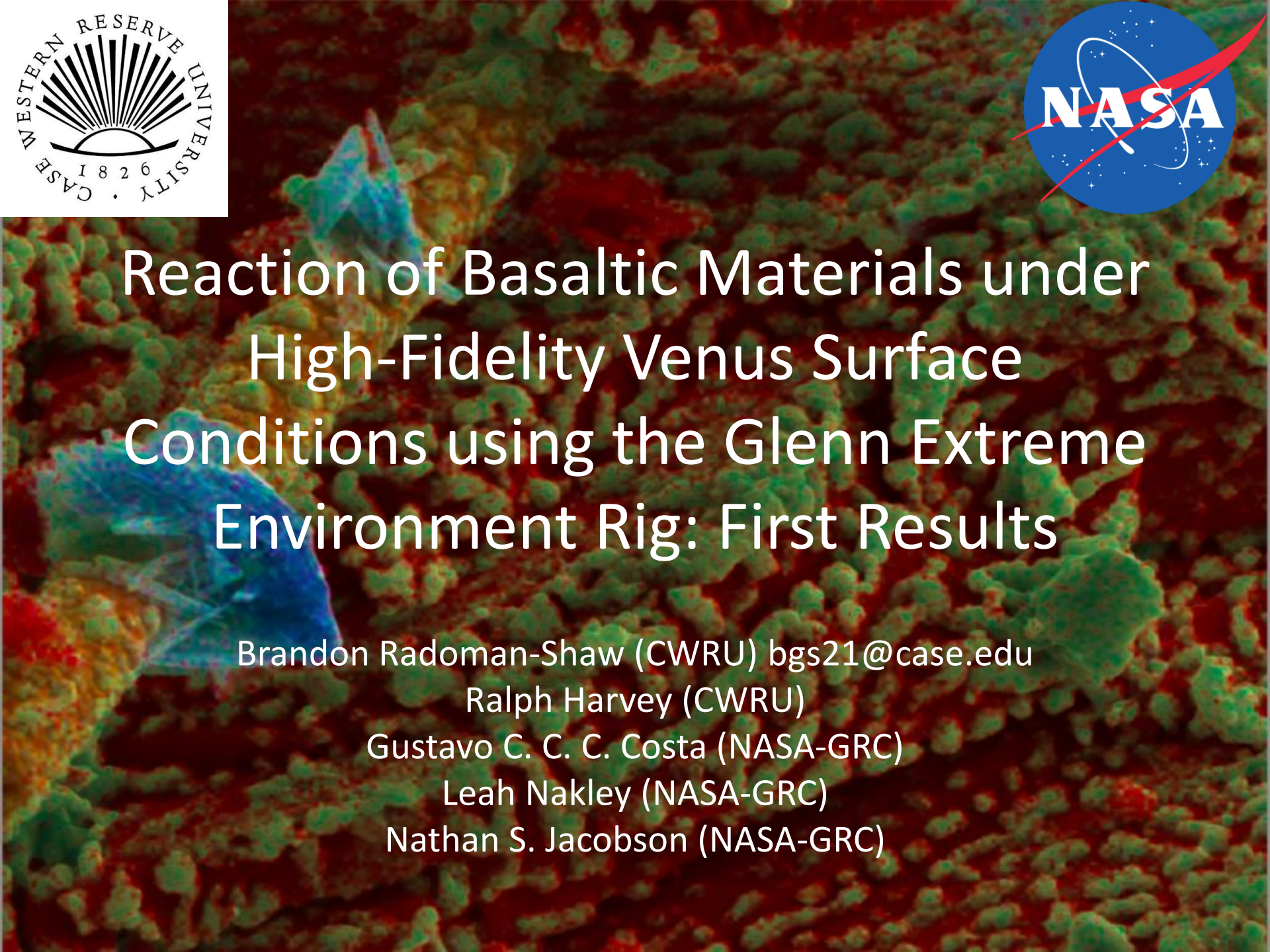

Reaction of Basaltic Materials under High-Fidelity Venus Surface Conditions using the Glenn Extreme Environment Rig: First Results

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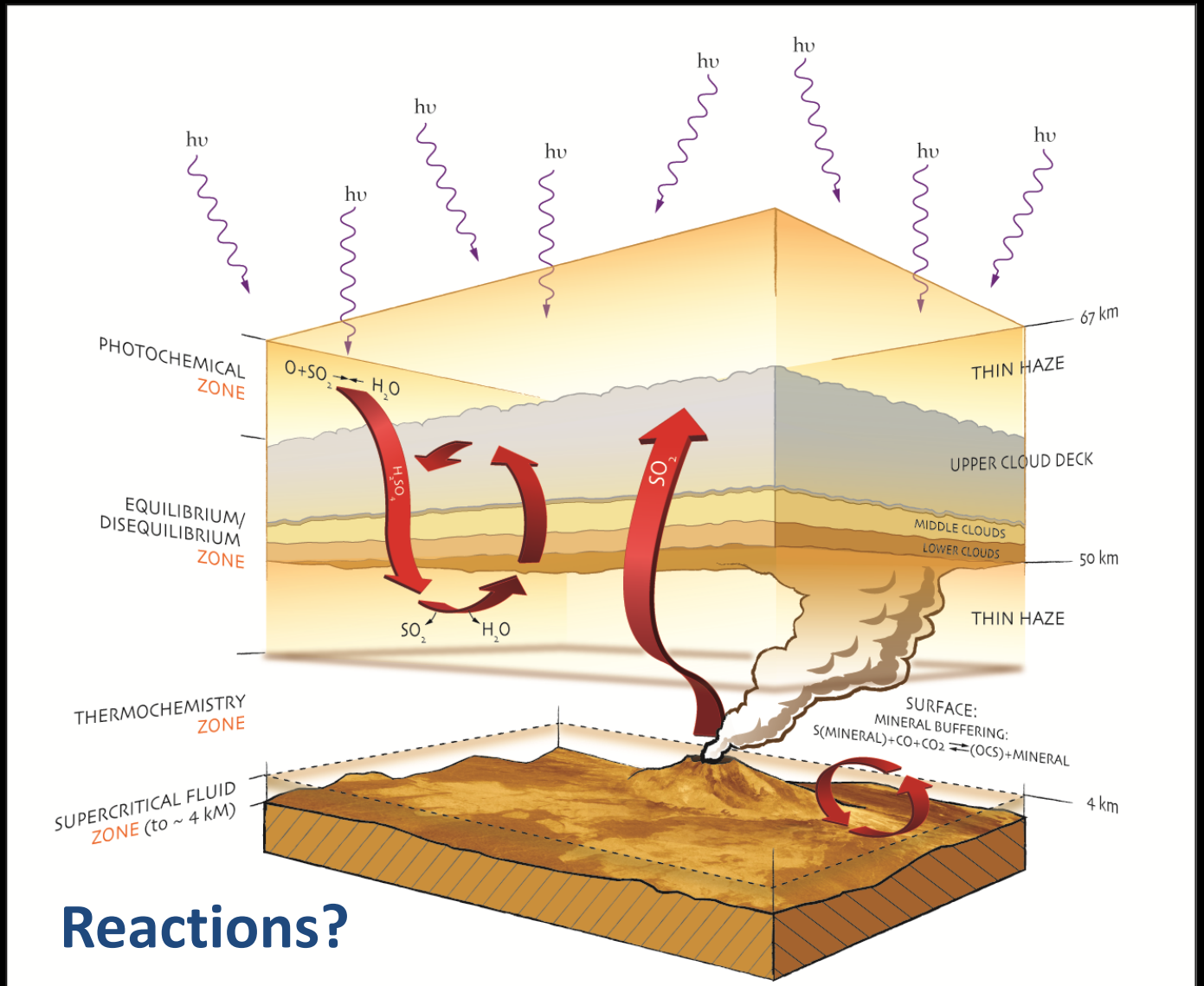
Experimental Design

