



Marine Lasbleis

*The Earth's core & the origin of
planetary magnetic fields*

1
00:00:12,860 --> 00:00:10,180

[Music]

2
00:00:15,260 --> 00:00:12,870

Thank You hall for being there so my

3
00:00:17,359 --> 00:00:15,270

name is Mohini let's blaze I'm going to

4
00:00:21,050 --> 00:00:17,369

talk about the magnetic field in earth

5
00:00:25,310 --> 00:00:21,060

and how its generated and obviously you

6
00:00:29,270 --> 00:00:25,320

may hear it from my voice I'm French

7
00:00:31,070 --> 00:00:29,280

which is why I put French here but don't

8
00:00:33,710 --> 00:00:31,080

don't worry I'm not going to speak in

9
00:00:35,990 --> 00:00:33,720

French I try to speak in English and I

10
00:00:39,200 --> 00:00:36,000

try to speak slowly to help for the

11
00:00:41,479 --> 00:00:39,210

translation and I put some Japanese text

12
00:00:43,130 --> 00:00:41,489

on my slides so I hope it's correct

13
00:00:47,149 --> 00:00:43,140

Japanese because I don't know any

14

00:00:49,130 --> 00:00:47,159

Japanese or almost and yeah so I'm going

15

00:00:53,509 --> 00:00:49,140

to talk about the Earth's core and the

16

00:00:56,689 --> 00:00:53,519

magnetic field and when I was trying to

17

00:00:59,719 --> 00:00:56,699

think about this talk I was wondering

18

00:01:02,899 --> 00:00:59,729

what people think when they hear the

19

00:01:06,320 --> 00:01:02,909

world magnetic field for me there is two

20

00:01:08,660 --> 00:01:06,330

things that are kind of amazing that

21

00:01:11,920 --> 00:01:08,670

happens on earth and that are related to

22

00:01:17,719 --> 00:01:11,930

magnetic field the first thing is that

23

00:01:21,649 --> 00:01:17,729

you all went hiking or you all use at

24

00:01:24,080 --> 00:01:21,659

least once a compass I also and we can

25

00:01:27,410 --> 00:01:24,090

see it we can decide what's north and

26

00:01:29,539 --> 00:01:27,420

what south on earth because of magnetic

27

00:01:32,270 --> 00:01:29,549

field and because it helped us with

28

00:01:34,310 --> 00:01:32,280

combusts be able to see which side is

29

00:01:37,069 --> 00:01:34,320

north which eyes which side the south

30

00:01:38,480 --> 00:01:37,079

and were not blessed whenever we have a

31

00:01:42,469 --> 00:01:38,490

compass at least for now so the house

32

00:01:45,620 --> 00:01:42,479

and the second thing is this which is

33

00:01:50,419 --> 00:01:45,630

Aurora's so that's a view from space of

34

00:01:52,789 --> 00:01:50,429

an Aurora on the South Pole and this is

35

00:01:55,340 --> 00:01:52,799

because of the interaction between the

36

00:01:58,130 --> 00:01:55,350

Sarah winds and the Earth's atmosphere

37

00:02:00,620 --> 00:01:58,140

and the reason it's only on the pole is

38

00:02:03,230 --> 00:02:00,630

because of the magnetic field and that's

39

00:02:06,020 --> 00:02:03,240

kind of crazy to think that some things

40

00:02:09,469 --> 00:02:06,030

that's created inside very center of the

41

00:02:12,950 --> 00:02:09,479

earth has so many implication for earth

42

00:02:19,179 --> 00:02:12,960

for the surface for life and for humans

43

00:02:23,420 --> 00:02:22,190

implication for life at the surface of

44

00:02:26,300 --> 00:02:23,430

the earth that you will learn about

45

00:02:28,520 --> 00:02:26,310

later this afternoon and couple of

46

00:02:31,490 --> 00:02:28,530

things that you may want to notice is

47

00:02:34,880 --> 00:02:31,500

that some animals use magnetic field to

48

00:02:38,240 --> 00:02:34,890

orientate themselves so turtles use

49

00:02:41,750 --> 00:02:38,250

magnetic field she'll be able to go back

50

