# AB GRAD CON23

1
00:00:13,669 --> 00:00:10,690
[Music]

2
00:00:15,350 --> 00:00:13,679
hello everybody my name is Justin Park I

3
00:00:17,630 --> 00:00:15,360
am a second year PhD student at

4
00:00:18,950 --> 00:00:17,640
Rensselaer Polytechnic Institute and one

5
00:00:20,570 --> 00:00:18,960
thing we're interested in doing in our

6
00:00:22,550 --> 00:00:20,580
Labs is reconstructing ancient

7
00:00:24,529 --> 00:00:22,560
atmospheres as they pertain to important

8
00:00:26,210 --> 00:00:24,539
evolutionary steps in our atmosphere's

9
00:00:28,550 --> 00:00:26,220
history

10
00:00:30,290 --> 00:00:28,560
so what I do is I look at ancient

11
00:00:32,450 --> 00:00:30,300
atmospheres trapped in halite fluid

12
00:00:34,130 --> 00:00:32,460
inclusions so halite as we've seen in

13
00:00:36,229 --> 00:00:34,140

previous talks is an evaporative mineral

14
00:00:37,910 --> 00:00:36,239
it forms in these really dry arid

15
00:00:40,430 --> 00:00:37,920
environments where evaporation is the

16
00:00:41,750 --> 00:00:40,440
dominating Force as it does so it can

17
00:00:43,729 --> 00:00:41,760
form these things called fluid

18
00:00:46,130 --> 00:00:43,739
inclusions as shown in the top right up

19
00:00:48,709 --> 00:00:46,140
here and they can encapture air or brine

20
00:00:51,049 --> 00:00:48,719
in the mineral Matrix now these can be

21
00:00:53,150 --> 00:00:51,059
primary or secondary meaning they form

22
00:00:54,770 --> 00:00:53,160
at the time the mineral precipitates or

23
00:00:57,110 --> 00:00:54,780
forming sometime later with some

24
00:00:59,029 --> 00:00:57,120
secondary fluid event and oftentimes

25
00:01:02,029 --> 00:00:59,039
they form an assemblages of hundreds or

26
00:01:03,830 --> 00:01:02,039
thousands of inclusions at once now what

27
00:01:05,390 --> 00:01:03,840
I'm interested in doing is looking at

28
00:01:07,310 --> 00:01:05,400
the gases that are trapped in these

29
00:01:09,410 --> 00:01:07,320
primary inclusions and saying something

30
00:01:11,270 --> 00:01:09,420
about the evolving composition of the

31
00:01:14,090 --> 00:01:11,280
atmosphere

32
00:01:15,469 --> 00:01:14,100
now we do have some evidence for what we

33
00:01:17,870 --> 00:01:15,479
think the atmosphere looked like and how

34
00:01:19,850 --> 00:01:17,880
it evolved here I have plotted one of

35
00:01:22,390 --> 00:01:19,860
the major models suggesting the change

36
00:01:25,190 --> 00:01:22,400
in partial pressure of nitrogen oxygen

37
00:01:27,109 --> 00:01:25,200
CO2 and methane as a function of time

38
00:01:28,910 --> 00:01:27,119

starting with the moon forming event 4.5

39
00:01:30,530 --> 00:01:28,920
billion years ago

40
00:01:32,390 --> 00:01:30,540
now if you'll notice here there is a lot

41
00:01:34,490 --> 00:01:32,400
of uncertainty in these measurements and

42
00:01:38,270 --> 00:01:34,500
this is due to them being made with

43
00:01:40,249 --> 00:01:38,280
indirect proxy measurements now also in

44
00:01:42,710 --> 00:01:40,259
the period between two and one billion

45
00:01:45,170 --> 00:01:42,720
years ago here

46
00:01:47,030 --> 00:01:45,180
we have this period known as the boring

47
00:01:49,010 --> 00:01:47,040
billion and it's aptly named for the

48
00:01:49,969 --> 00:01:49,020
apparent stagnancy of the atmospheric

49
00:01:51,830 --> 00:01:49,979
evolution

50
00:01:53,569 --> 00:01:51,840
now what we're interested in doing is

51
00:01:56,510 --> 00:01:53,579
providing ancient atmospheric

52
00:01:58,490 --> 00:01:56,520
constraints using fluid inclusions in

53
00:02:01,310 --> 00:01:58,500
the period between these two points

54
00:02:03,530 --> 00:02:01,320
using direct analysis from 1.4 billion