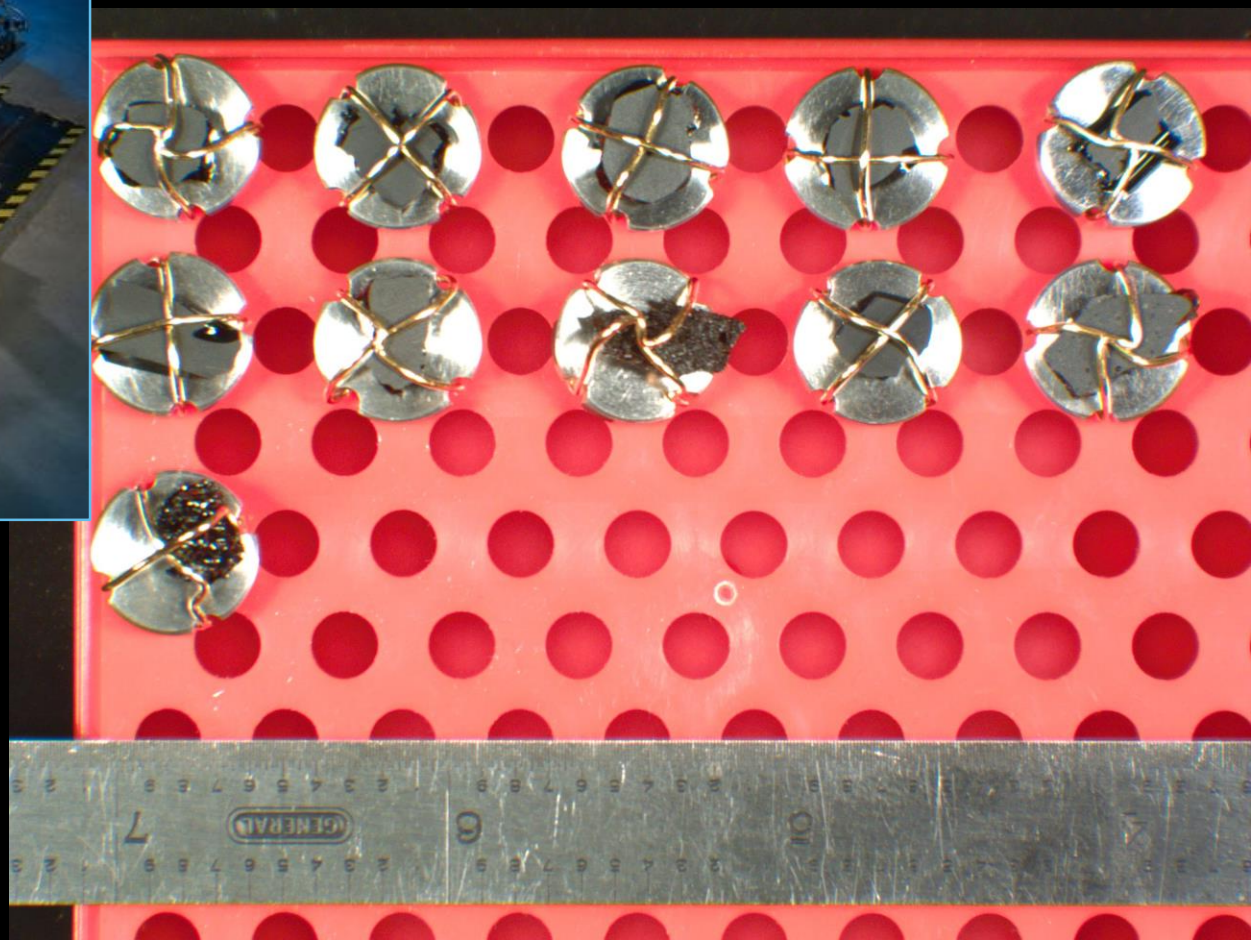


Reactions?