00:02:44,449 --> 00:02:41,760

to the original place of burrs and some

51
00:02:47,349 --> 00:02:44,459
birds also use magnetic field to be able

52
00:02:51,020 --> 00:02:47,359
to travel very very long distance and

53
00:02:53,420 --> 00:02:51,030
some scientists even used even try to

54
00:02:58,460 --> 00:02:53,430
see if dogs may actually orientate

55
00:03:01,330 --> 00:02:58,470
themselves when they're pooping you can

56
00:03:03,890 --> 00:03:01,340
look at the paper I'm not going to and

57
00:03:09,800 --> 00:03:03,900
other things that's very important for

58
00:03:12,559 --> 00:03:09,810
life for Earth is that the magnetic

59
00:03:14,629 --> 00:03:12,569
field is actually protecting earth from

60
00:03:17,839 --> 00:03:14,639
solar winds so it's protecting the earth

61
00:03:21,259 --> 00:03:17,849
from the charged particles that are

62
00:03:25,460 --> 00:03:21,269
generated as this understand and that

63
00:03:28,030 --> 00:03:25,470

preparing over the earth and with that

64

00:03:30,589 --> 00:03:28,040

magnetic field the earth would be

65

00:03:33,099 --> 00:03:30,599

graduating with with receive radiation

66

00:03:34,939 --> 00:03:33,109

from solar winds and most of our

67

00:03:41,479 --> 00:03:34,949

telecommunication would not be walking

68

00:03:43,189 --> 00:03:41,489

now because of this charged particles so

69

00:03:45,500 --> 00:03:43,199

magnetic field is something that's very

70

00:03:47,420 --> 00:03:45,510

important for life has been important

71

00:03:51,589 --> 00:03:47,430

for life for a very long time and is

72

00:03:53,059 --> 00:03:51,599

important for humans now so when you

73

00:03:55,759 --> 00:03:53,069

look at other planets

74

00:03:57,649 --> 00:03:55,769

you could also wonder do they have also

75

00:04:00,740 --> 00:03:57,659

a magnetic field and is it something

76

00:04:04,039 --> 00:04:00,750

that only for earth or is it for all

77

00:04:06,619 --> 00:04:04,049

planets that we know and so here is a

78

00:04:09,110 --> 00:04:06,629

view of our solar system with the Sun

79

00:04:12,979 --> 00:04:09,120

here that's obviously not to scale and

80

00:04:15,559 --> 00:04:12,989

you have Mercury Venus Earth Mars which

81

00:04:18,560 --> 00:04:15,569

are the so-called rocky planets because

82

00:04:20,120 --> 00:04:18,570

their composition is very close to the

83

00:04:22,069 --> 00:04:20,130

Earth's composition so it's basically

84

00:04:24,290 --> 00:04:22,079

rocks and there is a very thin

85

00:04:26,149 --> 00:04:24,300

atmosphere but we we can have a surface

86

00:04:30,620 --> 00:04:26,159

at where we can actually stand on and

87

00:04:31,570 --> 00:04:30,630

this is a four gas giant planet and I've

88

00:04:33,939 --> 00:04:31,580

been a couple of

89

00:04:35,980 --> 00:04:33,949

missions and observation of magnetic

90

00:04:38,710 --> 00:04:35,990

field inside the solar system and

91

00:04:42,129 --> 00:04:38,720

actually most of the planets in our

92

00:04:45,700 --> 00:04:42,139

solar system have a magnetic field so

93

00:04:48,580 --> 00:04:45,710

all of the gas-giant present magnetic

94

00:04:52,420 --> 00:04:48,590

field for which the duration is slightly

95

00:04:54,999 --> 00:04:52,430

different from the rocky planet but even

96

00:04:58,629 --> 00:04:55,009

amongst the rocky planets mercury in

97

00:05:01,719 --> 00:04:58,639

Earth's of a magnetic field now and Mars

98

00:05:04,240 --> 00:05:01,729

had evidence that was a magnetic field

99

00:05:05,710 --> 00:05:04,250

in the past for Venus

100

00:05:08,260 --> 00:05:05,720

it's a little bit more tricky and

101

