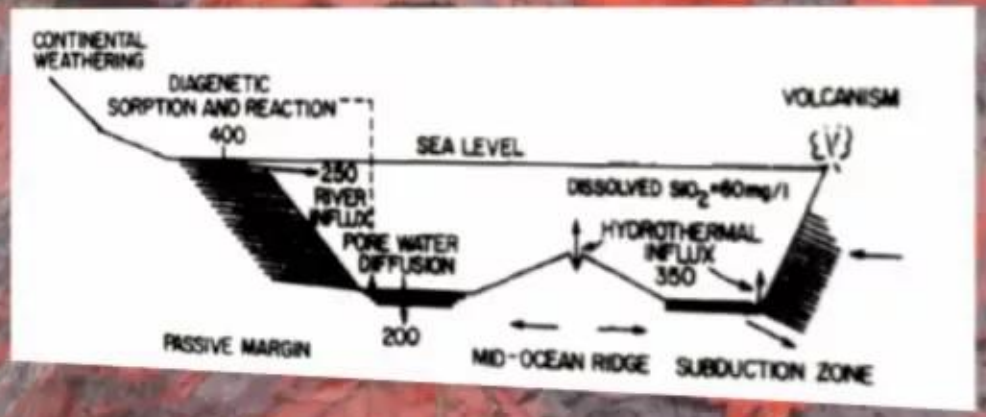
Precambrian Si cycle

- No biological precipitation of Si (no Si secreting organisms)
- high Si concentration, [Si] = 60 ppm
- Si precipitation in sedimentary layers



