

# FIB Section 1 – TEM

HAAD = high angle annular

2  $\mu\text{m}$

altered  
olivine

jarosite  
sulfate

Martian 'clay' phyllosilicate

low Fe phyllosilicate

Fe-rich

jarosite

jar+ol



1  
00:00:12,830 --> 00:00:09,379  
okay so and basically today I'm going to

2  
00:00:15,320 --> 00:00:12,840  
talk about the work that I presented at

3  
00:00:18,070 --> 00:00:15,330  
LPS see this year and it was a

4  
00:00:20,839 --> 00:00:18,080  
collaboration between our group at the

5  
00:00:22,490 --> 00:00:20,849  
University of Hawaii and the lava

6  
00:00:24,130 --> 00:00:22,500  
Lawrence Livermore National Laboratory

7  
00:00:27,429 --> 00:00:24,140  
where they have this really huge

8  
00:00:30,109 --> 00:00:27,439  
transmission electron microscope and

9  
00:00:32,540 --> 00:00:30,119  
basically we were looking at one single

10  
00:00:35,030 --> 00:00:32,550  
meteorite and I've tried to make this

11  
00:00:37,280 --> 00:00:35,040  
talk not so geological I took out all

12  
00:00:39,619 --> 00:00:37,290  
the data just left in the pictures aimed

13  
00:00:42,170 --> 00:00:39,629

at a five year old so I'm hoping that

14

00:00:43,690 --> 00:00:42,180

the biologists will still be able to to

15

00:00:50,470 --> 00:00:43,700

understand what I'm talking about I

16

00:00:55,549 --> 00:00:54,020

okay so the aim of the project and was

17

00:00:58,010 --> 00:00:55,559

really to compare the chemistry and

18

00:01:00,920 --> 00:00:58,020

mineralogy of the Martian and

19

00:01:02,540 --> 00:01:00,930

terrestrial alteration phases in this

20

00:01:07,550 --> 00:01:02,550

single meteorite which is called the

21

00:01:09,710 --> 00:01:07,560

mill arranged 0900 32 and on micrometer

22

00:01:12,529 --> 00:01:09,720

scale so as I said using a transmission

23

00:01:16,010 --> 00:01:12,539

electron microscope and so are the

24

00:01:17,930 --> 00:01:16,020

minerals that we find in the terrestrial

25

00:01:20,870 --> 00:01:17,940

alteration and the Martian alteration

26

00:01:23,270 --> 00:01:20,880

similar M is the chemistry similar what

27

00:01:25,400 --> 00:01:23,280

are the water rock ratios of the two

28

00:01:28,430 --> 00:01:25,410

environments like are they similar and

29

00:01:30,529 --> 00:01:28,440

and ultimately is the are the Antarctic

30

00:01:32,630 --> 00:01:30,539

Dry Valleys a really good analogue the

31

00:01:35,150 --> 00:01:32,640

best analog on earth for the environment

32

00:01:40,669 --> 00:01:35,160

that formed these Martian alteration

33

00:01:43,639 --> 00:01:40,679

minerals okay so this is our meat right

34

00:01:46,100 --> 00:01:43,649

it was collected in 2009 in the

35

00:01:48,919 --> 00:01:46,110

Antarctic Dry Valleys in the mill

36

00:01:51,139 --> 00:01:48,929

arranged region and by the Antarctic

37

00:01:52,580 --> 00:01:51,149

search for meteorites team which I think

38

00:01:55,969 --> 00:01:52,590

they covered a little bit this morning

39

00:01:57,979 --> 00:01:55,979

and so the mineralogy and chemistry

40

00:02:00,320 --> 00:01:57,989

designate as a Martian basaltic

41

00:02:01,999 --> 00:02:00,330

meteorite which means for those of you

42

00:02:04,010 --> 00:02:02,009

aren't geologist it's kind of like a

43

00:02:07,100 --> 00:02:04,020

lava that you would get in Hawaii or

44

00:02:09,320 --> 00:02:07,110

anyways it's a rip tavaris and it has

45

00:02:12,020 --> 00:02:09,330

these minerals in them known as olive

46

00:02:14,030 --> 00:02:12,030

eens Here I am the really interesting

47

00:02:16,340 --> 00:02:14,040

thing about this specific Martian

48

00:02:18,230 --> 00:02:16,350

meteorite is it's in the group's and

49

00:02:19,850 --> 00:02:18,240

knock lights all that means is that

50

00:02:22,280 --> 00:02:19,860

inside these all

51  
00:02:25,460 --> 00:02:22,290  