Illustration adapted from Grinspoon, Venus Revealed

PS-01784-01-0116

Design



Final Sample List

Diopside
Magnetite
Quartz
Olivine
Enstatite
Labradorite

Oligoclase
Siderite
Pyrite
Pyrrhotite
Hematite
Wollastonite
Calcite
Goethite

Leucite
Rhyolite
Mafic
Nepheline
Syenite
Phonolite
Trachyte
Andesite
Quartz Basalt
Tholeiitic
Flood Basalt
Olivine Basalt

Venera 13
Venera 14
Vega 2
DNC-1a Dolerite
AGV-2G Andesite
BHVO-2G Basaltic
NKT-1G Nephelinite
BCR-2G Basaltic
Kamoamoa
Halemaumau spatter
Pu'u O'o Lava Flow

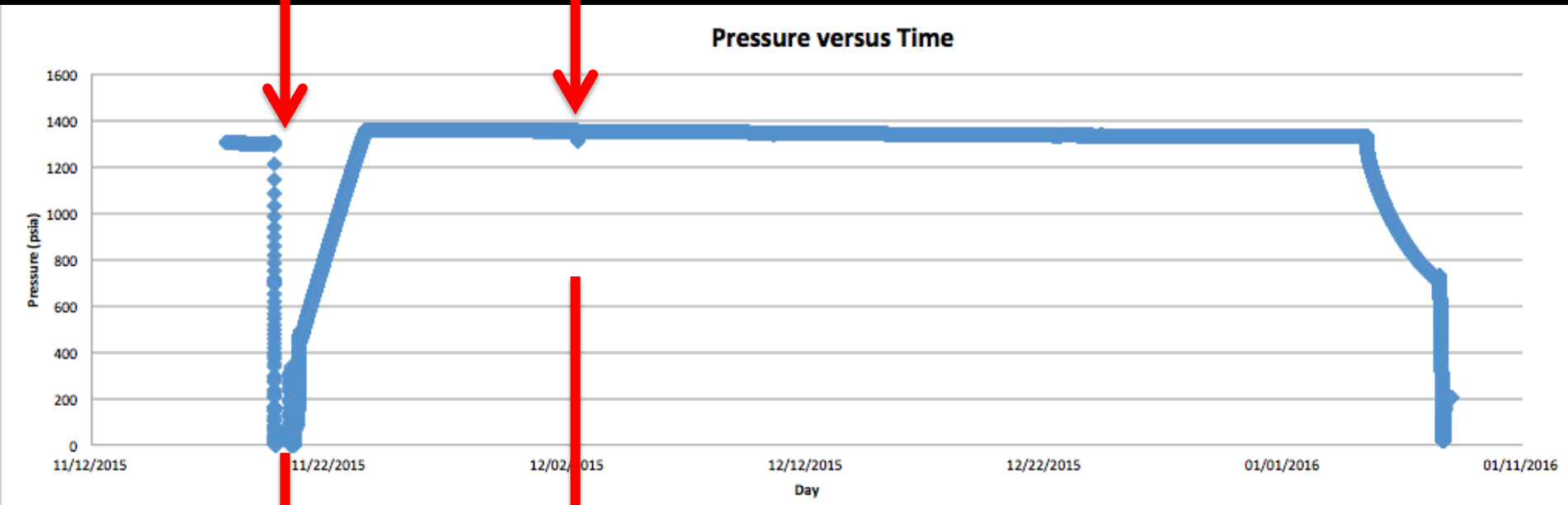
Venus Mixture

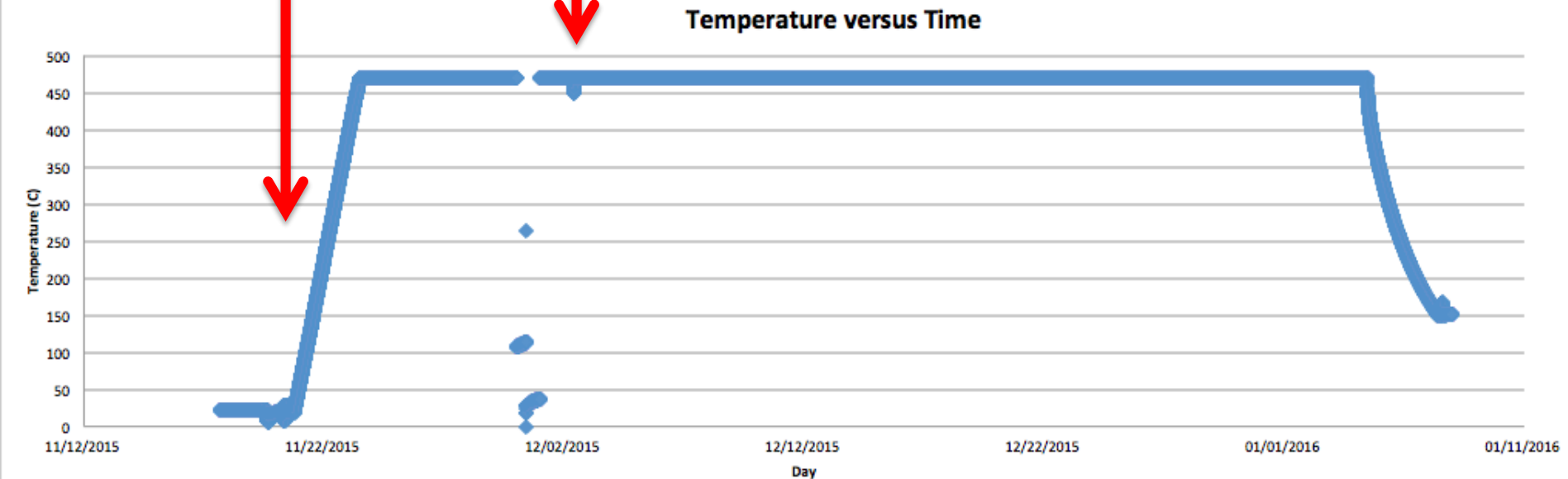
Table 1: Simulated Venus atmospheric composition loaded into GEER for the 40-day exposure.

Gas	Molar Mixing Ratio
CO_2	96.5%
N_2	3.5%
H_2O	30 ppm
SO_2	180 ppm
CO	12 ppm
OCS	51ppm
H_2S	2 ppm
HCl	0.5 ppm
HF	2.5 ppb

