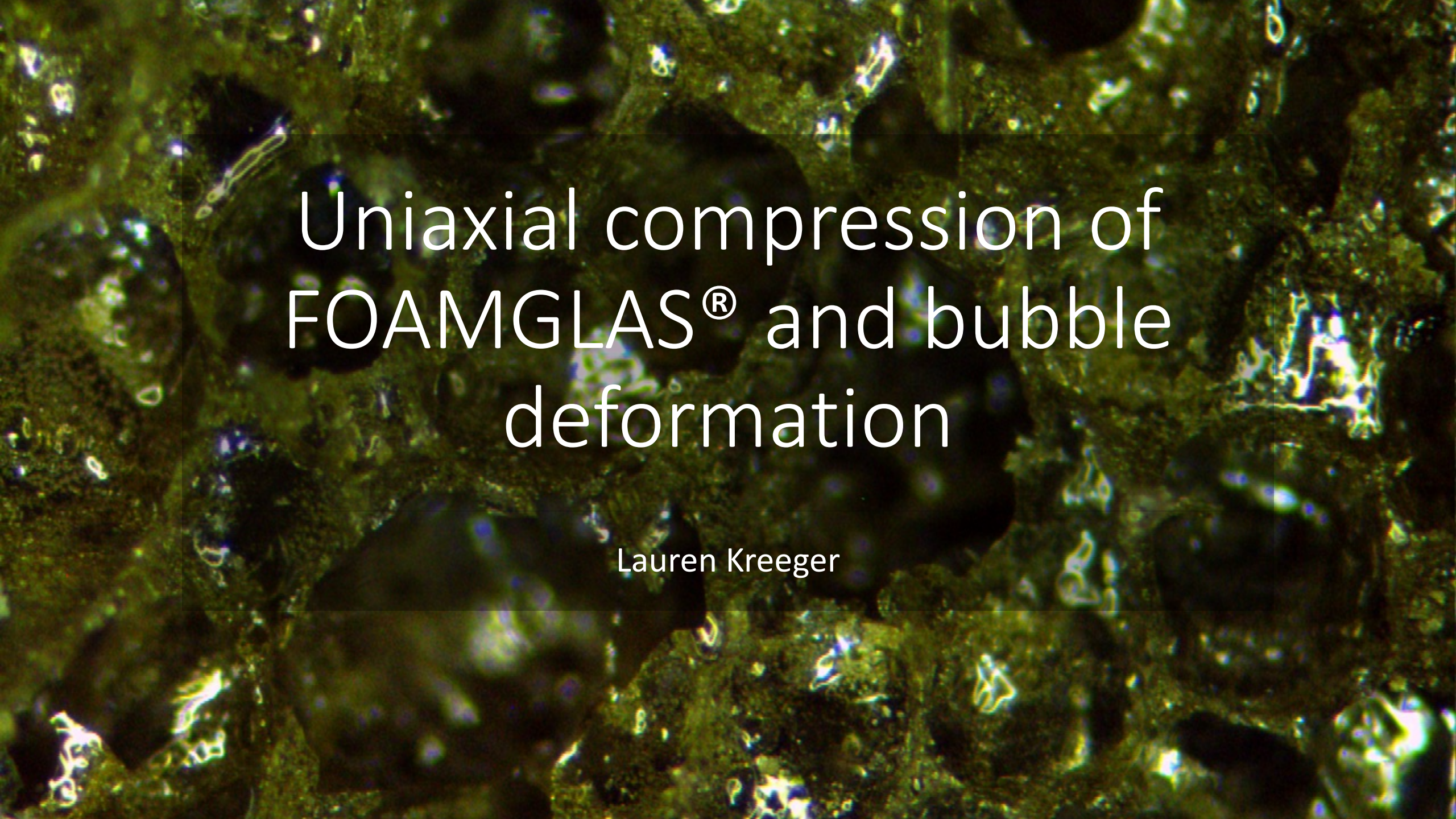
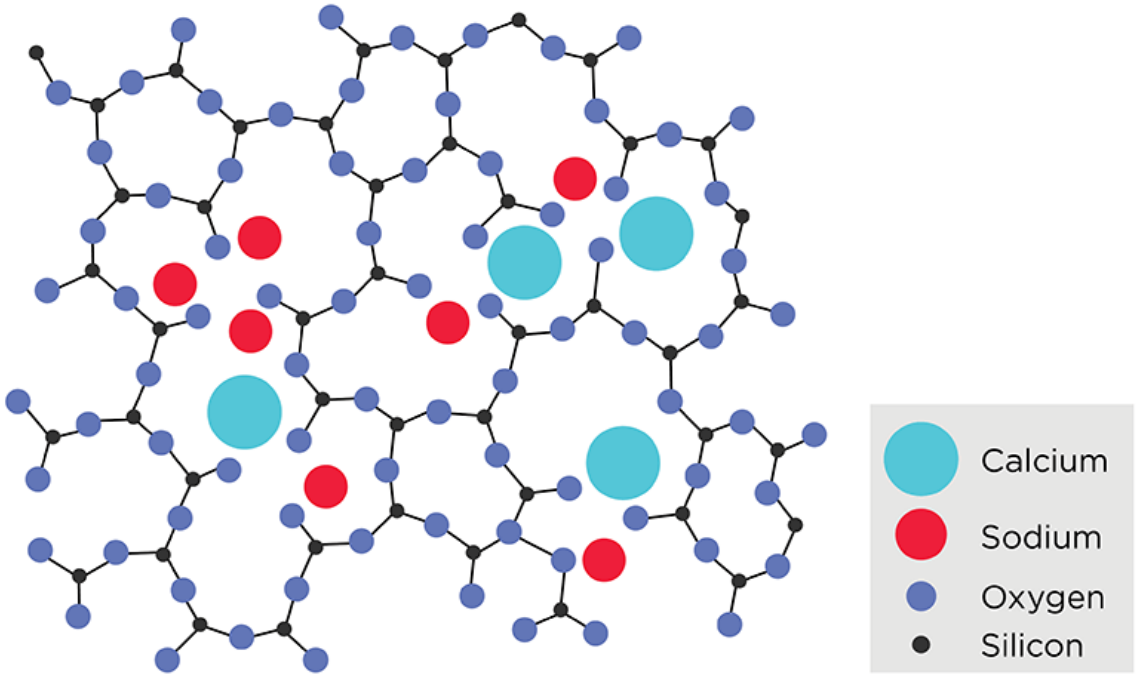