00:05:11,080 --> 00:05:08,270

everything related to Venice is usually

102

00:05:13,420 --> 00:05:11,090

more tricky but there is no magnetic

103

00:05:15,700 --> 00:05:13,430

field and Venus now and we don't know if

104

00:05:19,120 --> 00:05:15,710

Venice add a magnetic field in the past

105

00:05:20,620 --> 00:05:19,130

it's quite interesting to see that the

106

00:05:24,279 --> 00:05:20,630

magnetic field is something that looks

107

00:05:28,740 --> 00:05:24,289

like kind of Universal for rocky planets

108

00:05:31,839 --> 00:05:28,750

and for planets in the solar system that

109

00:05:34,059 --> 00:05:31,849

at least for Earth we can observe it and

110

00:05:36,459 --> 00:05:34,069

we can have very good observations so we

111

00:05:39,459 --> 00:05:36,469

can try to look at short scale short

112

00:05:43,870 --> 00:05:39,469

time scale and long time scale evolution

113

00:05:46,439 --> 00:05:43,880

of the magnetic field on earth we can do

114

00:05:49,029 --> 00:05:46,449

ground observations so we can look at

115

00:05:51,909 --> 00:05:49,039

evolution of the magnetic field today

116

00:05:54,370 --> 00:05:51,919

from ground observation and from space

117

00:05:57,879 --> 00:05:54,380

observations and both of them will give

118

00:05:59,980 --> 00:05:57,889

us a different information but for rugs

119

00:06:02,950 --> 00:05:59,990

what's also very interesting is that

120

00:06:06,459 --> 00:06:02,960

magnetic field can be recorded in rugs

121

00:06:09,100 --> 00:06:06,469

so when a rug is formed when it reach a

122

00:06:12,309 --> 00:06:09,110

certain temperature some minerals will

123

00:06:15,370 --> 00:06:12,319

record the magnetic field as it was when

124

00:06:17,019 --> 00:06:15,380

it was formed and so we know that the

125

00:06:19,029 --> 00:06:17,029

magnetic field is something that has

126

00:06:19,360 --> 00:06:19,039

been present on earth for a very long

127

00:06:22,779 --> 00:06:19,370

time

128

00:06:25,089 --> 00:06:22,789

and I've been evolution of the magnetic

129

00:06:29,189 --> 00:06:25,099

field but basically is a global

130

00:06:32,469 --> 00:06:29,199

intensity of magnetic field has been

131

00:06:33,879 --> 00:06:32,479

stable over most of Earth's history so

132

00:06:36,010 --> 00:06:33,889

the magnetic field is something ancient

133

00:06:41,409 --> 00:06:36,020

and some things that's still going on

134

00:06:43,879 --> 00:06:41,419

right now and where does it come from so

135

00:06:45,800 --> 00:06:43,889

this is the earth and

136

00:06:48,950 --> 00:06:45,810

magnetic field is something we see at

137

00:06:52,249 --> 00:06:48,960

the surface but it comes from the very

138

00:06:55,159 --> 00:06:52,259

deep interior you may have seen this

139

00:06:58,510 --> 00:06:55,169

figure in the past you've seen it once

140

00:07:02,179 --> 00:06:58,520

in ramen stock and it's a figure of the

141

00:07:05,959 --> 00:07:02,189

structure of the earth so now we're

142

00:07:11,779 --> 00:07:05,969

standing on the crest so we're standing

143

00:07:15,140 --> 00:07:11,789

on some rocks and below us there is 6000

144

00:07:18,110 --> 00:07:15,150

kilometers between us and the very

145

00:07:21,499 --> 00:07:18,120

center of the earth and this is what's

146

00:07:23,540 --> 00:07:21,509

between us here and the center of the

147

00:07:26,089 --> 00:07:23,550

earth first

148

00:07:28,939 --> 00:07:26,099

so we're in Japan so it's very maybe

149

00:07:30,589 --> 00:07:28,949

different from other places but we're on

150

00:07:32,659 --> 00:07:30,599

this subduction zone which means that