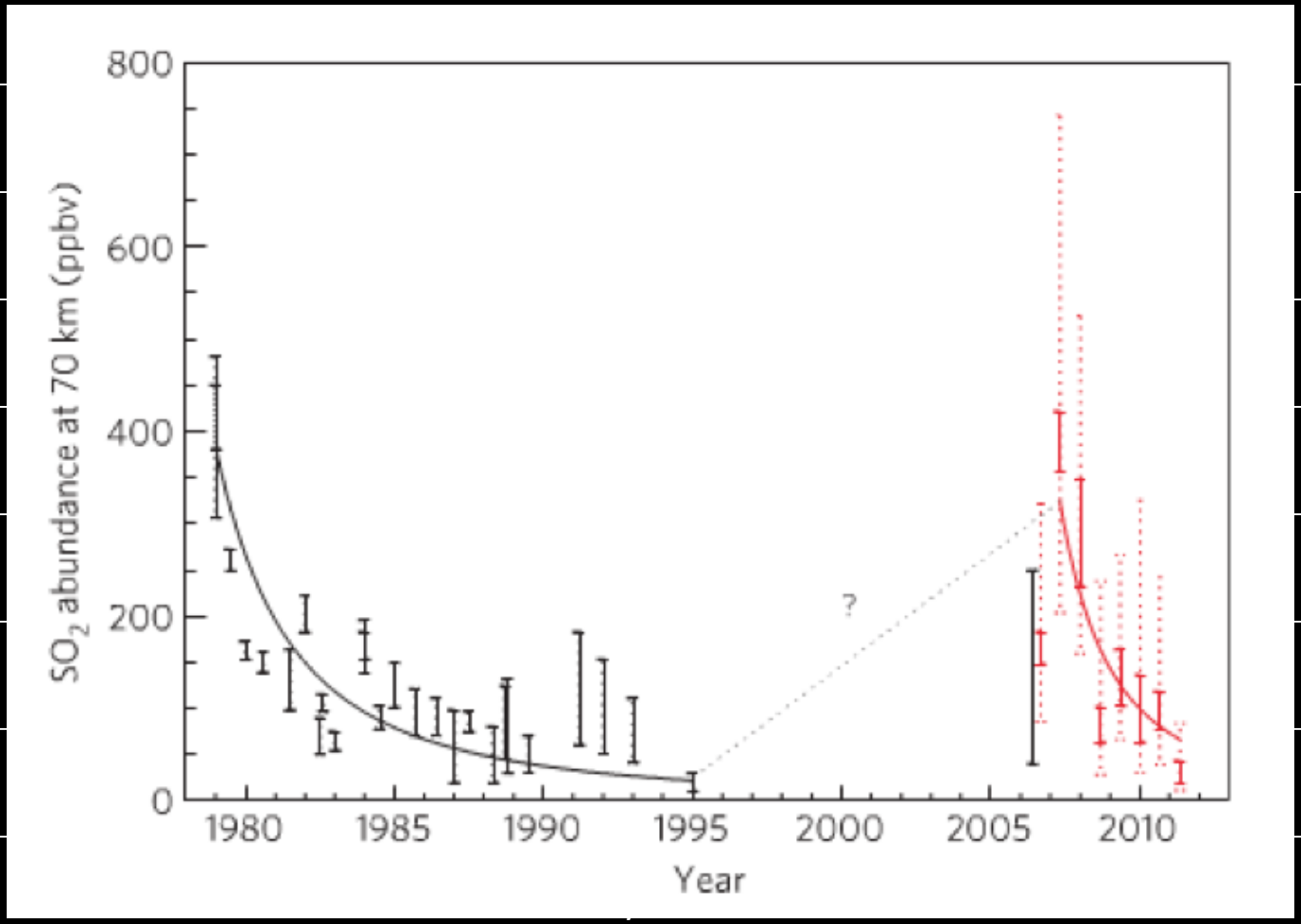
After Bullock and Grinspoon (2012)

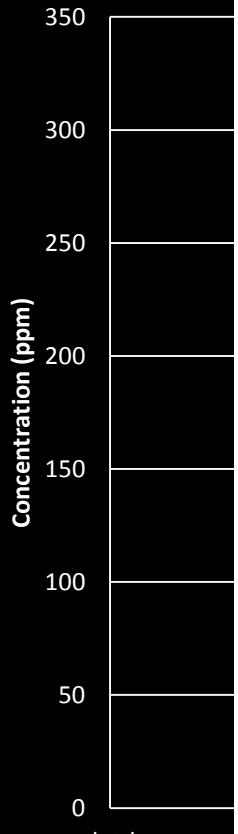
Exposure

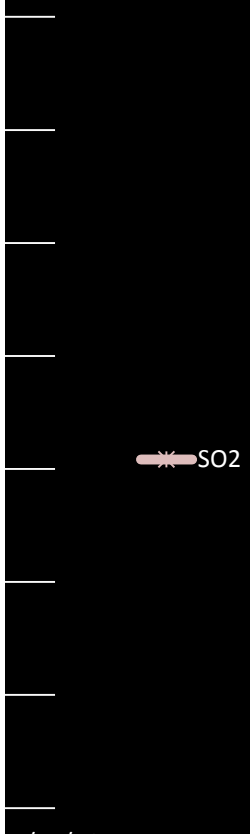

Pressure versus Time
Pressure (psia)
1600
1400
1200
1000
800
600
400
200
0
11/12/2015
11/22/2015
12/12/2015
12/22/2015
01/01/2016
01/11/2016
Day


Temperature versus Time
Temperature (C)
500
450
400
350
300
250
200
150
100
50
0
11/12/2015
11/22/2015
12/02/2015
12/12/2015
12/22/2015
01/01/2016
01/11/2016
Day