Uniaxial compression of FOAMGLAS® and bubble deformation

Lauren Kreeger

What is FOAMGLAS®?

- Closed-cell cellular glass insulation (glass Styrofoam)
- Manufactured by Owen-Corning
- Soda-lime glass



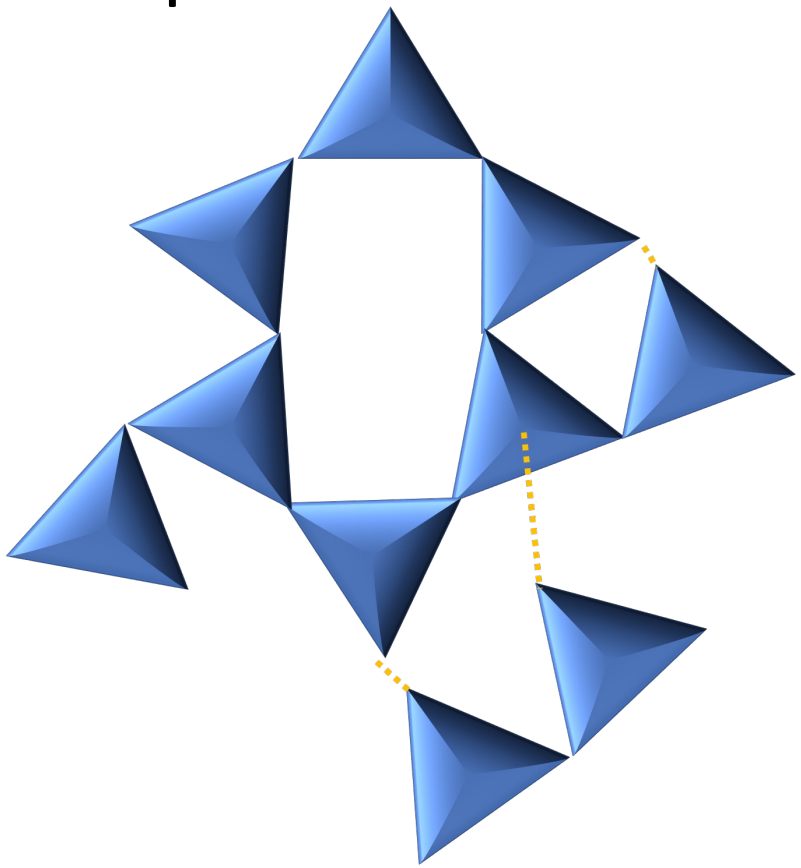
https://www.koppglass.com/blog/3-common-glass-types-properties-and-applications