in grains which has shown this bright

52  
00:02:29,390 --> 00:02:25,470  
green here you get these kind of darker

53  
00:02:32,720 --> 00:02:29,400  
grey areas that are Martian clay i'm

54  
00:02:35,210 --> 00:02:32,730  
going to say clay and like this because

55  
00:02:36,620 --> 00:02:35,220  
it's not really clay but it's just you

56  
00:02:43,220 --> 00:02:36,630  
don't need to know all that we'll just

57  
00:02:46,220 --> 00:02:43,230  
say clay for now um okay so okay yeah so

58  
00:02:48,980 --> 00:02:46,230  
how do we know they're Martian well in

59  
00:02:51,680 --> 00:02:48,990  
very specific areas in this meteorite

60  
00:02:55,400 --> 00:02:51,690  
you get a cross-cutting relationship

61  
00:02:57,680 --> 00:02:55,410  
between these clay veins and this fusion

62  
00:02:59,300 --> 00:02:57,690  
crust material fusion crust is what's

63  
00:03:01,520 --> 00:02:59,310

formed when the meteorite comes in

64

00:03:04,340 --> 00:03:01,530

through the atmosphere and the outside

65

00:03:06,199 --> 00:03:04,350

of the meteorite gets melted so you get

66

00:03:09,350 --> 00:03:06,209

this crustal area with lots of bubbles

67

00:03:11,570 --> 00:03:09,360

in it and it's just a melting of the

68

00:03:14,000 --> 00:03:11,580

meteorite itself and you can see that

69

00:03:16,699 --> 00:03:14,010

these veins in in certain areas they

70

00:03:18,590 --> 00:03:16,709

abut against the fusion crust and there

71

00:03:21,290 --> 00:03:18,600

d volatilized so they get bubbles in

72

00:03:23,330 --> 00:03:21,300

them they look like they've melted in

73

00:03:25,880 --> 00:03:23,340

this case one of them's kind of walked

74

00:03:28,490 --> 00:03:25,890

with the heat here if they were formed

75

00:03:30,380 --> 00:03:28,500

after the meteorite came in through the

76  
00:03:32,270 --> 00:03:30,390  
atmosphere then you would expect that

77  
00:03:33,979 --> 00:03:32,280  
they would cut across this fusion crust

78  
00:03:36,410 --> 00:03:33,989  
and we wouldn't see any kind of melting

79  
00:03:39,830 --> 00:03:36,420  
or anything and so we know that they're

80  
00:03:43,970 --> 00:03:39,840  
Martian but the problem is how do we

81  
00:03:47,030 --> 00:03:43,980  
distinguish these Martian em clay veins

82  
00:03:49,400 --> 00:03:47,040  
from the terrestrial alteration minerals

83  
00:03:52,280 --> 00:03:49,410  
that are formed in the Antarctic which

84  
00:03:54,979 --> 00:03:52,290  
are often quite similar in in terms of

85  
00:03:57,800 --> 00:03:54,989  
chemical composition nobody's really

86  
00:04:00,530 --> 00:03:57,810  
looked at this and in in so much detail

87  
00:04:02,030 --> 00:04:00,540  
before there's been one paper in 2011

88  
00:04:04,430 --> 00:04:02,040

that attempted to do the same thing that

89

00:04:08,720 --> 00:04:04,440

I did with with different meteorites but

90

00:04:11,060 --> 00:04:08,730

they concentrated on and Martian

91

00:04:13,100 --> 00:04:11,070

meteorites that were false so things

92

00:04:14,539 --> 00:04:13,110

that hadn't been SAT around on earth and

93

00:04:16,909 --> 00:04:14,549

they were just looking at the Martian

94

00:04:19,039 --> 00:04:16,919

material what we really wanted to do was

95

00:04:21,469 --> 00:04:19,049

make a comparison between the Martian

96

00:04:25,280 --> 00:04:21,479

alteration material and the stuff that's

97

00:04:28,730 --> 00:04:25,290

formed in Antarctica and so we

98

00:04:31,190 --> 00:04:28,740

concentrated on a tiny area in our meat

99

00:04:31,719 --> 00:04:31,200

right if I just go back I can show you

100

00:04:35,559 --> 00:04:31,729

what

101  
00:04:37,659 --> 00:04:35,569  
mean by that okay so say this is our

102  
00:04:40,959 --> 00:04:37,669  
whole meteorite stone when you take a

103  
