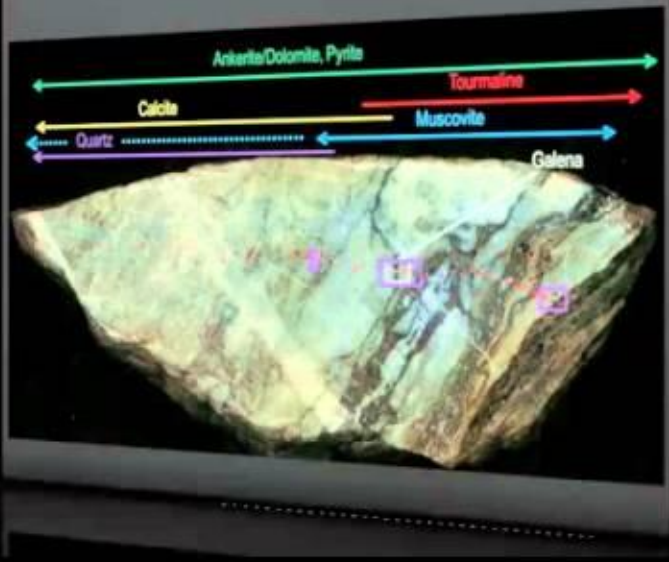
Ankerite/Dolomite, Pyrite
Tourmaline
Calcite
Muscovite
Quartz
Galena