151

00:07:34,429 --> 00:07:32,669

we're actually if you want to go from

152

00:07:36,589 --> 00:07:34,439

here towards the center of the earth

153

00:07:39,320 --> 00:07:36,599

you're actually going to cross a couple

154

00:07:42,409 --> 00:07:39,330

of crests because we are we have sub

155

00:07:46,100 --> 00:07:42,419

diction's and then you're go through the

156

00:07:49,390 --> 00:07:46,110

mantle which is also made of rocks and

157

00:07:53,420 --> 00:07:49,400

once you reach the core-mantle boundary

158

00:07:57,079 --> 00:07:53,430

you'll actually reach a big sphere of

159

00:08:00,790 --> 00:07:57,089

iron that at the very centre of our

160

00:08:03,350 --> 00:08:00,800

earth which is liquid and there is a

161

00:08:06,110 --> 00:08:03,360

central part which is called the inner

162

00:08:10,010 --> 00:08:06,120

core that's also made of iron that is

163

00:08:13,279 --> 00:08:10,020

also as that is solid you may wonder how

164

00:08:17,300 --> 00:08:13,289

we know that because we can't dig zuri

165

00:08:20,029 --> 00:08:17,310

we can't go there there is no space

166

00:08:23,269 --> 00:08:20,039

sheep or earth sheep that could go from

167

00:08:27,860 --> 00:08:23,279

the crest towards the core even if some

168

00:08:32,170 --> 00:08:27,870

movies try to do that so what we can do

169

00:08:35,420 --> 00:08:32,180

is we can actually use seismic

170

00:08:39,490 --> 00:08:35,430

observation to try to understand what is

171

00:08:44,180 --> 00:08:39,500

the structure of the earth and in Japan

172

00:08:46,400 --> 00:08:44,190

you know earthquakes and what you may

173

00:08:48,829 --> 00:08:46,410

not know is that seismologist use

174

00:08:52,699 --> 00:08:48,839

earthquake to understand what's going on

175

00:08:54,350 --> 00:08:52,709

deep inside the earth so if you think

176
00:08:54,999 --> 00:08:54,360
about an earthquake somewhere on the

177
00:08:57,429 --> 00:08:55,009
earth

178
00:09:01,569 --> 00:08:57,439
we have seismic stations that are all

179
00:09:05,379 --> 00:09:01,579
over most of the continents and that are

180
00:09:06,879 --> 00:09:05,389
recording what's going on so in Japan we

181
00:09:09,609 --> 00:09:06,889
have earthquakes we feel the surface

182
00:09:12,400 --> 00:09:09,619
waves but we have body waves that will

183
00:09:14,859 --> 00:09:12,410
travel inside ears and so if you have an

184
00:09:18,309 --> 00:09:14,869
earthquake here and you have a station

185
00:09:20,979 --> 00:09:18,319
here what you will record is a waves

186
00:09:24,009 --> 00:09:20,989
that have been traveling from here to

187
00:09:26,530 --> 00:09:24,019
here through the whole mantle and if you

188
00:09:30,869 --> 00:09:26,540

look at how fast this wave was traveling

189

00:09:33,609 --> 00:09:30,879

you can find information about the

190

00:09:36,039 --> 00:09:33,619

seismic structure of the earth and if

191

00:09:37,600 --> 00:09:36,049

you're looking at stations here you will

192

00:09:39,970 --> 00:09:37,610

actually get ways that have been

193

00:09:43,059 --> 00:09:39,980

traveler traveling through the mantle

194

00:09:46,449 --> 00:09:43,069

the core the mantle and back at the

195

00:09:49,030 --> 00:09:46,459

seismic station so that's how we can

196

00:09:52,569 --> 00:09:49,040

have information about seismic

197

00:09:55,689 --> 00:09:52,579

properties of rocks at inside the

198

00:09:59,559 --> 00:09:55,699

Earth's interior and the other thing

199

00:10:01,079 --> 00:09:59,569

that's also well used here in LC is high

200

00:10:06,039 --> 00:10:01,089

pressure and high temperature