00:04:43,510 --> 00:04:40,969  
thin section it's a 30 micron thick

104  
00:04:45,040 --> 00:04:43,520  
slice of rock that you then mount onto a

105  
00:04:47,399 --> 00:04:45,050  
glass slide so you can look under and

106  
00:04:51,070 --> 00:04:47,409  
under a microscope or a electron

107  
00:04:54,939 --> 00:04:51,080  
microscope and when you take a fib

108  
00:04:56,469 --> 00:04:54,949  
section you basically take this this is

109  
00:04:59,140 --> 00:04:56,479  
the whole thin section so we're talking

110  
00:05:01,119 --> 00:04:59,150  
about a centimeter across here and the

111  
00:05:03,219 --> 00:05:01,129  
thickness of this thin section it's

112  
00:05:04,659 --> 00:05:03,229  
going to be 30 microns when you take a

113  
00:05:07,809 --> 00:05:04,669

fib section of something you have to

114

00:05:10,450 --> 00:05:07,819

focus in on one on a target area in the

115

00:05:12,459 --> 00:05:10,460

thin section and decide which which area

116

00:05:14,920 --> 00:05:12,469

you want to focus in on so for us we

117

00:05:16,659 --> 00:05:14,930

pick this area here and this is the

118

00:05:19,540 --> 00:05:16,669

terrestrial exposed edge of the

119

00:05:20,799 --> 00:05:19,550

meteorite and this is a gypsum grain it

120

00:05:23,889 --> 00:05:20,809

shows it better in this false-color

121

00:05:25,689 --> 00:05:23,899

image it's this white grain there it's a

122

00:05:27,879 --> 00:05:25,699

longer crack and it's next to the

123

00:05:31,629 --> 00:05:27,889

terrestrial exposed area so we assumed

124

00:05:34,839 --> 00:05:31,639

that was terrestrial and if we focus in

125

00:05:36,670 --> 00:05:34,849

a little bit more so this is just an

126  
00:05:38,829 --> 00:05:36,680  
electron microscope image of the gypsum

127  
00:05:40,420 --> 00:05:38,839  
grain you can see this crack here and

128  
00:05:42,010 --> 00:05:40,430  
you can also see that it's next to one

129  
00:05:45,100 --> 00:05:42,020  
of these olive in grains that I pointed

130  
00:05:49,029 --> 00:05:45,110  
out with some pre terrestrial Martian

131  
00:05:54,129 --> 00:05:49,039  
clay so we focused in a tiny bit more

132  
00:05:56,619 --> 00:05:54,139  
and this is that olivene this is the pre

133  
00:05:58,420 --> 00:05:56,629  
terrestrial clay which is labeled idd

134  
00:06:00,279 --> 00:05:58,430  
that just ignore that it's because it's

135  
00:06:03,480 --> 00:06:00,289  
sometimes called eating site it has many

136  
00:06:06,189 --> 00:06:03,490  
names because it's not really clay and

137  
00:06:07,809 --> 00:06:06,199  
so this is the area we took our fib

138  
00:06:10,119 --> 00:06:07,819

section from and this image here just

139

00:06:12,249 --> 00:06:10,129

shows how you take a fib section from a

140

00:06:14,350 --> 00:06:12,259

thin section basically you drill down

141

00:06:15,969 --> 00:06:14,360

and make a vertical section which is

142

00:06:18,249 --> 00:06:15,979

what this line shows you make two

143

00:06:21,189 --> 00:06:18,259

trenches either side and you take out

144

00:06:24,699 --> 00:06:21,199

something that is around 10 microns by

145

00:06:28,209 --> 00:06:24,709

about 5 microns deep and in the bottom

146

00:06:30,730 --> 00:06:28,219

image it's around 50 nanometers thick so

147

00:06:33,429 --> 00:06:30,740

it's a tiny little wafer you have to do

148

00:06:36,100 --> 00:06:33,439

this em with a micromanipulator because

149

00:06:38,459 --> 00:06:36,110

by this stage you can't see it so you

150

00:06:43,179 --> 00:06:38,469

can't if you if it's if you drop it then

151  
00:06:45,490 --> 00:06:43,189  
you're screwed okay so we've got a fib

152  
00:06:48,220 --> 00:06:45,500  
section and because

153  
00:06:49,930 --> 00:06:48,230  
so wafer-thin you can then put it in the

154  