SO_2



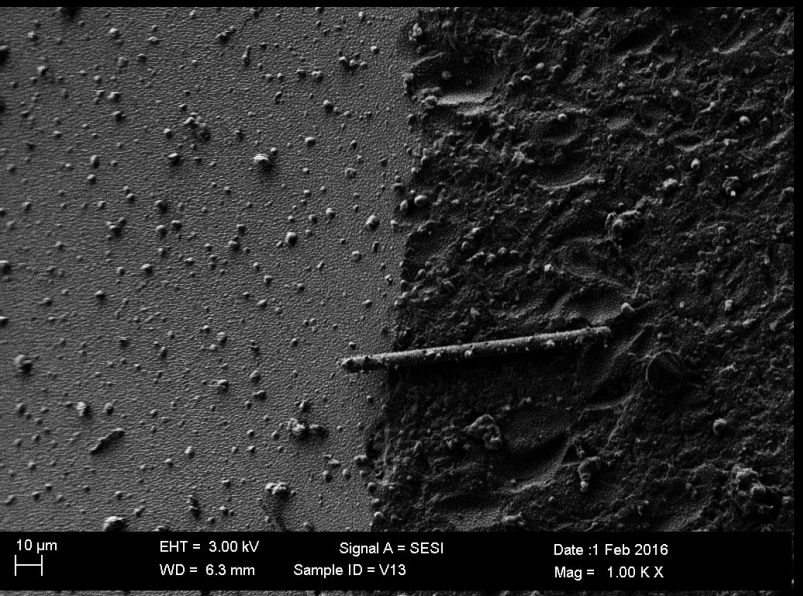


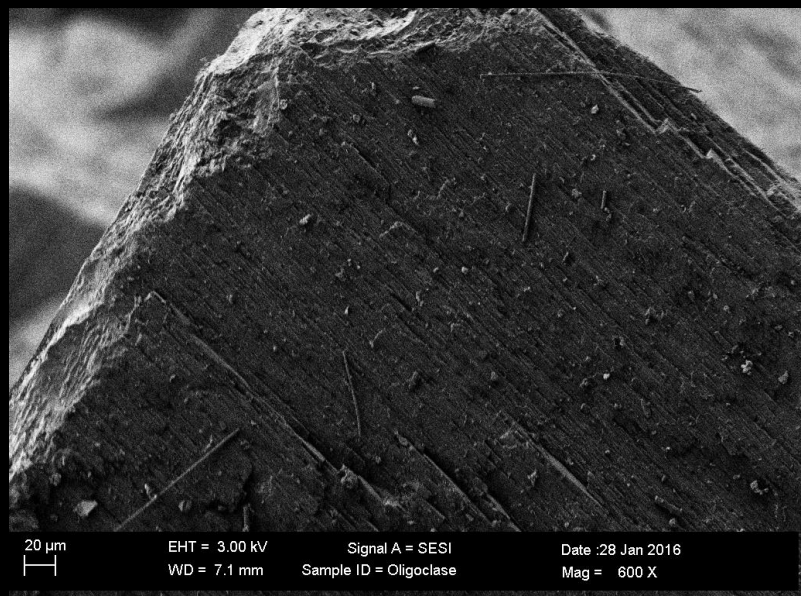


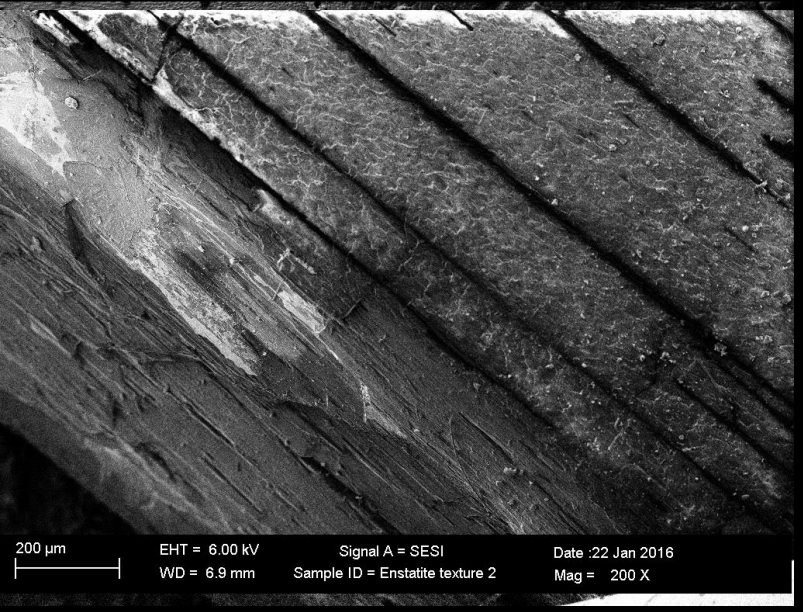
Marcq et al. (2013)

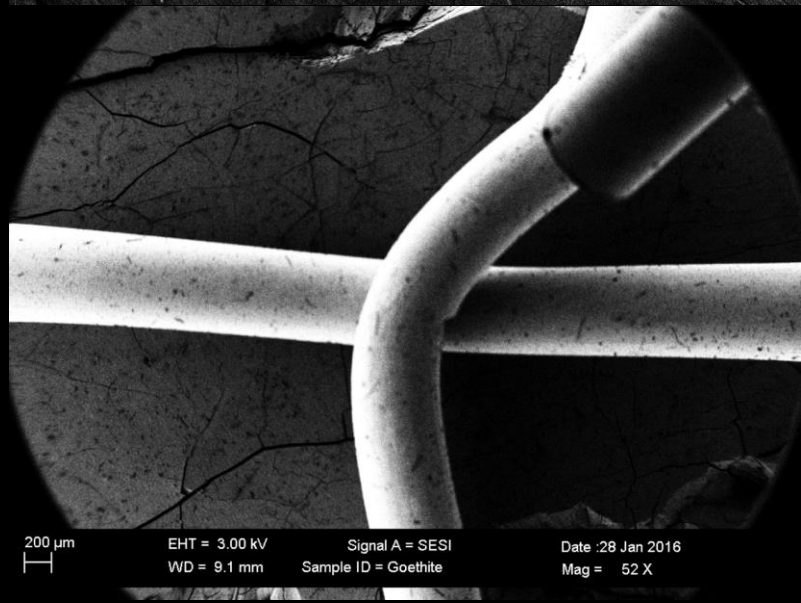
Sample Trays

Samples

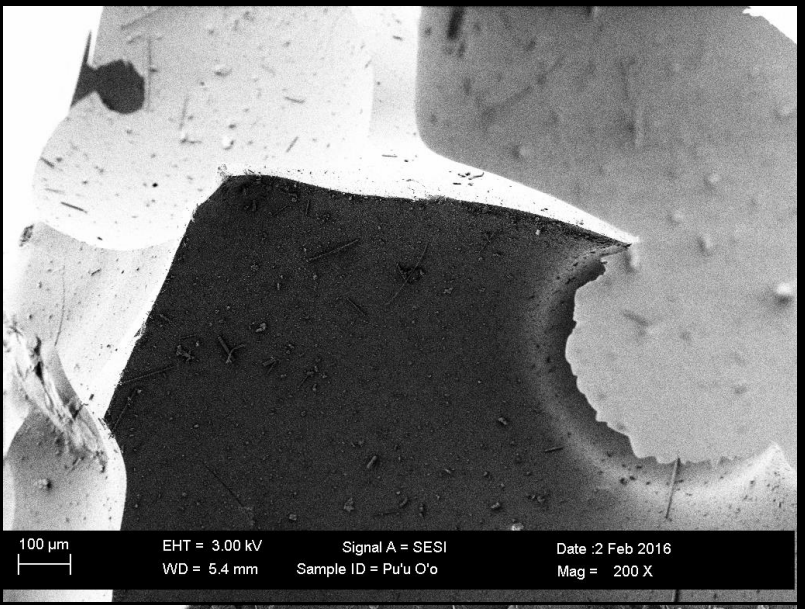

10 µm
EHT = 3.00 kV
WD = 6.3 mm
Signal A = SESI
Sample ID = V13
Date :1 Feb 2016
Mag = 1.00 K X