201
00:10:08,499 --> 00:10:06,049
experiments so what people what say

202
00:10:10,569 --> 00:10:08,509
scientists do is they use diamond under

203
00:10:13,869 --> 00:10:10,579
cells which are actually very tiny

204
00:10:16,809 --> 00:10:13,879
diamonds and you put a very very very

205
00:10:21,150 --> 00:10:16,819
small sample between the two up X of the

206
00:10:24,789 --> 00:10:21,160
diamonds and you push right here and

207
00:10:26,980 --> 00:10:24,799
because this here is a very very small

208
00:10:30,280 --> 00:10:26,990
surface you actually managed to get very

209
00:10:32,139 --> 00:10:30,290
high pressures so if you know what you

210
00:10:34,780 --> 00:10:32,149
think should be the composition of the

211
00:10:37,960 --> 00:10:34,790
core and you put it inside two diamonds

212
00:10:40,689 --> 00:10:37,970
you can actually manage to see what

213
00:10:43,150 --> 00:10:40,699

would be the properties of material that

214

00:10:46,509 --> 00:10:43,160

is supposed to be at the very centre of

215

00:10:49,389 --> 00:10:46,519

the earth so that's how we know so

216

00:10:52,569 --> 00:10:49,399

combining these two kind of observation

217

00:10:55,449 --> 00:10:52,579

we know that the core is mostly liquid

218

00:10:58,419 --> 00:10:55,459

and is made of iron and we have a

219

00:11:03,489 --> 00:10:58,429

central inner core that is most that is

220

00:11:07,350 --> 00:11:03,499

solid and this liquid outer core is

221

00:11:09,040 --> 00:11:07,360

where the magnetic field is generated so

222

00:11:11,829 --> 00:11:09,050

let's go to

223

00:11:14,050 --> 00:11:11,839

how to generate a magnetic field so what

224

00:11:17,530 --> 00:11:14,060

you need is you need an electrically

225

00:11:20,860 --> 00:11:17,540

conductive fluid which is Iran's liquid

226
00:11:24,100 --> 00:11:20,870
iron inside the core and you need some

227
00:11:27,430 --> 00:11:24,110
energy to start pushing them as a fluid

228
00:11:30,250 --> 00:11:27,440
and what's called a dynamo effect is

229
00:11:33,460 --> 00:11:30,260
when you start pushing a fluid you will

230
00:11:35,500 --> 00:11:33,470
induce a flow this flow because it's a

231
00:11:38,009 --> 00:11:35,510
flow inside an electrically conductive

232
00:11:41,380 --> 00:11:38,019
fluid will induce a magnetic field and

233
00:11:42,850 --> 00:11:41,390
if you choose carefully your flow if you

234
00:11:45,220 --> 00:11:42,860
choose carefully the geometry of the

235
00:11:49,000 --> 00:11:45,230
flow this magnetic field that was

236
00:11:50,949 --> 00:11:49,010
generated by flow will also induce

237
00:11:54,069 --> 00:11:50,959
another flow that we didn't do smack

238
00:11:56,350 --> 00:11:54,079

netic field and you'll get a loop that

239

00:11:58,750 --> 00:11:56,360

will basically increase the magnetic

240

00:12:01,780 --> 00:11:58,760

field up to a point where you get a

241

00:12:05,440 --> 00:12:01,790

dynamo so it's basically self self

242

00:12:07,630 --> 00:12:05,450

sustained a flow and magnetic field but

243

00:12:09,400 --> 00:12:07,640

for that you need some energy you need

244

00:12:11,860 --> 00:12:09,410

some energy available to actually

245

00:12:14,530 --> 00:12:11,870

generate this magnetic field so what's

246

00:12:16,150 --> 00:12:14,540

the energy available in the earth that's

247

00:12:18,760 --> 00:12:16,160

actually driving what we call the

248

00:12:21,940 --> 00:12:18,770

geodynamo so geo for Earth's and dynamo

249

00:12:25,860 --> 00:12:21,950

for this effect we're talking about

250

00:12:29,440 --> 00:12:25,870

liquid flowing and so the density

251