00:06:52,000 --> 00:06:49,940  
transmission electron microscope and it

155  
00:06:53,590 --> 00:06:52,010  
creates an image because the electrons

156  
00:06:55,900 --> 00:06:53,600  
actually pass straight through it and

157  
00:06:59,110 --> 00:06:55,910  
for this type of image anything that

158  
00:07:00,460 --> 00:06:59,120  
appears bright is dense and because the

159  
00:07:03,160 --> 00:07:00,470  
electrons are being back scattered

160  
00:07:04,990 --> 00:07:03,170  
anything that appears a darker color is

161  
00:07:09,010 --> 00:07:05,000  
less dense so more electrons get through

162  
00:07:13,930 --> 00:07:09,020  
and so here we cut through an area that

163  
00:07:17,320 --> 00:07:13,940

was partly a Martian clay and partly

164

00:07:18,850 --> 00:07:17,330

terrestrial alteration and and when we

165

00:07:22,330 --> 00:07:18,860

looked at the chemistry of these phases

166

00:07:24,130 --> 00:07:22,340

we found that em well first of all you

167

00:07:25,810 --> 00:07:24,140

can see there's a really clear boundary

168

00:07:27,700 --> 00:07:25,820

there between the two so this is the

169

00:07:29,800 --> 00:07:27,710

Martian side and this is the terrestrial

170

00:07:32,800 --> 00:07:29,810

side and when we looked at the chemistry

171

00:07:35,260 --> 00:07:32,810

you can see that the Martian side it is

172

00:07:36,909 --> 00:07:35,270

actually real clay that that was quite

173

00:07:39,159 --> 00:07:36,919

surprising to us because the people who

174

00:07:42,220 --> 00:07:39,169

study this before they said they hadn't

175

00:07:43,840 --> 00:07:42,230

found clay in any of the sections they

176  
00:07:45,460 --> 00:07:43,850  
found more and more for silicate

177  
00:07:48,370 --> 00:07:45,470  
material that didn't have any structure

178  
00:07:50,020 --> 00:07:48,380  
and it's an iron-rich clay and probably

179  
00:07:52,770 --> 00:07:50,030  
a lot of you would have heard of the

180  
00:07:55,150 --> 00:07:52,780  
Mars Curiosity rover recently and found

181  
00:07:57,610 --> 00:07:55,160  
smectite clay on the surface of Mars

182  
00:08:01,300 --> 00:07:57,620  
well we found it first because it's in

183  
00:08:02,800 --> 00:08:01,310  
this meteorite and so yeah I mean it

184  
00:08:04,930 --> 00:08:02,810  
kind of confirmed what we'd already

185  
00:08:07,030 --> 00:08:04,940  
found but this is an entire night

186  
00:08:08,350 --> 00:08:07,040  
smectite clay which is exactly the kind

187  
00:08:12,060 --> 00:08:08,360  
of stuff that they found on the surface

188  
00:08:14,560 --> 00:08:12,070

of Mars and in the gale crater on the

189

00:08:16,450 --> 00:08:14,570

terrestrial side is very different in

190

00:08:18,460 --> 00:08:16,460

this fib section and we've got something

191

00:08:21,010 --> 00:08:18,470

called jarosite which is a sulfate is an

192

00:08:23,260 --> 00:08:21,020

iron potassium sulfate and lots of

193

00:08:24,969 --> 00:08:23,270

slightly altered olivene and by that I

194

00:08:27,430 --> 00:08:24,979

just mean it's it's olivene but it has

195

00:08:29,230 --> 00:08:27,440

some sulfur in it weirdly which olivene

196

00:08:33,880 --> 00:08:29,240

never normally has sulfur in there and

197

00:08:37,839 --> 00:08:33,890

then these kind of bright our vein areas

198

00:08:40,000 --> 00:08:37,849

they're iron oxides and hydroxides so

199

00:08:42,459 --> 00:08:40,010

that was the first fib section and if we

200

00:08:45,520 --> 00:08:42,469

focus in on the Martian phyllosilicate

201  
00:08:47,650 --> 00:08:45,530  
or clay as I always saying it's got

202  
00:08:50,950 --> 00:08:47,660  
structure so the reason we can identify

203  
00:08:52,750 --> 00:08:50,960  
it as a smectite clay is because if you

204  
00:08:54,160 --> 00:08:52,760  
really focus down which is something