1
00:00:10,789 --> 00:00:08,390
alright um so today I'm going to talk to

2
00:00:13,340 --> 00:00:10,799
a little bit more about our key and

3
00:00:15,770 --> 00:00:13,350
hydrothermal systems part of a project

4
00:00:17,450 --> 00:00:15,780
that I called amp the dome anchor at

5
00:00:19,810 --> 00:00:17,460
mine project i found that acronyms are

6
00:00:22,820 --> 00:00:19,820
incredibly important in astrobiology so

7
00:00:24,950 --> 00:00:22,830
what i'm doing here is characterizing an

8
00:00:26,630 --> 00:00:24,960
anchor at horizon at the dome mine in

9
00:00:28,250 --> 00:00:26,640
Timmins Ontario now anchorites an iron

10
00:00:30,350 --> 00:00:28,260
carbonate so as you can see this is my

11
00:00:32,479 --> 00:00:30,360
field site underground in the gold mine

12
00:00:36,590 --> 00:00:32,489
this is myself in an undergrad assistant

13
00:00:37,910 --> 00:00:36,600

and so presumably by now you guys heard

14
00:00:39,439 --> 00:00:37,920
a lot about our key and hydrothermal

15
00:00:41,029 --> 00:00:39,449
systems why they're really interesting

16
00:00:44,569 --> 00:00:41,039
and why carbonates are pretty cool in

17
00:00:46,220 --> 00:00:44,579
the context of Mars so what my

18
00:00:48,200 --> 00:00:46,230
motivations behind understanding this

19
00:00:50,239 --> 00:00:48,210
system primarily our understanding our

20
00:00:52,369 --> 00:00:50,249
key and habitable or potentially

21
00:00:53,899 --> 00:00:52,379
habitable paleo environments with

22
00:00:55,369 --> 00:00:53,909
applications for interpretation of

23
00:00:57,290 --> 00:00:55,379
Martian paleo environments and the

24
00:00:58,939 --> 00:00:57,300
search for biosignatures and then also

25
00:01:00,770 --> 00:00:58,949
looking at biomarker preservation

26
00:01:03,229 --> 00:01:00,780
potential and detection and ancient

27
00:01:04,670 --> 00:01:03,239
carbonates so the region i'm working in

28
00:01:06,080 --> 00:01:04,680
is called the abitibi greenstone belt

29
00:01:07,700 --> 00:01:06,090
this is a largest and best-preserved

30
00:01:10,940 --> 00:01:07,710
greenstone belt in North error in the

31
00:01:13,580 --> 00:01:10,950
world sorry and it is right here in

32
00:01:14,830 --> 00:01:13,590
Northern Ontario and Quebec and it's

33
00:01:17,840 --> 00:01:14,840
been several hundred kilometers across

34
00:01:20,810 --> 00:01:17,850
as you can see it is host to multiple

35
00:01:24,170 --> 00:01:20,820
world-class gold deposits so these are

36
00:01:25,790 --> 00:01:24,180
primarily hydrothermal or well they're

37
00:01:28,400 --> 00:01:25,800
all hydrothermal pretty much but

38
00:01:29,810 --> 00:01:28,410

seafloor VMs deposits and quartz

39
00:01:34,130 --> 00:01:29,820
carbonate deposits so the area i'm

40
00:01:36,320 --> 00:01:34,140
working in is right there so this is the

41
00:01:39,050 --> 00:01:36,330
porcupine gold camp this is the most

42
00:01:41,000 --> 00:01:39,060
prolific gold camp in the world as you

43
00:01:42,980 --> 00:01:41,010
can see it's kind of your standard or

44
00:01:45,950 --> 00:01:42,990
for those use it our geologists your

45
00:01:47,800 --> 00:01:45,960
standard green stone sequence so what I

46
00:01:50,120 --> 00:01:47,810
mean by that is you've got a series of

47
00:01:51,470 --> 00:01:50,130
mafic and ultramafic results and

48
00:01:53,120 --> 00:01:51,480
sediments that are highly folded these

49
00:01:54,740 --> 00:01:53,130
will essentially come from the sea floor

50
00:01:57,050 --> 00:01:54,750
where you had a subduction zone and a

51
00:01:59,450 --> 00:01:57,060
hydrothermal alteration going on they've

52
00:02:01,970 --> 00:01:59,460
been squished heated and pushed up into

53
00:02:03,530 --> 00:02:01,980
the middle of Canada so what I'm looking

54
00:02:06,380 --> 00:02:03,540
at right here is this region right here

55
00:02:08,749 --> 00:02:06,390
the dome mine now the don't mine is the

56
00:02:10,729 --> 00:02:08,759
longest operating underground mining

57
00:02:13,130 --> 00:02:10,739
operation in North America it's been an

58
00:02:15,260 --> 00:02:13,140
operation since 1910 it's what we call a

59
00:02:17,660 --> 00:02:15,270