55
00:02:05,990 --> 00:02:03,540
year old fluid inclusions

56
00:02:08,389 --> 00:02:06,000
so we can do this by loading our samples

57
00:02:10,729 --> 00:02:08,399
into a special crushing device crushing

58
00:02:12,589 --> 00:02:10,739
them this ruptures our inclusions and we

59
00:02:14,690 --> 00:02:12,599
can pass the gas directly into a

60
00:02:16,790 --> 00:02:14,700
quadruple Mass spectrometer

61
00:02:18,830 --> 00:02:16,800
when we do so we see peaks in our signal

62
00:02:20,630 --> 00:02:18,840
that correspond to each Crush these

63
00:02:22,910 --> 00:02:20,640

Peaks can be integrated and Quantified

64
00:02:24,710 --> 00:02:22,920
by comparing to known calibration points

65
00:02:26,630 --> 00:02:24,720
thus we can get an idea of the

66
00:02:29,750 --> 00:02:26,640
composition and known amount of moles of

67
00:02:31,070 --> 00:02:29,760
nitrogen oxygen argon and CO2 present in

68
00:02:32,869 --> 00:02:31,080
these inclusions

69
00:02:34,430 --> 00:02:32,879
when we backtrack and calculate the

70
00:02:36,110 --> 00:02:34,440
ancient atmosphere composition we do

71
00:02:38,030 --> 00:02:36,120
have to be wary of any aqueous

72
00:02:39,830 --> 00:02:38,040
contributions as we know Henry's law

73
00:02:41,449 --> 00:02:39,840
tells us this atmosphere may also be

74
00:02:43,430 --> 00:02:41,459
dissolved in the brine phase and its

75
00:02:45,170 --> 00:02:43,440
equilibrium

76
00:02:47,330 --> 00:02:45,180
so when we did this we saw some

77
00:02:49,430 --> 00:02:47,340
variability in our results here I have

78
00:02:52,009 --> 00:02:49,440
plotted the mole fraction of nitrogen

79
00:02:54,530 --> 00:02:52,019
oxygen argon and CO2 as a function of

80
00:02:56,869 --> 00:02:54,540
the size of each sample one thing we can

81
00:02:58,369 --> 00:02:56,879
notice is that the primary and secondary

82
00:03:00,290 --> 00:02:58,379
inclusions do capture different

83
00:03:03,050 --> 00:03:00,300
atmospheres that are distinct from one

84
00:03:04,970 --> 00:03:03,060
of one another now we're very interested

85
00:03:06,830 --> 00:03:04,980
in the primary inclusions as that's the

86
00:03:08,990 --> 00:03:06,840
environment that the mineral formed in

87
00:03:11,210 --> 00:03:09,000
and we can compute a average partial

88
00:03:13,309 --> 00:03:11,220

pressure or density of each gas and

89
00:03:14,990 --> 00:03:13,319
compare it to the modern atmosphere

90
00:03:17,630 --> 00:03:15,000
when we do that we saw some very

91
00:03:19,550 --> 00:03:17,640
interesting things back 1.4 billion

92
00:03:21,290 --> 00:03:19,560
years ago we found atmospheric nitrogen

93
00:03:23,690 --> 00:03:21,300
was roughly the same partial pressure as

94
00:03:25,550 --> 00:03:23,700
it is today atmospheric oxygen was

95
00:03:27,770 --> 00:03:25,560
around a tenth as dense

96
00:03:29,390 --> 00:03:27,780
argon was about half as dense and carbon

97
00:03:31,970 --> 00:03:29,400
dioxide was actually eight times more

98
00:03:34,190 --> 00:03:31,980
dense now each of these gases has really

99
00:03:35,570 --> 00:03:34,200
important implications but due to time

100
00:03:37,850 --> 00:03:35,580
I'm only going to have time to talk

101
00:03:39,890 --> 00:03:37,860
about oxygen today

102
00:03:41,630 --> 00:03:39,900
so when we looked at our auction results

103
00:03:43,309 --> 00:03:41,640
there are measured partial pressure

104
00:03:45,470 --> 00:03:43,319
revealed some pretty interesting things

105
00:03:47,270 --> 00:03:45,480
here I have it compared to many of the

106
00:03:49,610 --> 00:03:47,280
predicted models that have been proposed

107
00:03:51,229 --> 00:03:49,620
what we saw is that we captured more

108
00:03:53,570 --> 00:03:51,239