205  
00:08:56,470 --> 00:08:54,170  
that you can only do really with a

206  
00:08:59,199 --> 00:08:56,480  
transmission electron microscope you can

207  
00:09:02,679 --> 00:08:59,209  
see on the scale of angstroms so here we

208  
00:09:04,480 --> 00:09:02,689  
got and the fringes here and each fringe

209  
00:09:06,369 --> 00:09:04,490  
between here and here is roughly 10

210  
00:09:09,749 --> 00:09:06,379  
angstroms and that's ident that

211  
00:09:12,100 --> 00:09:09,759  
identifies this clay as a smectite

212  
00:09:14,889 --> 00:09:12,110  
specifically as an entre night it is

213  
00:09:17,499 --> 00:09:14,899

poorly ordered so the images are not

214

00:09:19,419 --> 00:09:17,509

fantastic if you look to the terrestrial

215

00:09:21,759 --> 00:09:19,429

clay they would be just lines going

216

00:09:27,669 --> 00:09:21,769

straight across here and but we do have

217

00:09:29,439 --> 00:09:27,679

some structure okay so so we also look

218

00:09:31,600 --> 00:09:29,449

to the second area so again we're

219

00:09:33,460 --> 00:09:31,610

looking at this gypsum green and this

220

00:09:34,989 --> 00:09:33,470

area at the bottom of the gypsum grain

221

00:09:37,629 --> 00:09:34,999

to me looked really interesting because

222

00:09:40,509 --> 00:09:37,639

not only if we got gypsum but there's

223

00:09:42,879 --> 00:09:40,519

also these other layers in there and and

224

00:09:45,280 --> 00:09:42,889

I couldn't identify these with any other

225

00:09:46,869 --> 00:09:45,290

method because they're so narrow and so

226

00:09:50,079 --> 00:09:46,879

I thought okay we'll make it a fib

227

00:09:53,679 --> 00:09:50,089

section there and see whether this grey

228

00:09:57,970 --> 00:09:53,689

area is actually a clay that was formed

229

00:09:59,619 --> 00:09:57,980

in the Antarctic so this is our second

230

00:10:02,199 --> 00:09:59,629

food section we've got the gypsum grain

231

00:10:04,480 --> 00:10:02,209

here we've got the lair next to the

232

00:10:07,030 --> 00:10:04,490

gypsum grain which is very rich in again

233

00:10:09,519 --> 00:10:07,040

sulfates which seems to be a trend with

234

00:10:11,679 --> 00:10:09,529

the Antarctic alteration material and

235

00:10:14,470 --> 00:10:11,689

then we've got two layers actually in

236

00:10:17,379 --> 00:10:14,480

this firm in this what I thought could

237

00:10:19,419 --> 00:10:17,389

be clay region and but it actually turns

238

00:10:21,400 --> 00:10:19,429

out to be amorphous there's no structure

239

00:10:24,129 --> 00:10:21,410

in here when we zoomed in there was no

240

00:10:26,769 --> 00:10:24,139

and phyllosilicate fringes there at all

241

00:10:29,169 --> 00:10:26,779

it's just an amorphous silica it is very

242

00:10:32,619 --> 00:10:29,179

rich in iron and and it's quite rich in

243

00:10:34,509 --> 00:10:32,629

manganese and sulfur but there's no

244

00:10:37,569 --> 00:10:34,519

structure there and the interesting

245

00:10:39,609 --> 00:10:37,579

thing about that is you only get

246

00:10:41,499 --> 00:10:39,619

structural phyllosilicates when the

247

00:10:43,869 --> 00:10:41,509

water rot ratio goes above a certain

248

00:10:45,999 --> 00:10:43,879

threshold below that you still get

249

00:10:48,400 --> 00:10:46,009

alteration but you get this amorphous

250

00:10:50,859 --> 00:10:48,410

eyes material because it's kind of like

251  
00:10:53,199 --> 00:10:50,869  
a stunted material this is why people

252  
00:10:54,970 --> 00:10:53,209  
weren't surprised to find it on Mars

253  
00:10:57,489 --> 00:10:54,980  
because we know that there's not much

254  
00:11:00,129 --> 00:10:57,499  
water hanging around on Mars but in the

255  
00:11:03,069 --> 00:11:00,139  
Antarctic it's surprising that we see