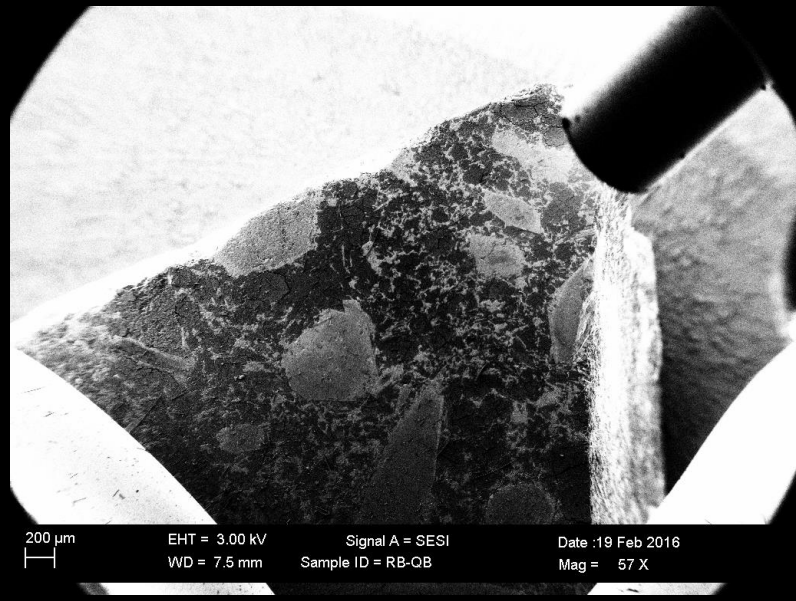

20 µm
EHT = 3.00 kV
WD = 7.1 mm
Signal A = SESI
Sample ID = Oligoclase
Date :28 Jan 2016
Mag = 600 X

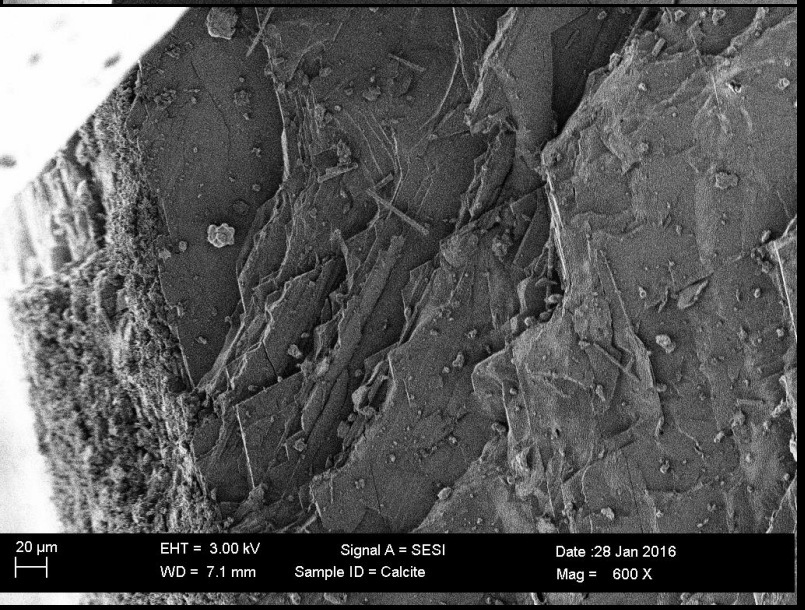

200 µm
EHT = 6.00 kV
WD = 6.9 mm
Signal A = SESI
Sample ID = Enstatite texture 2
Date :22 Jan 2016
Mag = 200 X

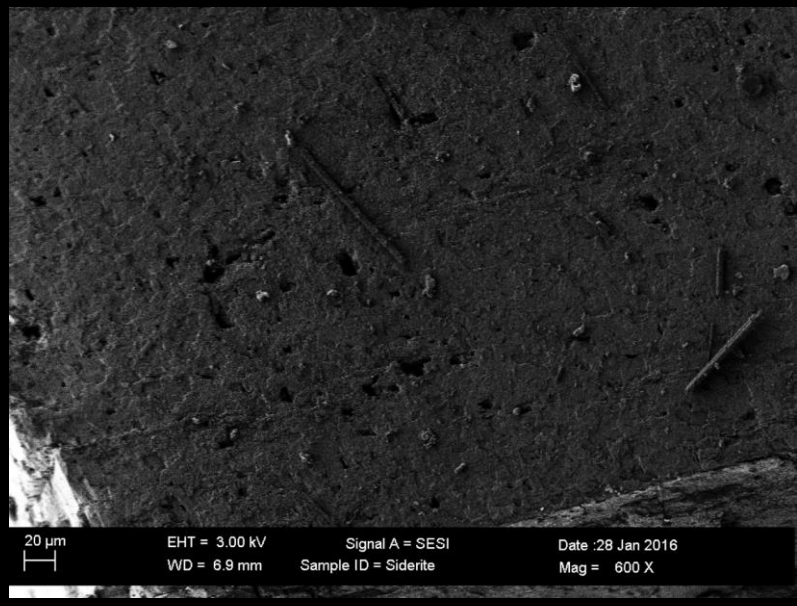

200 µm
EHT = 3.00 kV
WD = 9.1 mm
Signal A = SESI
Sample ID = Goethite
Date :28 Jan 2016
Mag = 52 X