What is Glass?

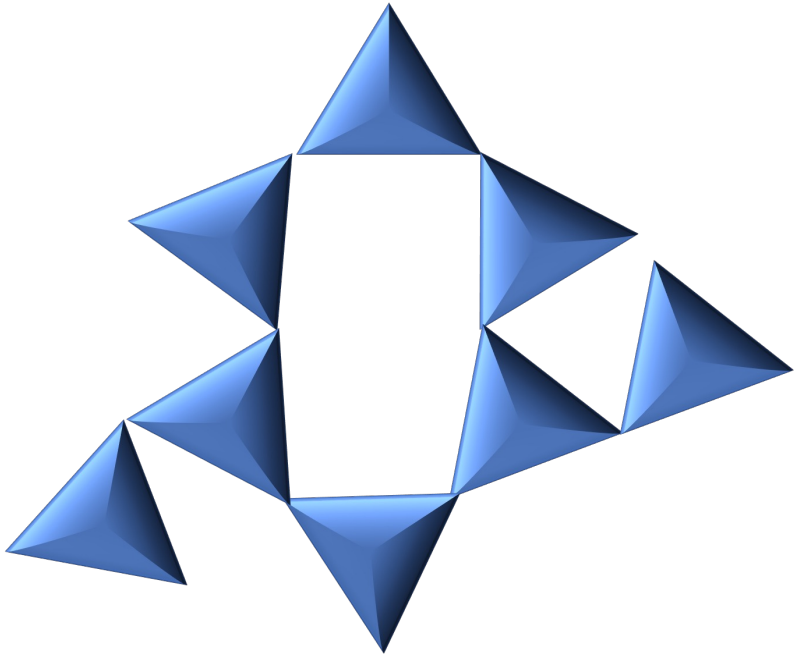
- Glass is a liquid (structurally)
- “supercooled liquid”

https://commons.wikimedia.org/wiki/File:Mahogany_obsidian_(Tertiary,_5.03-7.7_Ma;_Glass_Buttes,_Oregon,_USA)_2.jpg