256  
00:11:06,429 --> 00:11:03,079  
the amorphous material as the Antarctic

257  
00:11:08,139 --> 00:11:06,439  
alteration and whereas there's material

258  
00:11:11,949 --> 00:11:08,149  
in there that's Martian and unease

259  
00:11:13,030 --> 00:11:11,959  
phyllosilicate okay so some of the main

260  
00:11:15,790 --> 00:11:13,040  
conclusions that we

261  
00:11:17,290 --> 00:11:15,800  
for this from this work and well we

262  
00:11:19,870 --> 00:11:17,300  
found out that the Martian clay is

263  
00:11:21,749 --> 00:11:19,880

actually clay it's a smectite play known

264

00:11:25,269 --> 00:11:21,759

as one entire night the same stuff that

265

00:11:28,930 --> 00:11:25,279

msl is found on Mars and something I

266

00:11:31,439 --> 00:11:28,940

didn't talk about was the fact that this

267

00:11:34,689 --> 00:11:31,449

meteorite from the chemistry of the

268

00:11:36,189 --> 00:11:34,699

Martian clay we could determine that the

269

00:11:38,800 --> 00:11:36,199

meteorite actually came from very close

270

00:11:40,990 --> 00:11:38,810

to the surface of Mars and I'm not going

271

00:11:44,920 --> 00:11:41,000

to go into that in too much detail but

272

00:11:47,499 --> 00:11:44,930

it kind of helps us to determine how the

273

00:11:50,290 --> 00:11:47,509

fluids formed in this certain group of

274

00:11:52,930 --> 00:11:50,300

meteorites and but the really important

275

00:11:55,720 --> 00:11:52,940

thing that we found was the fact that

276

00:11:57,999 --> 00:11:55,730

actually in the Antarctic the water rock

277

00:12:01,389 --> 00:11:58,009

ratio in this specific meteorite was

278

00:12:04,480 --> 00:12:01,399

lower than it was when these Martian

279

00:12:06,160 --> 00:12:04,490

alteration clays formed so it could be

280

00:12:08,230 --> 00:12:06,170

that the Antarctic is actually drier

281

00:12:10,449 --> 00:12:08,240

than the surface of Mars or at least at

282

00:12:28,569 --> 00:12:10,459

the time that these clays were formed

283

00:12:35,509 --> 00:12:32,169

okay I have a two-part question so

284

00:12:37,549 --> 00:12:35,519

you're comparing the Martian in the

285

00:12:40,220 --> 00:12:37,559

Antarctic alteration but the Eddings

286

00:12:41,900 --> 00:12:40,230

aight in the neck lights is like a

287

00:12:43,819 --> 00:12:41,910

combination it's mostly primary

288

00:12:45,259 --> 00:12:43,829

alteration of the minerals and then a

289

00:12:49,759 --> 00:12:45,269

little bit of secondary deposition so

290

00:12:51,439 --> 00:12:49,769

all of your terrestrial stuff is like

291

00:12:53,329 --> 00:12:51,449

secondary precipitation out of fluids

292

00:12:56,539 --> 00:12:53,339

it's not actually altering the minerals

293

00:12:58,369 --> 00:12:56,549

so like are the conditions of the

294

00:13:01,249 --> 00:12:58,379

alteration really comparable like so

295

00:13:02,689 --> 00:13:01,259

what I mean is that this altar because

296

00:13:04,160 --> 00:13:02,699

it was sitting on the surface and fluids

297

00:13:06,919 --> 00:13:04,170

kind of percolated through and deposited

298

00:13:08,900 --> 00:13:06,929

sulfates and things like that but the

299

00:13:10,910 --> 00:13:08,910

neck lights were altered at depth from

300

00:13:12,139 --> 00:13:10,920

hydrothermal fluids going through them

301  
00:13:15,229 --> 00:13:12,149  
for a long period of time and actually

302  
00:13:17,689 --> 00:13:15,239  
primary altering Aldean so like we find

303  
00:13:19,069 --> 00:13:17,699  
Jerry site on the surface of Mars from

304  
00:13:22,220 --> 00:13:19,079  
like basically the exact same setting I

305  
00:13:24,619 --> 00:13:22,230  
really dry just flew precipitation but

306  
00:13:26,689 --> 00:13:24,629  
is this really like a comparable analog

307  
00:13:29,090 --> 00:13:26,699  