oxygen than these models would have

109
00:03:55,130 --> 00:03:53,580
proposed this indicates that these

110
00:03:56,630 --> 00:03:55,140
direct measurements might be able to

111
00:03:57,649 --> 00:03:56,640
capture things that the proxies are

112
00:03:59,149 --> 00:03:57,659
unable to

113
00:04:01,490 --> 00:03:59,159

and this has some pretty important

114
00:04:03,830 --> 00:04:01,500
implications the oxygen that we measured

115
00:04:05,690 --> 00:04:03,840
is above theoretical lower limits

116
00:04:07,789 --> 00:04:05,700
necessary for the early evolution of

117
00:04:09,350 --> 00:04:07,799
life and it's also an agreement with

118
00:04:11,929 --> 00:04:09,360
some evidence suggesting there was a

119
00:04:14,330 --> 00:04:11,939
developed ozone layer at this time

120
00:04:16,550 --> 00:04:14,340
now on the right here I have plotted a

121
00:04:19,030 --> 00:04:16,560
phylogenetic tree showing the marked

122
00:04:21,650 --> 00:04:19,040
diversification of red algae in the

123
00:04:23,210 --> 00:04:21,660
mesopoterozoic Now red algae are very

124
00:04:25,310 --> 00:04:23,220
important as they're some of the first

125
00:04:27,050 --> 00:04:25,320
photosynthetic eukaryotes that gives

126
00:04:28,310 --> 00:04:27,060
them an evolutionary advantage to

127
00:04:30,110 --> 00:04:28,320
produce more oxygen than their

128
00:04:31,670 --> 00:04:30,120
predecessors

129
00:04:33,830 --> 00:04:31,680
it was really interesting when we

130
00:04:35,870 --> 00:04:33,840
compare this to our timing of the

131
00:04:38,210 --> 00:04:35,880
deposition of our samples we can see

132
00:04:40,249 --> 00:04:38,220
they're roughly contemporaneous and thus

133
00:04:42,230 --> 00:04:40,259
our elevated oxygen measurements are

134
00:04:44,990 --> 00:04:42,240
likely due to the presence of these red

135
00:04:47,390 --> 00:04:45,000
algae so I hope I've shown here today

136
00:04:49,310 --> 00:04:47,400
that the atmospheric oxygen here is

137
00:04:50,689 --> 00:04:49,320
pointing a more Dynamic picture of the

138
00:04:53,090 --> 00:04:50,699

boring billion and it might not have

139
00:04:55,610 --> 00:04:53,100
been so boring at all we have important

140
00:04:57,530 --> 00:04:55,620
implications of these ancient red algae

141
00:04:59,390 --> 00:04:57,540
evolving at this time period that led to

142
00:05:03,710 --> 00:04:59,400
this

143
00:05:05,689 --> 00:05:03,720
inclusions can capture and maintain

144
00:05:07,430 --> 00:05:05,699
direct evidence of ancient atmospheres

145
00:05:08,450 --> 00:05:07,440
for hundreds of millions of years if not

146
00:05:10,730 --> 00:05:08,460
billions

147
00:05:12,170 --> 00:05:10,740
with mass spectrometry we can probe the

148
00:05:13,969 --> 00:05:12,180
contents of the gas that are trapped

149
00:05:16,189 --> 00:05:13,979
within these and we can look into how

150
00:05:18,170 --> 00:05:16,199
the atmosphere has evolved we aimed to

151
00:05:20,330 --> 00:05:18,180
make compositional measurements of the

152
00:05:21,890 --> 00:05:20,340
atmosphere 1.4 billion years ago and we

153
00:05:23,870 --> 00:05:21,900
found something very different than our

154
00:05:25,670 --> 00:05:23,880
present atmosphere hopefully in the

155
00:05:27,230 --> 00:05:25,680
future we can make isotopic ratio

156
00:05:30,290 --> 00:05:27,240
measurements and see any further

157
00:05:31,909 --> 00:05:30,300
Evolution trends so with that thank you

158
00:05:33,409 --> 00:05:31,919
all for listening if you have any

159
00:05:35,970 --> 00:05:33,419
questions I'd be happy to talk to you

160
00:05:39,320 --> 00:05:35,980
about my poster number 14 after this

161
00:05:40,440 --> 00:05:39,330
[Applause]