Siever, 1992

1
00:00:10,620 --> 00:00:08,940
hi everyone I'm fury and today I'm going

2
00:00:12,629 --> 00:00:10,630
to take us back into the archaean wall

3
00:00:14,699 --> 00:00:12,639
we're gonna look into silica isotope

4
00:00:17,580 --> 00:00:14,709
fractionation during the reductive

5
00:00:21,240 --> 00:00:17,590
dissolution of I and silica gel and this

6
00:00:23,310 --> 00:00:21,250
reduction is mediated by an organism

7
00:00:25,560 --> 00:00:23,320
diesel parameters which is capable of

8
00:00:27,390 --> 00:00:25,570
iron reduction and before we proceed any

9
00:00:30,210 --> 00:00:27,400
further I would like to just tank

10
00:00:32,040 --> 00:00:30,220
uw-madison and also NASA for allowing me

11
00:00:37,829 --> 00:00:32,050
the opportunity to be a part of this

12
00:00:39,479 --> 00:00:37,839
study alright if I jump into any details

13
00:00:41,819 --> 00:00:39,489

I'll just outline give you a brief

14
00:00:43,500 --> 00:00:41,829
outline of my talk today so first of all

15
00:00:45,090 --> 00:00:43,510
we're going to look into two papers from

16
00:00:47,009 --> 00:00:45,100
the literature that served as a

17
00:00:49,380 --> 00:00:47,019
motivation towards the science silica

18
00:00:51,899 --> 00:00:49,390
gel study and then we'll move into the

19
00:00:53,639 --> 00:00:51,909
Precambrian silica cycle and contrast it

20
00:00:55,529 --> 00:00:53,649
with a modern silica cycle and look at

21
00:00:58,049 --> 00:00:55,539
the difference and then we'll go into

22
00:01:00,360 --> 00:00:58,059
some silica shuttup basics looking into

23
00:01:03,599 --> 00:01:00,370
silica is to abundances Delta silica

24
00:01:05,790 --> 00:01:03,609
notation well cross it into looking why

25
00:01:07,620 --> 00:01:05,800
is it that Seleka isotope is an

26
00:01:11,999 --> 00:01:07,630
important factor in the Precambrian

27
00:01:14,520 --> 00:01:12,009
record why are people interested why are

28
00:01:16,649 --> 00:01:14,530
people interested why are people why is

29
00:01:18,330 --> 00:01:16,659
their interest for silica isotopes in

30
00:01:20,310 --> 00:01:18,340
the Precambrian record so the first

31
00:01:22,350 --> 00:01:20,320
example we would look at as the couple

32
00:01:25,200 --> 00:01:22,360
iron and silica bottle and then we're

33
00:01:26,670 --> 00:01:25,210
moving to select isotopes in shirts that

34
00:01:28,859 --> 00:01:26,680
have been particularly used to spill

35
00:01:32,340 --> 00:01:28,869
your thermometers we'll also go into

36
00:01:34,260 --> 00:01:32,350
silica isotopes as a sauce tracer we'll

37
00:01:36,420 --> 00:01:34,270
wrap that up and then we'll move into my

38
00:01:39,060 --> 00:01:36,430

experimental approach looking into how I

39
00:01:41,520 --> 00:01:39,070
synthesize the iron silica gel and also

40
00:01:45,539 --> 00:01:41,530
the artificial arc in seawater which is

41
00:01:47,789 --> 00:01:45,549
the seawater matrix media here and then

42
00:01:51,770 --> 00:01:47,799
I'll show you some data will go into the

43
00:01:54,480 --> 00:01:51,780
iron reduction of this gel over time and

44
00:01:56,609 --> 00:01:54,490
then we'll move into isotopic data in

45
00:01:59,719 --> 00:01:56,619
the sense of silica sio2 Berra for the

46
00:02:02,039 --> 00:01:59,729
equals and solid phase of my samples

47
00:02:04,560 --> 00:02:02,049
will conclude with some fractionation

48
00:02:08,400 --> 00:02:04,570
factor over time and what that means to

49
00:02:10,350 --> 00:02:08,410
us or at least to me at this point all

50
00:02:11,820 --> 00:02:10,360
right I mentioned earlier that there

51
00:02:14,250 --> 00:02:11,830
were two papers from the literature that

52
00:02:16,619 --> 00:02:14,260
sort of motivated the study the first

53
00:02:17,900 --> 00:02:16,629
paper looked at ionized took

54
00:02:20,360 --> 00:02:17,910
fractionation of this

55
00:02:22,430 --> 00:02:20,370
I'm silica gel a co precipitate in an