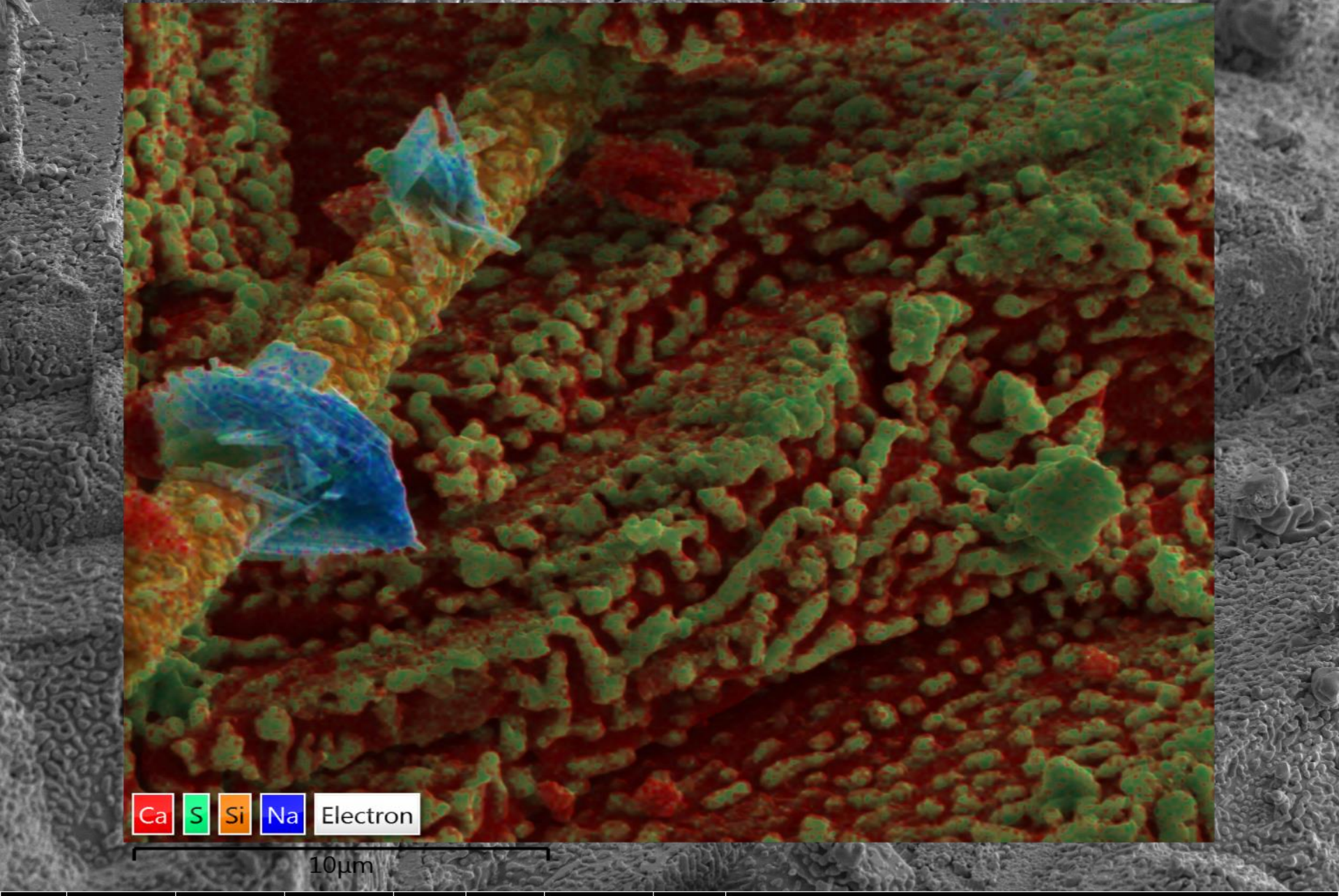
Samples


100 µm
EHT = 3.00 kV
WD = 5.4 mm
Signal A = SESI
Sample ID = Pu'u O'o
Date :2 Feb 2016
Mag = 200 X


200 µm
EHT = 3.00 kV
WD = 7.5 mm
Signal A = SESI
Sample ID = RB-QB
Date :19 Feb 2016
Mag = 57 X

