> 00:11:21,510
you turn on life and still wind up with

204
00:11:28,010 --> 00:11:23,130
an appropriate amount of continental

205
00:11:29,840 --> 00:11:28,020
surface area authorial kind of good what

206
00:11:32,240 --> 00:11:29,850
is the range of times where you can turn

207
00:11:34,100 --> 00:11:32,250
life on in your models to wind up with

208
00:11:37,400 --> 00:11:34,110
the right amount of continental area ah

209
00:11:39,740 --> 00:11:37,410
you mean at one billions of years or

210
00:11:47,570 --> 00:11:39,750
right yeah how far can you lose that um

211
00:11:51,579 --> 00:11:47,580
its relative robust so I I can turn it

212
00:11:54,680 --> 00:11:51,589
off just at the beginning of the OC us

213
00:11:57,650 --> 00:11:54,690

but but you're right if I turn it too

214

00:11:59,810 --> 00:11:57,660

late on then you will evolve into the

215

00:12:02,960 --> 00:11:59,820

first ever fixed point with the lowest

216

00:12:05,420 --> 00:12:02,970

continental surface area I did not find

217

00:12:07,370 --> 00:12:05,430

out where the transition asst but there

218

00:12:14,570 --> 00:12:07,380

will be some transition over there all