56
00:02:24,800 --> 00:02:22,440
aqueous media similar to the akhiyan sea

57
00:02:27,880 --> 00:02:24,810
water and found that the eye on silica

58
00:02:30,710 --> 00:02:27,890
gel is of highly reducible nature and

59
00:02:32,960 --> 00:02:30,720
the silica president this gel leads to

60
00:02:34,970 --> 00:02:32,970
formation of silica bearing products say

61
00:02:36,890 --> 00:02:34,980
for example precursor to green elite's

62
00:02:39,620 --> 00:02:36,900
in banded iron formations that we see

63
00:02:42,350 --> 00:02:39,630

today and then the second paper also

64
00:02:43,940 --> 00:02:42,360
looks into ionizer top fractionation but

65
00:02:47,060 --> 00:02:43,950
looks into ionizer to a fractionation

66
00:02:49,550 --> 00:02:47,070
between the Equus ferus ion and also I

67
00:02:51,620 --> 00:02:49,560
and select that gel in an aqueous in an

68
00:02:53,570 --> 00:02:51,630
aqueous media of seawater composition

69
00:02:55,520 --> 00:02:53,580
from the akhiyan and found that by

70
00:02:57,350 --> 00:02:55,530
wearing iron to select our ratio in the

71
00:02:59,510 --> 00:02:57,360
gel you get different fractionation

72
00:03:02,690 --> 00:02:59,520
factors so when you have an iron to

73
00:03:04,790 --> 00:03:02,700
select a ratio that is high you have a

74
00:03:06,440 --> 00:03:04,800
lesser negative fractionation factor as

75
00:03:09,140 --> 00:03:06,450
compared to when you have an iron to

76
00:03:12,140 --> 00:03:09,150
silica ratio which is smaller you see a

77
00:03:14,420 --> 00:03:12,150
more negative fractionation Factor both

78
00:03:16,250 --> 00:03:14,430
of these papers look into iron isotope

79
00:03:18,530 --> 00:03:16,260
fractionation stone but what about the

80
00:03:19,880 --> 00:03:18,540
silica that's present in this gel so

81
00:03:22,610 --> 00:03:19,890
what is the silica isotope fractionation

82
00:03:24,949 --> 00:03:22,620
that you see you in silica is mobilized

83
00:03:26,360 --> 00:03:24,959
during the similar tree iron reduction

84
00:03:28,520 --> 00:03:26,370
so that's what we're going to try to

85
00:03:30,680 --> 00:03:28,530
answer with my research but Before we

86
00:03:35,530 --> 00:03:30,690
jump into answering this question let's

87
00:03:39,230 --> 00:03:38,090
sorry about that so I mentioned earlier

88
00:03:41,360 --> 00:03:39,240

that we're going to look into the

89
00:03:43,699 --> 00:03:41,370
Precambrian and also the modern silica

90
00:03:45,620 --> 00:03:43,709
cycle as we have seen from the previous

91
00:03:47,330 --> 00:03:45,630
talks one of the major difference

92
00:03:49,699 --> 00:03:47,340
between the Precambrian in modern psyche

93
00:03:51,470 --> 00:03:49,709
silica cycle is the presence of biology

94
00:03:53,930 --> 00:03:51,480
so in the Precambrian there was no

95
00:03:55,910 --> 00:03:53,940
biology there was no Psilakis recruiting

96
00:03:57,890 --> 00:03:55,920
organisms present therefore there was a

97
00:04:00,590 --> 00:03:57,900
high concentration of silica in ocean

98
00:04:02,660 --> 00:04:00,600
juarez so precipitation of amorphous

99
00:04:05,390 --> 00:04:02,670
silica in sedimentary is in beast in

100
00:04:07,670 --> 00:04:05,400
juarez was possible and that led and

101
00:04:12,020 --> 00:04:07,680
that is evidence of the church that we

102
00:04:14,390 --> 00:04:12,030
see today some silica isotope basics so

103
00:04:16,340 --> 00:04:14,400
that tree stable silica isotopes with 28

104
00:04:19,039 --> 00:04:16,350
Seleka being the most abundant one and

105
00:04:21,380 --> 00:04:19,049
30 silica being lease abandon Delta

106
00:04:26,150 --> 00:04:21,390
silica notation is presented in the

107
00:04:28,610 --> 00:04:26,160
traditional primal notation so tight so

108
00:04:31,640 --> 00:04:28,620
tops in the Precambrian record why is it

109
00:04:33,620 --> 00:04:31,650
of any interest so the first model here

110
00:04:35,900 --> 00:04:33,630