because the environment and a type of

308  
00:13:32,509 --> 00:13:29,100  
alteration that the actual rust is is

309  
00:13:34,759 --> 00:13:32,519  
totally different yeah okay so and so in

310  
00:13:36,919 --> 00:13:34,769  
terms of the sulfates yes I would agree

311  
00:13:39,829 --> 00:13:36,929  
with you the sulfates that we find in

312  
00:13:42,049 --> 00:13:39,839  
the Antarctic they are depositional you

313  
00:13:43,879 --> 00:13:42,059

can see that because on the meteorite if

314

00:13:46,549 --> 00:13:43,889

you get an external surface they kind of

315

00:13:49,309 --> 00:13:46,559

like grade in words so they are too

316

00:13:51,799 --> 00:13:49,319

mostly terrestrial in this meteorite and

317

00:13:55,280 --> 00:13:51,809

they do come from small amounts of water

318

00:13:57,229 --> 00:13:55,290

on the surface and they well I we

319

00:13:59,840 --> 00:13:57,239

actually published a paper maybe there's

320

00:14:01,309 --> 00:13:59,850

a lot of them there's a lot of biogenic

321

00:14:03,169 --> 00:14:01,319

material in the Antarctic in the

322

00:14:04,999 --> 00:14:03,179

atmosphere it's a lot of the sulfur and

323

00:14:06,710 --> 00:14:05,009

a lot of the salts do come from from

324

00:14:09,619 --> 00:14:06,720

from the atmosphere and from

325

00:14:13,369 --> 00:14:09,629

precipitation of water but when you said

326

00:14:15,650 --> 00:14:13,379

that that the the fluids in the

327

00:14:17,659 --> 00:14:15,660

Antarctic doesn't actually alter the

328

00:14:20,720 --> 00:14:17,669

minerals I don't think that's true for

329

00:14:22,269 --> 00:14:20,730

and I don't know if I can go back now I

330

00:14:25,519 --> 00:14:22,279

don't think it's true for all of the

331

00:14:28,030 --> 00:14:25,529

minerals because the the amorphous

332

00:14:31,100 --> 00:14:28,040

material that we found that's not

333

00:14:32,449 --> 00:14:31,110

depositional it's not from things come

334

00:14:36,199 --> 00:14:32,459

in and from the outside of the meteorite

335

00:14:37,999 --> 00:14:36,209

the chemistry of that and the the

336

00:14:40,730 --> 00:14:38,009

Martian phyllosilicate material but

337

00:14:45,199 --> 00:14:40,740

eating site it's exactly the same

338

00:14:46,579 --> 00:14:45,209

and it is an alteration of em are you

339

00:14:49,670 --> 00:14:46,589  
saying that the amorphous gel is

340

00:14:52,460 --> 00:14:49,680  
terrestrial its terrestrial but it's all

341

00:14:54,829 --> 00:14:52,470  
its it's from alteration of the primary

342

00:14:56,240 --> 00:14:54,839  
minerals in the Martian meteorite are

343

00:14:58,730 --> 00:14:56,250  
you sure because all the other nak

344

00:15:01,040 --> 00:14:58,740  
lights have amorphous gel that has the

345

00:15:05,019 --> 00:15:01,050  
same composition as the Clay's that is

346

00:15:07,940 --> 00:15:05,029  
Martian yes it's Martian yes exactly and

347

00:15:10,360 --> 00:15:07,950  
we know that its terrestrial because um

348

00:15:12,920 --> 00:15:10,370  
because of the manganese content and

349

00:15:15,170 --> 00:15:12,930  
it's next to a kleiner purok scene

350

00:15:16,310 --> 00:15:15,180  
that's been altered and the kleiner park

351

00:15:20,269 --> 00:15:16,320

scene contains a small amount of

352

00:15:22,190 --> 00:15:20,279

manganese the clay the pre terrestrial

353

00:15:23,990 --> 00:15:22,200

clay doesn't contain any manganese and

354

00:15:27,139 --> 00:15:24,000

just texturally you can tell that its

355

00:15:29,570 --> 00:15:27,149

terrestrial the paper that published the

356

00:15:32,720 --> 00:15:29,580

morphus gel material that was all inside

357

00:15:34,310 --> 00:15:32,730

the eating site veins we do actually

358

00:15:37,660 --> 00:15:34,320

have a paper coming out it's difficult