Liquid



Glass

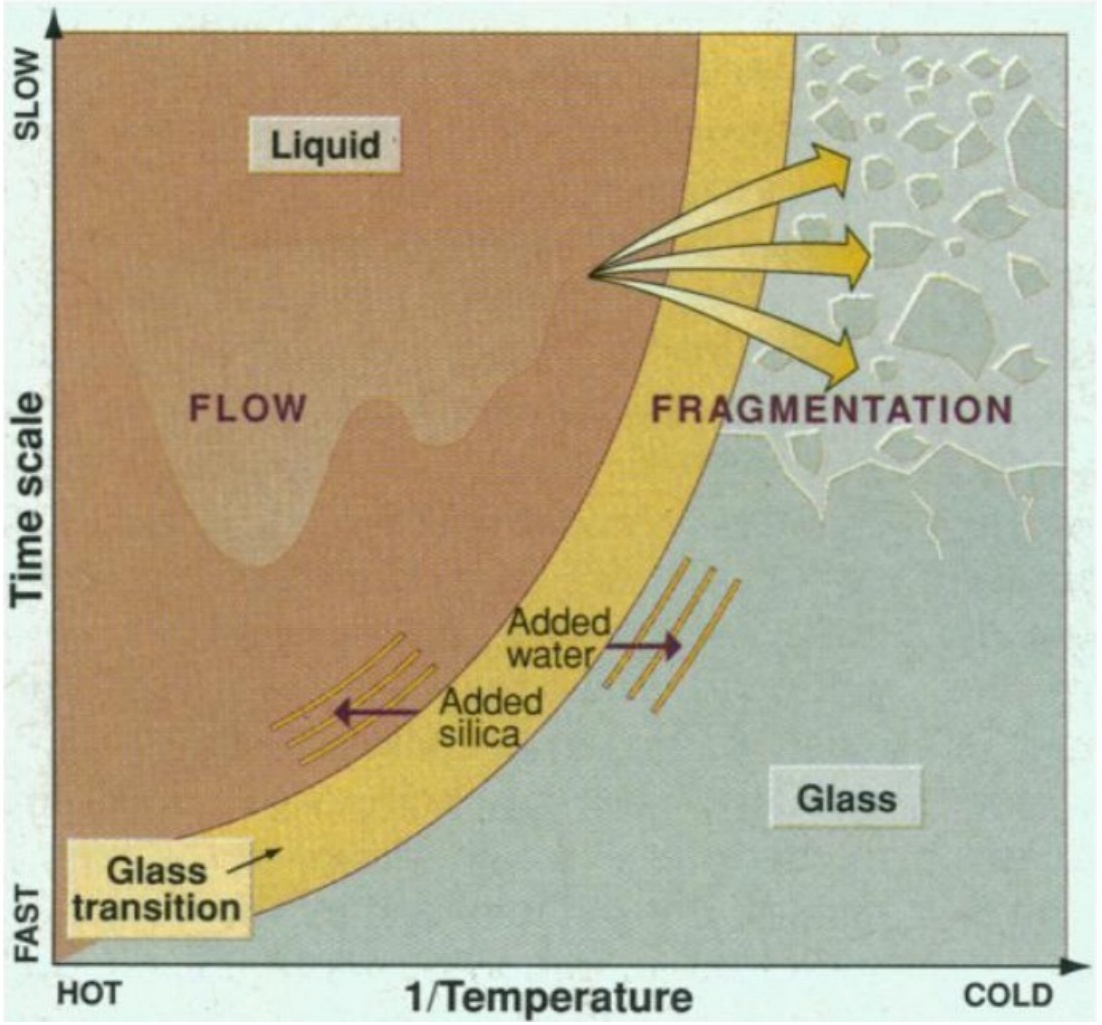


Forming/breaking bond

Silica tetrahedron

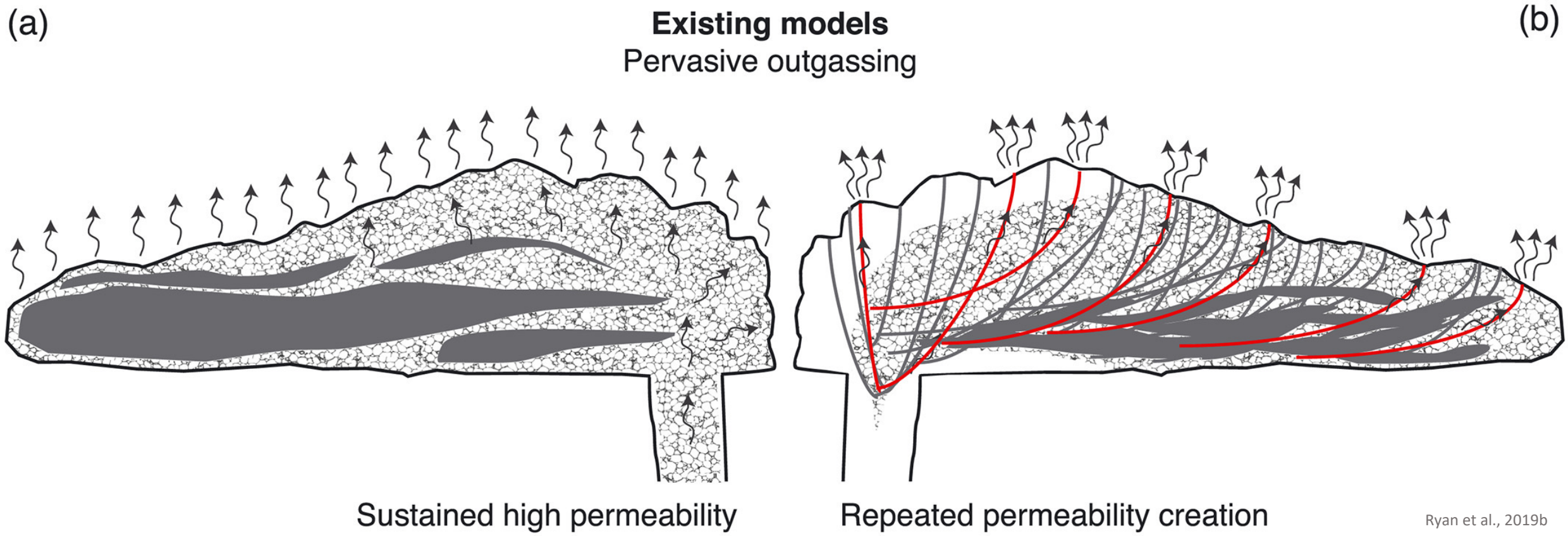
Glass transition