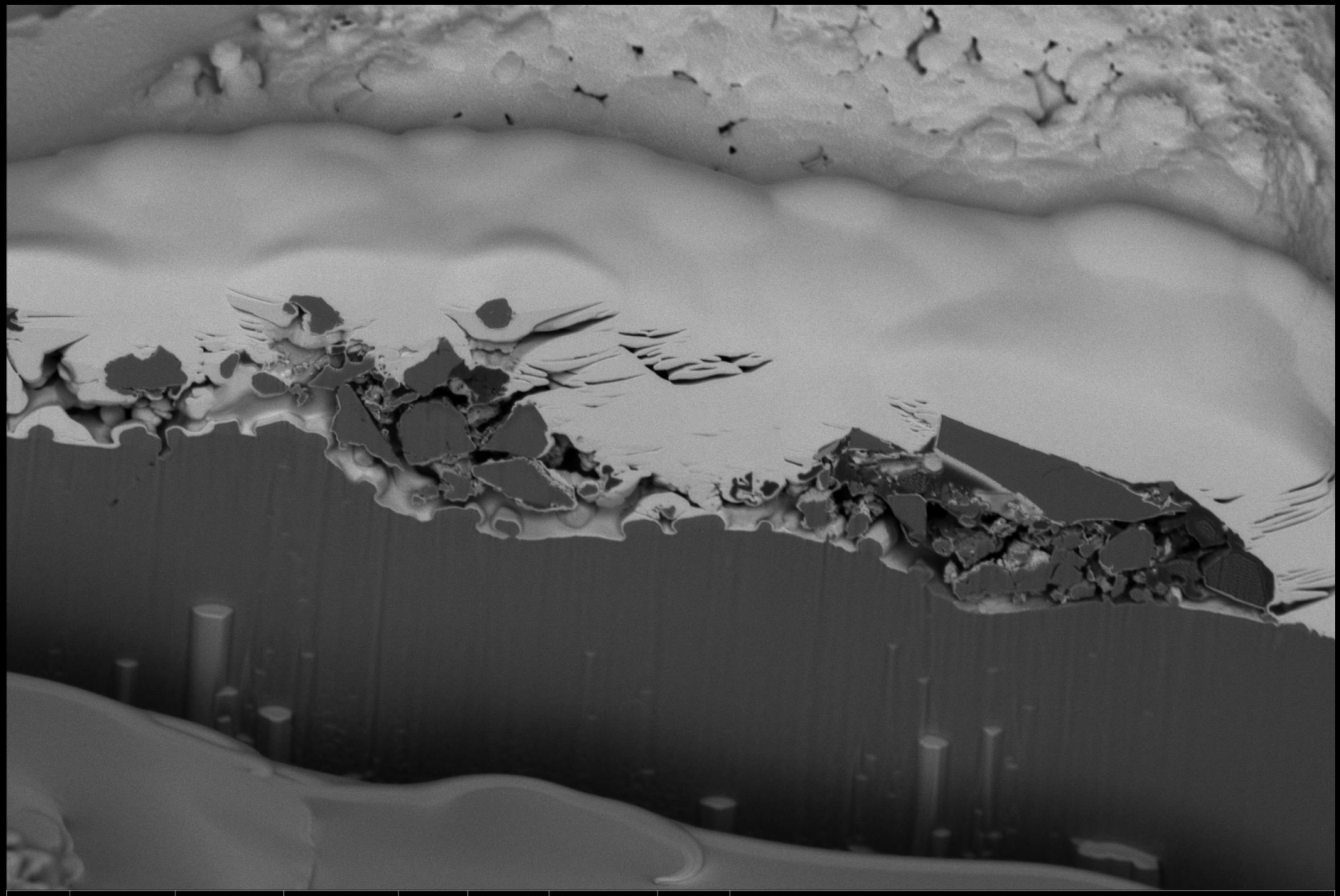

20 µm
EHT = 3.00 kV
WD = 7.1 mm
Signal A = SESI
Sample ID = Calcite
Date :28 Jan 2016
Mag = 600 X


20 µm
EHT = 3.00 kV
WD = 6.9 mm
Signal A = SESI
Sample ID = Siderite
Date :28 Jan 2016
Mag = 600 X

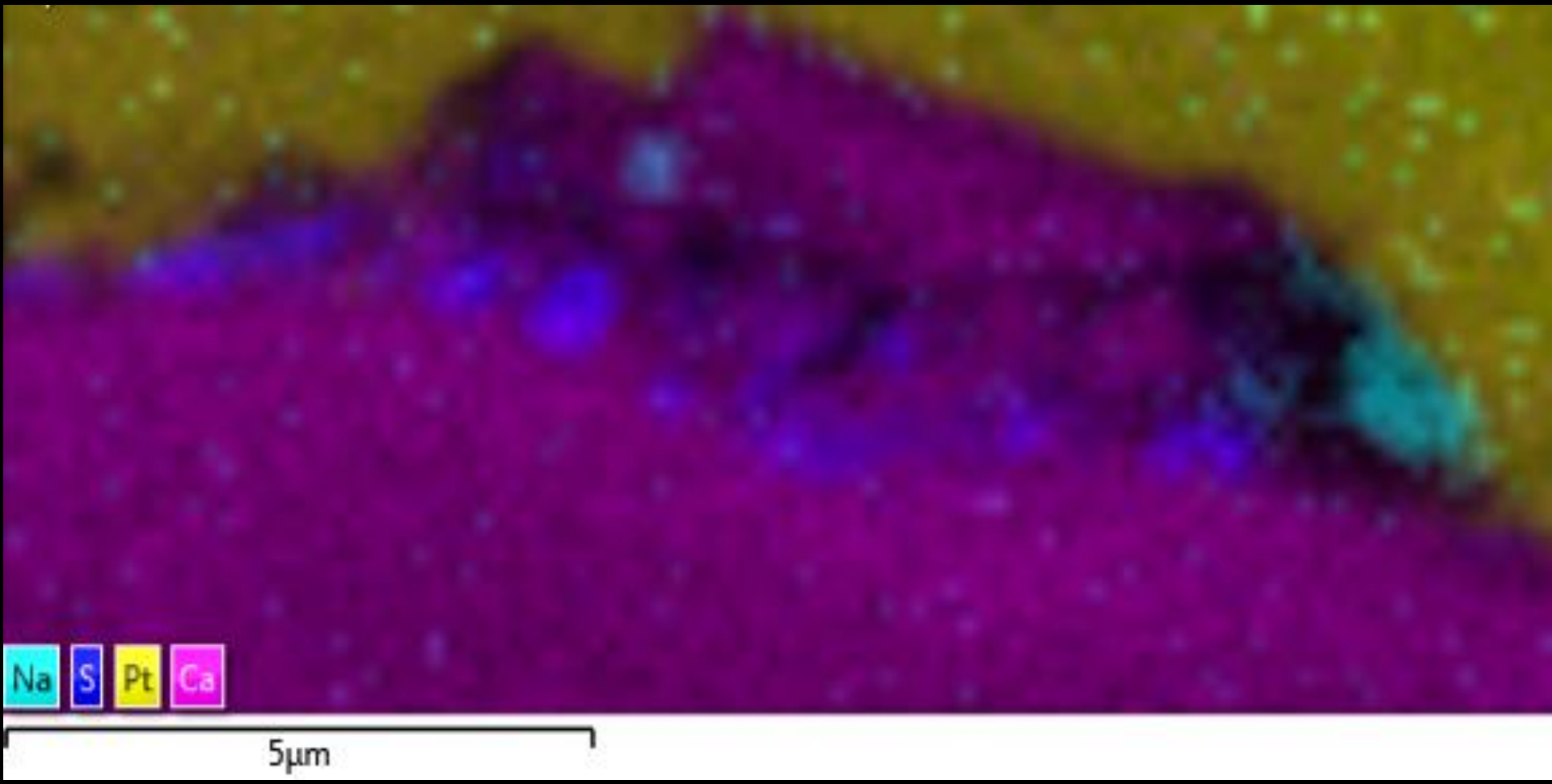


mag	HV	HFW	det	mode	WD	tilt	40 µm
1 250 x	5.00 kV	102 µm	ETD	SE	4.1 mm	52 °	Calcite

Calcite


mag
5 000 x
HV
2.00 kV
HFW
25.6 µm
det
TLD
mode
BSE
WD
4.1 mm
tilt
52 °
10 µm
Calcite

Calcite



Calcite

$CaSO_4 + CO_{(g)} = CaCO_3 + SO_{2(g)}$

Anhydrite + CO = calcite + SO_2

Conclusions

- Initial electron microscopy at low resolution suggested major particulate deposition.
  - Effect of particulate deposition is unknown
  - Future electron microscopy suggests evidence of reaction.
- Necessity for sub-chamber for higher fidelity atmospheric control and reduction of chamber particulate deposition.
- Longer duration of experimentation, beyond the 42 day longest exposure.