is the iron and silica cycle model that

111
00:04:38,360 --> 00:04:35,910
was proposed by Fisher and canal so they

112
00:04:40,610 --> 00:04:38,370
proposed that in the forex zone where

113
00:04:42,920 --> 00:04:40,620

anoxic photosynthesis takes place you

114
00:04:45,170 --> 00:04:42,930
have ferrous ion which gets oxidized

115
00:04:48,230 --> 00:04:45,180
into ferric hydroxide and then the

116
00:04:50,210 --> 00:04:48,240
silica dioxide in ocean waters that has

117
00:04:52,730 --> 00:04:50,220
a high affinity to sort to ferric

118
00:04:55,100 --> 00:04:52,740
hydroxide once the sorption takes place

119
00:04:57,350 --> 00:04:55,110
the ferric hydroxide then seems to both

120
00:04:59,779 --> 00:04:57,360
bottom water and undergoes reductive

121
00:05:02,210 --> 00:04:59,789
dissolution with reductive the solution

122
00:05:04,640 --> 00:05:02,220
we have a first component of hot iron

123
00:05:06,830 --> 00:05:04,650
and we have the silica dioxide that can

124
00:05:09,320 --> 00:05:06,840
then combine and form iron silicates

125
00:05:11,659 --> 00:05:09,330
again we see iron silicates are

126
00:05:14,779 --> 00:05:11,669
precursors to minerals that we see in

127
00:05:17,629 --> 00:05:14,789
banded iron formations today moving on

128
00:05:20,719 --> 00:05:17,639
selita isotopes have also been utilized

129
00:05:23,540 --> 00:05:20,729
as paleo tomorrow mirrors from the

130
00:05:25,550 --> 00:05:23,550
Precambrian record for example robert

131
00:05:28,610 --> 00:05:25,560
inchasa don used the correlation between

132
00:05:30,589 --> 00:05:28,620
delta 18 oxygen and alpha perestroika to

133
00:05:34,100 --> 00:05:30,599
actually trace the temperatures of ocean

134
00:05:35,990 --> 00:05:34,110
waters back to the archaean the next

135
00:05:37,909 --> 00:05:36,000
example of silica isotopes from the

136
00:05:40,760 --> 00:05:37,919
Precambrian record would be as a sauce

137
00:05:43,100 --> 00:05:40,770
tracer as we can see here that there are

138
00:05:45,560 --> 00:05:43,110

two different types of kids based on the

139
00:05:47,870 --> 00:05:45,570
atomic composition one is the ass shirts

140
00:05:50,540 --> 00:05:47,880
and the other as the secrets the ass

141
00:05:52,460 --> 00:05:50,550
shirts is said to be from silica

142
00:05:54,920 --> 00:05:52,470
saturated seawater that has been

143
00:05:57,409 --> 00:05:54,930
continuously been sillas continuously

144
00:05:59,390 --> 00:05:57,419
responsible for solicitation and the

145
00:06:01,399 --> 00:05:59,400
second one is chemical church which

146
00:06:05,810 --> 00:06:01,409
represents a mixing gradient between the

147
00:06:08,300 --> 00:06:05,820
hydrothermal inputs in seawater we've

148
00:06:11,180 --> 00:06:08,310
seen that selected isotopes is affected

149
00:06:12,680 --> 00:06:11,190
or controlled by temperature sauces but

150
00:06:15,379 --> 00:06:12,690
what about the processes that affect

151
00:06:18,620 --> 00:06:15,389
them what about biology that's where my

152
00:06:20,240 --> 00:06:18,630
experimental approach comes in so we

153
00:06:22,790 --> 00:06:20,250
have the iron select our gel and the

154
00:06:24,830 --> 00:06:22,800
artificial I can see water representing

155
00:06:27,830 --> 00:06:24,840
the seawater composition of the art kid

156
00:06:29,779 --> 00:06:27,840
so for the iron silica gel I use tree of

157
00:06:31,909 --> 00:06:29,789
the ingredients above allowed them to

158
00:06:34,219 --> 00:06:31,919
make sweet open atmosphere for about two

159
00:06:36,080 --> 00:06:34,229
weeks on a shaker once the acid

160
00:06:38,180 --> 00:06:36,090
extraction accounts for about ninety

161
00:06:40,240 --> 00:06:38,190
five percent of the ferric component to

162
00:06:41,490 --> 00:06:40,250
total iron that is in close

163
00:06:44,100 --> 00:06:41,500

representation of

164
00:06:46,410 --> 00:06:44,110
the I entry phases that might have been