- “Melting” of glass
- Temperature, silica and water, time



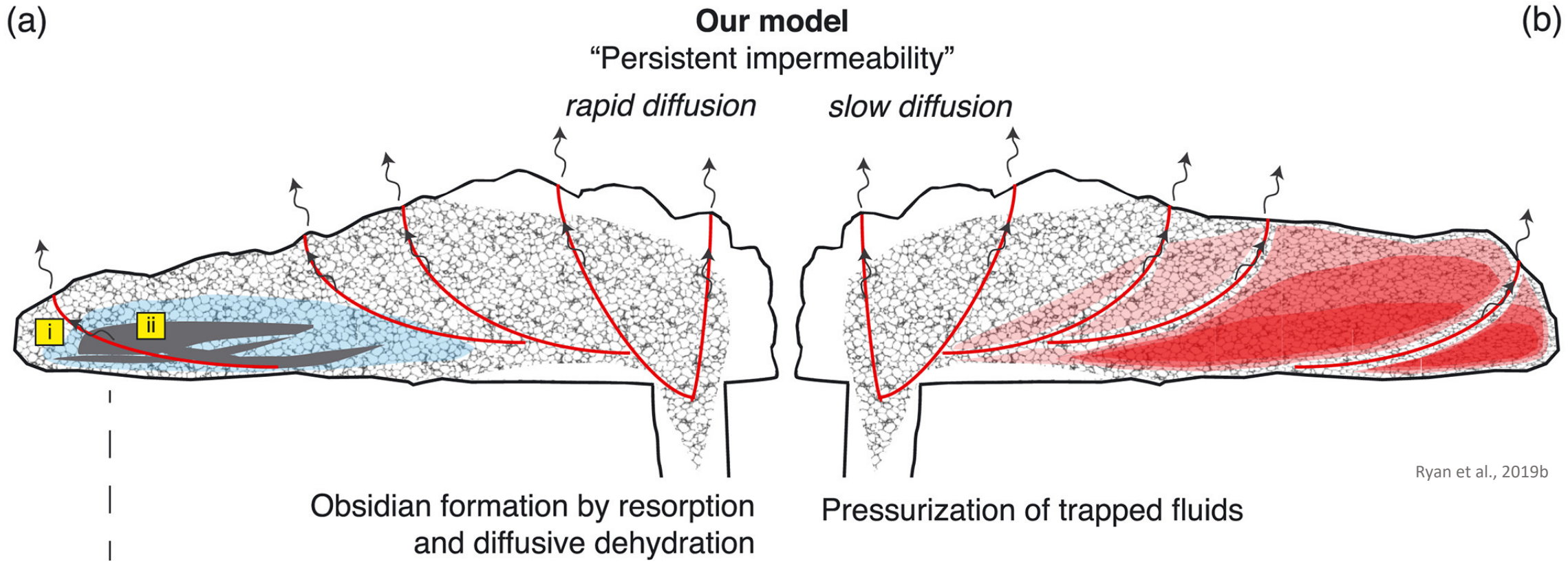
Dingwell ,1996

Impermeable foam model and degassing



Ryan et al., 2019b