late archaean greenstone hosted quartz

60
00:02:19,880 --> 00:02:17,670
carbonate game gold deposit so it's

61
00:02:22,790 --> 00:02:19,890
hosted in green stone the salts

62
00:02:25,160 --> 00:02:22,800
and the gold is in quartz carbonate

63
00:02:28,699 --> 00:02:25,170

veins so this is structurally controlled

64
00:02:30,410 --> 00:02:28,709
hydrothermal alteration so the

65
00:02:32,150 --> 00:02:30,420
geologists eat it up this is the only

66
00:02:34,280 --> 00:02:32,160
strats x you're going to see i'm not

67
00:02:35,750 --> 00:02:34,290
going to discuss it too much what I want

68
00:02:38,420 --> 00:02:35,760
to get across is the area i'm interested

69
00:02:40,070 --> 00:02:38,430
in is in here right here in the middle

70
00:02:42,230 --> 00:02:40,080
of these two point seven billion year

71
00:02:44,030 --> 00:02:42,240
old volcanics and it's hillsdale

72
00:02:45,920 --> 00:02:44,040
assemblage here these are where the

73
00:02:47,390 --> 00:02:45,930
anchorite veins or anchorite horizon

74
00:02:50,300 --> 00:02:47,400
depending here talking to you so these

75
00:02:52,550 --> 00:02:50,310
are somewhere between 2679 and 26 90

76
00:02:54,920 --> 00:02:52,560
million years old and they're massive

77
00:02:56,570 --> 00:02:54,930
they run 500 meters and strike 900

78
00:02:58,580 --> 00:02:56,580
meters vertically and up to two metres

79
00:03:00,050 --> 00:02:58,590
in width so that's why they call it

80
00:03:03,530 --> 00:03:00,060
anchor at horizon because it pretty much

81
00:03:05,300 --> 00:03:03,540
is conformable between volcanic flows so

82
00:03:06,590 --> 00:03:05,310
it was in place to sometime around the

83
00:03:08,180 --> 00:03:06,600
time when we had this gigantic

84
00:03:09,530 --> 00:03:08,190
sedimentary assemblers a porcupine

85
00:03:11,300 --> 00:03:09,540
assemblage which if you can imagine

86
00:03:13,310 --> 00:03:11,310
formed in a big basin so you've got a

87
00:03:14,960 --> 00:03:13,320
sub seafloor volcanics and then you have

88
00:03:16,790 --> 00:03:14,970

this big sedimentary unit forming in a

89
00:03:20,600 --> 00:03:16,800
basin at the same time you have this

90
00:03:21,770 --> 00:03:20,610
carbonate forming so why would we want

91
00:03:22,790 --> 00:03:21,780
to understand this carbonate well

92
00:03:25,430 --> 00:03:22,800
primarily we want to know what the

93
00:03:26,630 --> 00:03:25,440
depositional context was we want to know

94
00:03:29,330 --> 00:03:26,640
how did it form what were the

95
00:03:30,410 --> 00:03:29,340
environmental conditions again what were

96
00:03:31,610 --> 00:03:30,420
the environmental conditions how did

97
00:03:33,440 --> 00:03:31,620
they vary spatially this is a huge

98
00:03:35,210 --> 00:03:33,450
horizon it's almost a kilometer long was

99
00:03:37,370 --> 00:03:35,220
it uniform in terms of conditions and

100
00:03:39,140 --> 00:03:37,380
this will dictate whether or not it was

101
00:03:40,640 --> 00:03:39,150
habitable and whether or not we'll find

102
00:03:43,330 --> 00:03:40,650
any bio signatures there or biome

103
00:03:47,660 --> 00:03:43,340
organic biomarkers I should say so

104
00:03:48,830 --> 00:03:47,670
deposition originally in both the 70s

105
00:03:50,210 --> 00:03:48,840
like I said this has been worked on

106
00:03:52,160 --> 00:03:50,220
we've been mined for a hundred years so

107
00:03:53,990 --> 00:03:52,170
a lot of works been done people thought

108
00:03:55,940 --> 00:03:54,000
that this could be in a sin volcanic

109
00:03:59,449 --> 00:03:55,950
chemical executive from a sea floor vent

110
00:04:02,060 --> 00:03:59,459
system so basically this you've got sea

111
00:04:03,170 --> 00:04:02,070
floor fluids coming up in probably more

112
00:04:04,580 --> 00:04:03,180
of a white smoker system you're

113
00:04:06,020 --> 00:04:04,590

precipitating carbonate almost like a

114
00:04:07,759 --> 00:04:06,030
blanket of carbonate on top of volcanic

115
00:04:10,640 --> 00:04:07,769
so that's why they call it a horizon a

116
00:04:12,470 --> 00:04:10,650
conformable horizon but more recently we

117
00:04:14,150 --> 00:04:12,480
found this is just a math of the

118