165
00:06:48,870 --> 00:06:46,420
present in the arc en environment and

166
00:06:51,210 --> 00:06:48,880
then for the unofficial akhiyan sea

167
00:06:53,010 --> 00:06:51,220
water is just a recipe modified from the

168
00:06:55,170 --> 00:06:53,020
first motivational paper that I showed

169
00:06:57,330 --> 00:06:55,180
you guys it's basically made to be an

170
00:07:00,150 --> 00:06:57,340
opposite and low in sulphate content and

171
00:07:02,010 --> 00:07:00,160
we did not introduce any selecta in this

172
00:07:04,290 --> 00:07:02,020
equal space because we didn't want any

173
00:07:06,900 --> 00:07:04,300
of the minus signal released by the

174
00:07:10,770 --> 00:07:06,910
microbes to be blocked when we analyzed

175
00:07:13,320 --> 00:07:10,780
it for silica isotopes these sulfur a

176
00:07:15,510 --> 00:07:13,330
minus is the organism of choice in our

177
00:07:18,000 --> 00:07:15,520
experiment and the reason being saw is

178
00:07:20,280 --> 00:07:18,010
because the sulfur a minus is the marine

179
00:07:22,020 --> 00:07:20,290
cousins of geobacter which have been

180
00:07:23,370 --> 00:07:22,030
recognized for iron reduction and

181
00:07:25,620 --> 00:07:23,380
previous studies in the literature

182
00:07:29,640 --> 00:07:25,630
proven that they are capable of reducing

183
00:07:33,840 --> 00:07:29,650
very component ferric iron in components

184
00:07:35,820 --> 00:07:33,850
which contains silica also so those are

185
00:07:37,950 --> 00:07:35,830
my experimental while as you can see

186
00:07:41,280 --> 00:07:37,960
from day one I have four experimental

187
00:07:42,960 --> 00:07:41,290
vial to Wiles contains cells of diesel

188
00:07:44,760 --> 00:07:42,970

for Ramona's while two other wiles

189
00:07:47,909 --> 00:07:44,770
adjust the gel and the artificial

190
00:07:49,920 --> 00:07:47,919
audience seawater at day 30 it becomes

191
00:07:52,380 --> 00:07:49,930
really obvious to us that which wire's

192
00:07:54,330 --> 00:07:52,390
contains cells and which world are the

193
00:08:02,490 --> 00:07:54,340
control experiments you can see the

194
00:08:06,540 --> 00:08:04,860
alright so as I've mentioned earlier the

195
00:08:08,520 --> 00:08:06,550
coloration difference are the first two

196
00:08:10,950 --> 00:08:08,530
vials so they transform from being

197
00:08:13,320 --> 00:08:10,960
yellow to a little bit of that greenish

198
00:08:15,690 --> 00:08:13,330
that is the vowels with the cells that

199
00:08:17,940 --> 00:08:15,700
shows us that the ferric component in

200
00:08:19,530 --> 00:08:17,950
the gel has been reduced to ferrous

201
00:08:21,300 --> 00:08:19,540
component has been reduced to the

202
00:08:23,430 --> 00:08:21,310
fairest component and in the control

203
00:08:25,470 --> 00:08:23,440
experiment since there were no cells of

204
00:08:27,720 --> 00:08:25,480
the sulfur a minus the coloration

205
00:08:30,090 --> 00:08:27,730
remained the theme and there was no

206
00:08:32,370 --> 00:08:30,100
presence of ferrous iron or there might

207
00:08:34,320 --> 00:08:32,380
have been very insignificant amounts of

208
00:08:38,969 --> 00:08:34,330
ferrous iron from the initial iron

209
00:08:41,219 --> 00:08:38,979
silica gel this is the iron reduction

210
00:08:43,589 --> 00:08:41,229
vera for the iron silica gel over time

211
00:08:45,300 --> 00:08:43,599
and as you can see corresponding with

212
00:08:48,450 --> 00:08:45,310
the coloration from the first two

213
00:08:50,520 --> 00:08:48,460

vessels someone and sell to you can see

214
00:08:53,400 --> 00:08:50,530
that the reduction increases in that

215
00:08:55,320 --> 00:08:53,410
sells the reduction is at about sixty to

216
00:08:58,080 --> 00:08:55,330
seventy percent over a period of seven

217
00:08:59,790 --> 00:08:58,090
tds as for the control experiment the

218
00:09:02,760 --> 00:08:59,800
ferrous iron presence is insignificant

219