00:12:32,380 --> 00:12:29,450

variations in a liquid will induce flows

252

00:12:34,090 --> 00:12:32,390

so that's what we're usually thinking

253

00:12:37,360 --> 00:12:34,100

when we're thinking about driving the

254

00:12:40,720 --> 00:12:37,370

Dynamo so by NZ effects are basically

255

00:12:43,510 --> 00:12:40,730

when you take a V per set of fluid and

256

00:12:45,130 --> 00:12:43,520

you put it in water it will go down so

257

00:12:47,590 --> 00:12:45,140

if you put milk in water it's slightly

258

00:12:49,990 --> 00:12:47,600

heavier than water so the milk will go

259

00:12:54,100 --> 00:12:50,000

at the bottom of your cap or if you have

260

00:12:56,380 --> 00:12:54,110

a light fluid in a overall fridge that's

261

00:12:59,680 --> 00:12:56,390

slightly heavier it will go up just

262

00:13:02,710 --> 00:12:59,690

because of density variation and if you

263

00:13:05,699 --> 00:13:02,720

manage to get a way to get light or evie

264

00:13:08,860 --> 00:13:05,709

fluids you will in juice flow and that's

265

00:13:11,970 --> 00:13:08,870

what we call convection and for example

266

00:13:16,240 --> 00:13:11,980

in the ocean it's something that's very

267

00:13:19,870 --> 00:13:16,250

important so you have the freezing of

268

00:13:21,750 --> 00:13:19,880

ice at the pole that will create salty

269

00:13:25,680 --> 00:13:21,760

and cold water the

270

00:13:30,240 --> 00:13:25,690

salty encode water will go down and will

271

00:13:33,600 --> 00:13:30,250

be warmed at the equator and it will you

272

00:13:35,520 --> 00:13:33,610

will get liquid that's warm and not too

273

00:13:38,280 --> 00:13:35,530

salty so it would be slightly lighter

274

00:13:41,640 --> 00:13:38,290

and so this will induce an overall

275

00:13:43,670 --> 00:13:41,650

circulation that's called thermo aligned

276

00:13:46,470 --> 00:13:43,680

circulations that for example

277

00:13:49,260 --> 00:13:46,480

represented here where you have a

278

00:13:52,920 --> 00:13:49,270

formation of deep water at the pores

279

00:13:54,710 --> 00:13:52,930

that will actually roll and do this kind

280

00:13:59,070 --> 00:13:54,720

of very very large-scale circulation

281

00:14:00,780 --> 00:13:59,080

into the ocean and in France it's some

282

00:14:03,120 --> 00:14:00,790

things that people are very happy about

283

00:14:07,320 --> 00:14:03,130

it because I don't know if you notice

284

00:14:09,960 --> 00:14:07,330

here but there is a warm water coming

285

00:14:12,840 --> 00:14:09,970

from the equator that goes up to France

286

00:14:17,040 --> 00:14:12,850

to the French coast and that actually is

287

00:14:18,540 --> 00:14:17,050

why we can swim here so it should go to

288

00:14:19,980 --> 00:14:18,550

France and you go to the ocean and

289

00:14:22,200 --> 00:14:19,990

you're actually managed to swim because

290

00:14:23,730 --> 00:14:22,210

the water will be not too cold but if

291

00:14:26,130 --> 00:14:23,740

you go at the same place here in Canada

292

00:14:28,560 --> 00:14:26,140

or in the u.s. if you're at the same

293

00:14:30,840 --> 00:14:28,570

latitude you're not going to go in the

294

00:14:36,630 --> 00:14:30,850

water it's going to be way too cold so

295

00:14:39,720 --> 00:14:36,640

if you want vacation go to France so

296

00:14:41,850 --> 00:14:39,730

let's go back to the earth and we're

297

00:14:44,190 --> 00:14:41,860

looking at the outer core here and

298

00:14:48,510 --> 00:14:44,200

what's actually driving density

299

00:14:53,040 --> 00:14:48,520

variation in two years first the Earth's

300

00:14:55,230 --> 00:14:53,050