00:04:15,470 --> 00:04:14,160
twenty-first level of the mine so these

119
00:04:17,990 --> 00:04:15,480
are your volcanic sequences all this

120
00:04:20,060 --> 00:04:18,000
green stuff is volcanic this is a later

121
00:04:22,370 --> 00:04:20,070
intrusion and these are your sediments

122
00:04:24,050 --> 00:04:22,380
up top so you can see these are the mine

123
00:04:26,360 --> 00:04:24,060
workings here and if we overlay the

124
00:04:29,089 --> 00:04:26,370
anchor at horizons here they are they're

125
00:04:30,860 --> 00:04:29,099
pretty much conformable along volcanics

126
00:04:32,120 --> 00:04:30,870
between volcanic flows but we've

127
00:04:33,350 --> 00:04:32,130
actually found because there's been so

128
00:04:35,300 --> 00:04:33,360
much mining down here

129
00:04:37,429 --> 00:04:35,310
is that there is an anchor of Ian that

130
00:04:38,929 --> 00:04:37,439
actually cross cuts the volcanic so this

131
00:04:40,610 --> 00:04:38,939
is some evidence against a sea floor

132
00:04:42,980 --> 00:04:40,620
deposition unless this is just kinda

133
00:04:44,779 --> 00:04:42,990
like a conduit but then also it's more

134
00:04:47,959 --> 00:04:44,789
interesting is there is a one horizon

135
00:04:49,159 --> 00:04:47,969
that cross cuts a later intrusion so

136
00:04:51,140 --> 00:04:49,169
this tells us that it's most likely not

137
00:04:53,589 --> 00:04:51,150
a sea floor deposition because it cross

138
00:04:57,709 --> 00:04:53,599

cuts something that was in place later

139
00:05:00,679 --> 00:04:57,719
so what are we proposing probably sin

140
00:05:01,909 --> 00:05:00,689
tectonic subsea floor deposition so what

141
00:05:05,089 --> 00:05:01,919
you have is a situation kind of like

142
00:05:07,070 --> 00:05:05,099
this you've got volcanic rocks is some

143
00:05:09,740 --> 00:05:07,080
sort of sedimentary cap what I call an

144
00:05:11,119 --> 00:05:09,750
aquitard so the fluids are flowing and

145
00:05:12,230 --> 00:05:11,129
they can't get up to the surface so

146
00:05:14,499 --> 00:05:12,240
they're flowing along with illogical

147
00:05:17,089 --> 00:05:14,509
boundaries between the volcanic layers

148
00:05:18,800 --> 00:05:17,099
where there's less competent rock there

149
00:05:20,510 --> 00:05:18,810
so you end up with this seemingly

150
00:05:23,059 --> 00:05:20,520
conformable horizon that actually cross

151
00:05:25,249 --> 00:05:23,069
cuts so what we're doing is taking a

152
00:05:28,580 --> 00:05:25,259
mind and micron approach to understand

153
00:05:29,899 --> 00:05:28,590
this anchor right so basically coming

154
00:05:31,070 --> 00:05:29,909
from the mine scale i'm lucky i can go

155
00:05:32,409 --> 00:05:31,080
underground and see the entire horizon

156
00:05:34,999 --> 00:05:32,419
you can see it cross-country

157
00:05:36,800 --> 00:05:35,009
cost-cutting different lithologies so

158
00:05:39,290 --> 00:05:36,810
here's the carbonate here here's the

159
00:05:41,269 --> 00:05:39,300
sediment unit you can see that and then

160
00:05:42,980 --> 00:05:41,279
taking sub-samples like this one for

161
00:05:45,230 --> 00:05:42,990
instance the hand sample scale you can

162
00:05:46,820 --> 00:05:45,240
also see para netic relationships like

163
00:05:49,189 --> 00:05:46,830

this later cross-cutting quartz vein

164
00:05:52,100 --> 00:05:49,199
here and then looking down to the micron

165
00:05:54,260 --> 00:05:52,110
scale SEM analysis things like that

166
00:05:56,450 --> 00:05:54,270
carbonate carbon or oxygen isotopes you

167
00:05:58,219 --> 00:05:56,460
can tell more about para genesis fluid

168
00:05:59,719 --> 00:05:58,229
conditions and fluid source because

169
00:06:01,369 --> 00:05:59,729
ultimately we want to understand the

170
00:06:02,869 --> 00:06:01,379
mineralogy in geochemistry because this

171
00:06:05,809 --> 00:06:02,879
will allow us to constrain the

172
00:06:08,540 --> 00:06:05,819
environmental conditions so we're taking

173
00:06:10,339 --> 00:06:08,550
a multiscale multi technique approach

174
00:06:11,899 --> 00:06:10,349
this is one technique am using

175
00:06:14,390 --> 00:06:11,909
spectroscopy this would be kind of