00:09:04,920 --> 00:09:02,770
it's about two to three percent and it

220
00:09:07,260 --> 00:09:04,930
remains stable it doesn't fluctuate much

221
00:09:11,780 --> 00:09:07,270
so that shows us that reduction hasn't

222
00:09:17,070 --> 00:09:14,670
alright this is the silica isotope data

223
00:09:19,440 --> 00:09:17,080
for the aqueous phase in the solid phase

224
00:09:21,210 --> 00:09:19,450
for my samples the general take away

225
00:09:23,670 --> 00:09:21,220
from those two plots would be for the

226
00:09:25,890 --> 00:09:23,680
APIs face you see an enrichment in Delta

227
00:09:27,780 --> 00:09:25,900
that is silica but for the solids you

228
00:09:29,460 --> 00:09:27,790
see a depletion in Delta that is so like

229
00:09:31,260 --> 00:09:29,470
that but the other thing that you want

230
00:09:33,090 --> 00:09:31,270
to take away from those plots is when

231
00:09:35,130 --> 00:09:33,100
you look at the aqueous phase you can

232
00:09:37,170 --> 00:09:35,140
see that the enrichment for Delta that

233
00:09:39,060 --> 00:09:37,180
is silica for the sole experiment is

234
00:09:41,370 --> 00:09:39,070
slightly higher than that of the control

235
00:09:43,650 --> 00:09:41,380
experiment and that tells you that

236
00:09:47,040 --> 00:09:43,660
ferrous iron presence of ferrous ion is

237
00:09:49,470 --> 00:09:47,050
causing that difference with the solid

238
00:09:51,120 --> 00:09:49,480

with the equus and solid data for the

239
00:09:52,860 --> 00:09:51,130
select isotopes we can actually

240
00:09:54,870 --> 00:09:52,870
calculate the fractionation factor our

241
00:09:57,840 --> 00:09:54,880
time and those are the numbers that I've

242
00:09:59,610 --> 00:09:57,850
came up with so I'd like to point out

243
00:10:01,829 --> 00:09:59,620
that for the cell experiment you see a

244
00:10:04,170 --> 00:10:01,839
larger fractionation factor as compared

245
00:10:06,329 --> 00:10:04,180
to the control experiment and again that

246
00:10:08,310 --> 00:10:06,339
is due to the presence of ferrous ion in

247
00:10:11,000 --> 00:10:08,320
the cell experiment and the absence of

248
00:10:13,500 --> 00:10:11,010
ferrous ion in the control experiment

249
00:10:15,850 --> 00:10:13,510
therefore we can conclude that first

250
00:10:18,100 --> 00:10:15,860
iron when it's produced by

251
00:10:20,560 --> 00:10:18,110
dissolution of the science select a gel

252
00:10:23,110 --> 00:10:20,570
causes a larger fractionation factor as

253
00:10:25,900 --> 00:10:23,120
compared to a vessel with no ferrous ion

254
00:10:27,699 --> 00:10:25,910
or minimal ferrous ion and the isotopic

255
00:10:29,530 --> 00:10:27,709
fractionation here is probably not

256
00:10:32,500 --> 00:10:29,540
controlled by biology but the magnitude

257
00:10:33,970 --> 00:10:32,510
of this fractionation is more attributed

258
00:10:37,329 --> 00:10:33,980
towards the absence or presence of

259
00:10:39,130 --> 00:10:37,339
ferrous ion therefore it's not only

260
00:10:41,380 --> 00:10:39,140
temperature or sauces that's an

261
00:10:50,579 --> 00:10:41,390
influence towards silica isotopes but

262
00:11:07,110 --> 00:10:54,250
okie dokie we have time for a few quick

263
00:11:10,389 --> 00:11:07,120

questions um do you have any idea out

264
00:11:12,880 --> 00:11:10,399
how easy it would be to find evidence

265
00:11:15,970 --> 00:11:12,890
for the sort of increased fractionation

266
00:11:18,220 --> 00:11:15,980
in the actual fossil record that's all

267
00:11:20,230 --> 00:11:18,230
in the actual fossil record mmm yeah

268
00:11:21,370 --> 00:11:20,240
looking at actual Iron Man informations

269
00:11:25,329 --> 00:11:21,380
would this be something that would

270
00:11:27,160 --> 00:11:25,339
survive that long I know Andy chaya this

271
00:11:29,139 --> 00:11:27,170
person has looked into fossil records in

272
00:11:31,030 --> 00:11:29,149
the Precambrian but I don't necessarily