core is very warm it's very hot it has

301
00:14:57,780 --> 00:14:55,240
been hot since the formation of the

302
00:15:01,520 --> 00:14:57,790
Earth's because of all this energy that

303
00:15:04,350 --> 00:15:01,530
was accreted or this energy that was

304
00:15:07,830 --> 00:15:04,360
that somehow during the accretion and

305
00:15:10,500 --> 00:15:07,840
this heat wants to go out and the mantle

306
00:15:14,250 --> 00:15:10,510
is actually pumping heat from the outer

307
00:15:17,640 --> 00:15:14,260
core and this induce a density variation

308
00:15:19,680 --> 00:15:17,650
at the top of the outer core and the

309
00:15:22,260 --> 00:15:19,690
second important thing that will create

310
00:15:25,560 --> 00:15:22,270
density variation is the freezing of the

311
00:15:28,170 --> 00:15:25,570
inner core so I told you in our Korea

312
00:15:29,560 --> 00:15:28,180
solid an inner core is actually made of

313
00:15:33,580 --> 00:15:29,570

the same

314

00:15:36,580 --> 00:15:33,590

allow that the article but since the

315

00:15:39,930 --> 00:15:36,590

temperature in the core decrease it's

316

00:15:42,910 --> 00:15:39,940

like eyes formed in your freezer it's

317

00:15:45,490 --> 00:15:42,920

freezing of the solid area of the liquid

318

00:15:47,020 --> 00:15:45,500

iron from the outer core and so at the

319

00:15:49,690 --> 00:15:47,030

surface of the inner core you will

320

00:15:52,180 --> 00:15:49,700

believe late and eat because of this

321

00:15:55,020 --> 00:15:52,190

freezing and you will also release light

322

00:15:58,990 --> 00:15:55,030

elements because the same way the eyes

323

00:16:02,140 --> 00:15:59,000

in the ocean as less salt and the water

324

00:16:05,590 --> 00:16:02,150

then here is a solid inner core is

325

00:16:08,170 --> 00:16:05,600

actually Foreman of an iron that has

326

00:16:11,770 --> 00:16:08,180

less impurities what we got light

327

00:16:13,930 --> 00:16:11,780

elements than the global outer core so

328

00:16:16,660 --> 00:16:13,940

at the surface of the inner core you're

329

00:16:19,780 --> 00:16:16,670

releasing a liquid that's lighter

330

00:16:24,940 --> 00:16:19,790

because it has more impurities and it's

331

00:16:27,430 --> 00:16:24,950

also hotter so due to this density

332

00:16:32,920 --> 00:16:27,440

variation you're inducing flows inside

333

00:16:35,110 --> 00:16:32,930

the outer core that drives a dynamo here

334

00:16:37,450 --> 00:16:35,120

I draw this kind of flows because it's

335

00:16:39,870 --> 00:16:37,460

how we usually see convection it's like

336

00:16:43,330 --> 00:16:39,880

nice prunes and it goes up and goes down

337

00:16:45,910 --> 00:16:43,340

but for the core of the earth it's a lot

338

00:16:48,670 --> 00:16:45,920

more complicated and the Earth's core is

339

00:16:52,090 --> 00:16:48,680

rotating very fastly it's also very and

340

00:16:55,930 --> 00:16:52,100

viscous and what it means it means that

341

00:16:58,660 --> 00:16:55,940

the Earth's core actually the flows

342

00:17:02,410 --> 00:16:58,670

inside it looks like the ocean it looks

343

00:17:07,510 --> 00:17:02,420

like water so it see it means that it's

344

00:17:10,120 --> 00:17:07,520

very turbulent and now people manage to

345

00:17:12,579 --> 00:17:10,130

do simulations to actually model this

346

00:17:14,860 --> 00:17:12,589

kind of flows and we get this kind of

347

00:17:17,199 --> 00:17:14,870

pictures and which does not look like

348

00:17:18,520 --> 00:17:17,209

what I showed you just before was just

349

00:17:20,860 --> 00:17:18,530

like nice plumes

350

00:17:25,660 --> 00:17:20,870