176
00:06:16,339 --> 00:06:14,400
comparable to chrism data this is UV vis

177
00:06:18,409 --> 00:06:16,349
near-ir i did this include asus lab in

178
00:06:20,209 --> 00:06:18,419
winnipeg just an example of several

179
00:06:23,659 --> 00:06:20,219
spectra so what we see here is we've got

180
00:06:25,490 --> 00:06:23,669
this feature here around 2.5 and 2.3

181
00:06:27,800 --> 00:06:25,500
microns this is a carbon and oxygen

182
00:06:29,990 --> 00:06:27,810
feature this tells us we have carbonate

183
00:06:31,610 --> 00:06:30,000
present that's what they used to

184
00:06:32,990 --> 00:06:31,620
carbonate on Mars do that same feature

185
00:06:34,700 --> 00:06:33,000
here we see these iron crystal field

186
00:06:37,459 --> 00:06:34,710
transitions we have an iron rich

187
00:06:39,260 --> 00:06:37,469
carbonate it's an anchorite we also see

188
00:06:41,779 --> 00:06:39,270

an o H feature here she tells us we have

189
00:06:43,100 --> 00:06:41,789
something hydrated some sort of water

190
00:06:46,679 --> 00:06:43,110
and new crystal lattice in the mineral

191
00:06:49,139 --> 00:06:46,689
we also have a metal Oh age feature

192
00:06:50,759 --> 00:06:49,149
this is probably I think magnesium o.h

193
00:06:51,989 --> 00:06:50,769
this tells us we have a mica this is

194
00:06:54,419 --> 00:06:51,999
what they use to detect phyllosilicates

195
00:06:57,499 --> 00:06:54,429
on Mars so we have a carbonate mica

196
00:06:59,609 --> 00:06:57,509
assemblage now we can also do this is a

197
00:07:01,169 --> 00:06:59,619
information that i got from micro x-ray

198
00:07:03,659 --> 00:07:01,179
diffraction so like x-ray diffraction

199
00:07:06,749 --> 00:07:03,669
what was shown earlier but you can do it

200
00:07:09,600 --> 00:07:06,759
in CA Choo so I did a transect all these

201
00:07:13,069 --> 00:07:09,610
little red dots are spots that I did

202
00:07:15,989 --> 00:07:13,079
micro xrd on and you can see the general

203
00:07:17,789 --> 00:07:15,999
mineralogy here so you've got anchorite

204
00:07:19,229 --> 00:07:17,799
or dolomite and some pirate that's kind

205
00:07:20,579 --> 00:07:19,239
of everywhere I say anchorite slashed

206
00:07:22,229 --> 00:07:20,589
all night because they're Isis

207
00:07:24,149 --> 00:07:22,239
structural it's basically can't really

208
00:07:25,529 --> 00:07:24,159
tell an xrd which is which it's just to

209
00:07:28,619 --> 00:07:25,539
solve a solution series of iron

210
00:07:30,149 --> 00:07:28,629
magnesium calcium carbonate then you've

211
00:07:31,350 --> 00:07:30,159
got a little bit of calcite but this is

212
00:07:33,299 --> 00:07:31,360
one of the few samples that actually has

213
00:07:35,489 --> 00:07:33,309

any calcite quartz kind of threw out

214
00:07:38,609 --> 00:07:35,499
some mica so that's a fellow silicate

215
00:07:41,159 --> 00:07:38,619
and then some different types of

216
00:07:43,199 --> 00:07:41,169
sulfides Galena but then also tourmaline

217
00:07:44,639 --> 00:07:43,209
so this is telling us we have some sort

218
00:07:46,199 --> 00:07:44,649
of sedimentary and put into the fluid to

219
00:07:49,199 --> 00:07:46,209
provide the boron Fitzwilliam so we've

220
00:07:51,059 --> 00:07:49,209
got multiple fluids and then down to SEM

221
00:07:52,709 --> 00:07:51,069
analysis these are backscatter sem

222
00:07:54,659 --> 00:07:52,719
images showing different types of

223
00:07:58,079 --> 00:07:54,669
sulfides that we see so here we've got

224
00:08:00,569 --> 00:07:58,089
pyrite and molybdenite got sphalerite

225
00:08:03,869 --> 00:08:00,579
which is a zinc sulfide some more pie

226
00:08:07,769 --> 00:08:03,879
right Galena calcio products we got lead

227
00:08:08,879 --> 00:08:07,779
zinc copper sulfides these will all form

228
00:08:10,139 --> 00:08:08,889
at different temperatures we know we

229
00:08:11,819 --> 00:08:10,149
have different fluid sources in

230
00:08:13,019 --> 00:08:11,829
different temperatures but what does

231
00:08:15,769 --> 00:08:13,029
this all tell us about the geochemistry

232
00:08:18,749 --> 00:08:15,779
and the potential habitability well

233
00:08:21,209 --> 00:08:18,759
firstly we have carbonates aracite or

234
00:08:24,569 --> 00:08:21,219
potassium this is low salinity co2

235
00:08:26,729 --> 00:08:24,579
dominated fluids so a pretty monday and

236
00:08:28,290 --> 00:08:26,739
hydrothermal fluid but then we see

237
00:08:29,850 --> 00:08:28,300
variability and accessory middles and

238
00:08:32,939 --> 00:08:29,860

trace metals so accessory minerals like

239
00:08:34,619 --> 00:08:32,949
different types of sulfide species rue

240
00:08:36,600 --> 00:08:34,629
tiles things like that n trace metals

241
00:08:37,949 --> 00:08:36,610
like titanium vanadium chromium

242
00:08:41,129 --> 00:08:37,959
molybdenum some of which are really

243
00:08:43,980 --> 00:08:41,139
important we talk about metal catalysts

244
00:08:46,559 --> 00:08:43,990
for life and enzymes we also see

245
00:08:49,139 --> 00:08:46,569
multiple fluid sources which partially

246
00:08:51,389 --> 00:08:49,149
we attribute some of this trace metal

247
00:08:53,670 --> 00:08:51,399
variability to episodic magmatic fluid

248
00:08:56,150 --> 00:08:53,680
input so little pulses of these metal

249
00:09:00,170 --> 00:08:56,160
rich really interesting fluids into this

250
00:09:03,650 --> 00:09:00,180
pretty you know just carbonate rich

251
00:09:04,880 --> 00:09:03,660
fluid providing areas of fluid mixing

252
00:09:06,200 --> 00:09:04,890
which is really interesting you got

253
00:09:08,090 --> 00:09:06,210
different fluids different temperatures

254
00:09:10,400 --> 00:09:08,100
you're creating potential for redox

255
00:09:14,329 --> 00:09:10,410
gradients and pH gradients as we know

256
00:09:17,180 --> 00:09:14,339
are important for life so what we're

257
00:09:19,100 --> 00:09:17,190
doing now and working on is trying to

258
00:09:20,750 --> 00:09:19,110
further understand this fluid source and

259
00:09:22,970 --> 00:09:20,760
mixing so looking at carbon and oxygen

260
00:09:24,790 --> 00:09:22,980
stable isotopes I will start running

261
00:09:27,620 --> 00:09:24,800
them as soon as I get back to London and

262
00:09:29,150 --> 00:09:27,630
then I've done some synchrotron x-ray

263
00:09:30,800 --> 00:09:29,160

mapping and speciation of pyrite grains

264
00:09:32,720 --> 00:09:30,810
to look at trace metal speciation and

265
00:09:34,970 --> 00:09:32,730
abundances and correlations between

266
00:09:39,079 --> 00:09:34,980
different trace metals and gold for

267
00:09:40,699 --> 00:09:39,089
instance and yeah primarily gold it sits

268
00:09:43,010 --> 00:09:40,709
in a mind the gold company wants to know

269
00:09:44,780 --> 00:09:43,020
where the gold is from but I get to get

270
00:09:47,990 --> 00:09:44,790
cool samples and do awesome science is

271
00:09:49,250 --> 00:09:48,000
kind of again it's a trade off and then

272
00:09:50,300 --> 00:09:49,260
we won't understand flu temperatures

273
00:09:52,070 --> 00:09:50,310
this is what I'm excited but we're going

274
00:09:53,990 --> 00:09:52,080
to do some clumped carbonate isotope

275
00:09:55,519 --> 00:09:54,000
thermometry this will allow us to

276
00:09:58,040 --> 00:09:55,529
elucidate what temperature this

277
00:09:59,810 --> 00:09:58,050
carbonate was precipitated at and then

278
00:10:01,610 --> 00:09:59,820
also to fully understand the timing and

279
00:10:03,199 --> 00:10:01,620
pear genesis the rock record ins area is

280
00:10:04,390 --> 00:10:03,209
pretty well understood a lot of things

281
00:10:07,370 --> 00:10:04,400
have been dated it's been worked on for

282
00:10:09,920 --> 00:10:07,380
you know 100 years but if we can put

283
00:10:11,840 --> 00:10:09,930
this hydrothermal alteration in two

284
00:10:13,100 --> 00:10:11,850
contexts with when the basin was forming

285
00:10:14,449 --> 00:10:13,110
what intrusions were for me we can

286
00:10:16,160 --> 00:10:14,459
better understand what's going on on the

287
00:10:17,810 --> 00:10:16,170
large scale so we're going to do either

288
00:10:20,930 --> 00:10:17,820

some monocyte or molybdenite dating

289
00:10:24,680 --> 00:10:20,940
having decided yet with that I would

290
00:10:25,970 --> 00:10:24,690
like to thank my sponsors and everyone