it's very turbulent it has lots of very

351

00:17:29,590 --> 00:17:25,670

small scale it is and it's a lot more

352

00:17:33,730 --> 00:17:29,600

complicated but that was simplest view

353

00:17:35,410 --> 00:17:33,740

to see it so here is a simulation of the

354

00:17:38,800 --> 00:17:35,420

best thing we can do to model the

355

00:17:40,530 --> 00:17:38,810

Earth's core which is very tricky to do

356

00:17:45,900 --> 00:17:40,540

because of the turbulence and

357

00:17:49,140 --> 00:17:45,910

highly rotating fluid and you see a

358

00:17:52,770 --> 00:17:49,150

small circle like small plumes of light

359

00:17:55,410 --> 00:17:52,780

fluid that goes up here and every fluid

360

00:18:00,690 --> 00:17:55,420

that goes down so that's what's actually

361

00:18:05,040 --> 00:18:00,700

generating the Dynamo and now there is a

362

00:18:07,500 --> 00:18:05,050

question of the Dynamo history so here

363

00:18:09,960 --> 00:18:07,510

is a simplest view of the Earth's

364

00:18:12,090 --> 00:18:09,970

formation so it looks like what we see

365

00:18:15,750 --> 00:18:12,100

in the tolls before so you start with

366

00:18:18,270 --> 00:18:15,760

small planets you build you build a

367

00:18:21,060 --> 00:18:18,280

bigger planets the planetesimals and

368

00:18:23,240 --> 00:18:21,070

protoplanets and then the Earth's but

369

00:18:26,250 --> 00:18:23,250

here I should use a structure inside

370

00:18:29,550 --> 00:18:26,260

because in green you have the mantle in

371

00:18:32,760 --> 00:18:29,560

red is a core and at first the planet is

372

00:18:34,440 --> 00:18:32,770

so hot that there is no inner core but

373

00:18:36,330 --> 00:18:34,450

for now we think that the inner core is

374

00:18:39,300 --> 00:18:36,340

driving the Dynamo in okok

375

00:18:42,000 --> 00:18:39,310

crystallization is driving the Dynamo so

376

00:18:43,710 --> 00:18:42,010

a big question now for research is

377

00:18:48,660 --> 00:18:43,720

trying to understand what was happening

378

00:18:51,240 --> 00:18:48,670

before this inner core first crystal so

379

00:18:54,900 --> 00:18:51,250

before we add any inner core how can we

380

00:18:57,060 --> 00:18:54,910

still have a dynamo people here in LCE

381

00:18:59,580 --> 00:18:57,070

are working on a different hypothesis

382

00:19:02,550 --> 00:18:59,590

one of the main one recently has been

383

00:19:04,830 --> 00:19:02,560

the publication of SiO_2 crystallization

384

00:19:07,260 --> 00:19:04,840

inside the Earth's core which is

385

00:19:11,400 --> 00:19:07,270

basically instead of crystallizing the

386

00:19:13,350 --> 00:19:11,410

inner core which is dense solid made

387

00:19:15,630 --> 00:19:13,360

mostly of iron you would crystallize

388

00:19:19,670 --> 00:19:15,640

something that's very light that will go

389

00:19:24,180 --> 00:19:19,680

up and goes up to the commenter boundary

390

00:19:28,200 --> 00:19:24,190

but I think now what's interesting is

391

00:19:31,050 --> 00:19:28,210

that we can also have a look at other

392

00:19:33,600 --> 00:19:31,060

planets and so another thing we're

393

00:19:37,740 --> 00:19:33,610

thinking here at LC is trying to see

394

00:19:39,960 --> 00:19:37,750

what is universal in planetary dynamos

395

00:19:42,420 --> 00:19:39,970

and can we actually try to understand

396

00:19:44,310 --> 00:19:42,430

better the earth and here's magnetic

397

00:19:47,580 --> 00:19:44,320

field by looking at other planets and

398

00:19:53,670 --> 00:19:47,590

even at looking at other exoplanets so

399

00:19:53,680 --> 00:20:26,860

[Music]