Impermeable foam model and degassing

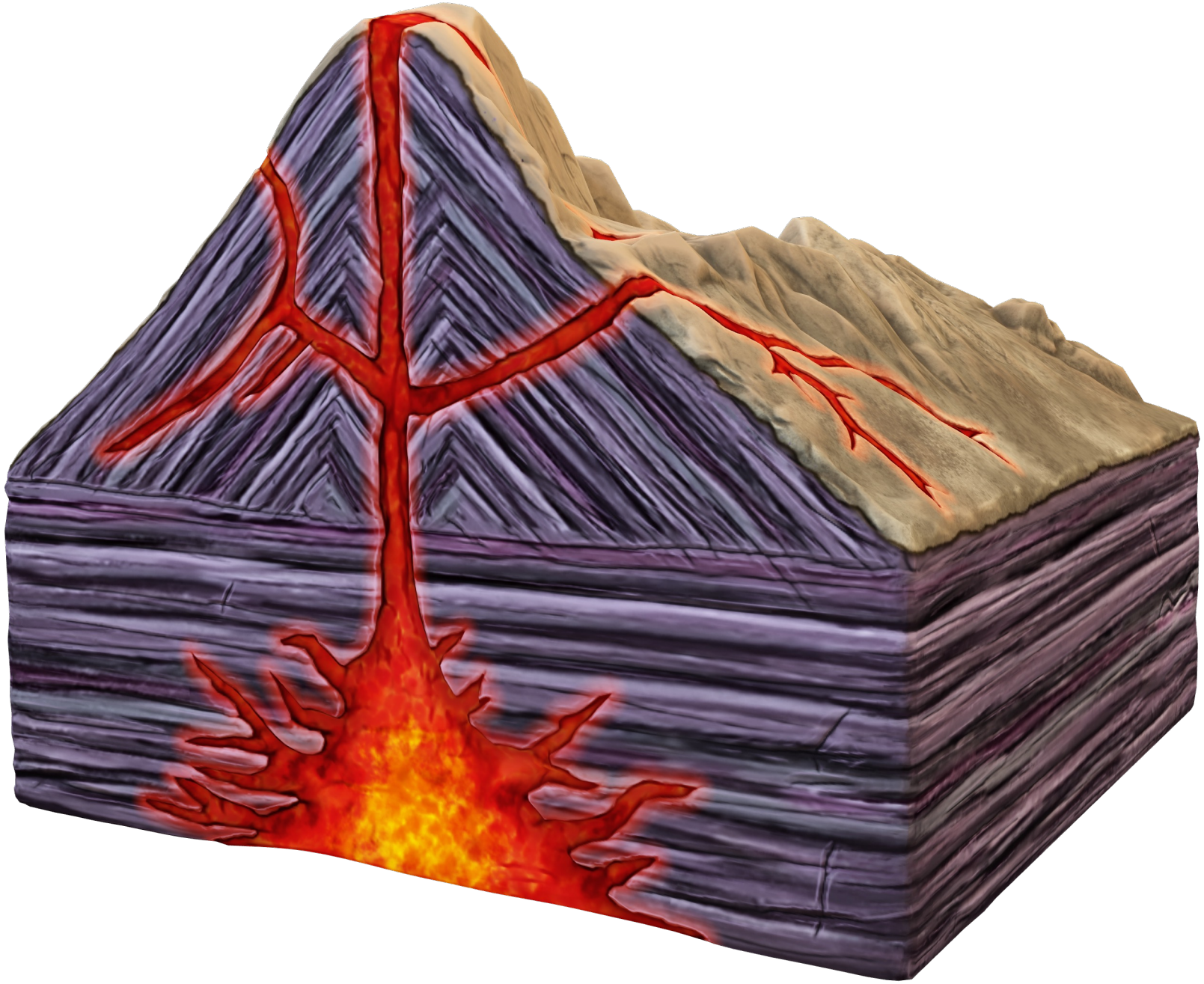


- Mostly isolated bubbles
- Some obsidian bands

- Potentially explosive

Why?

- Volcanism

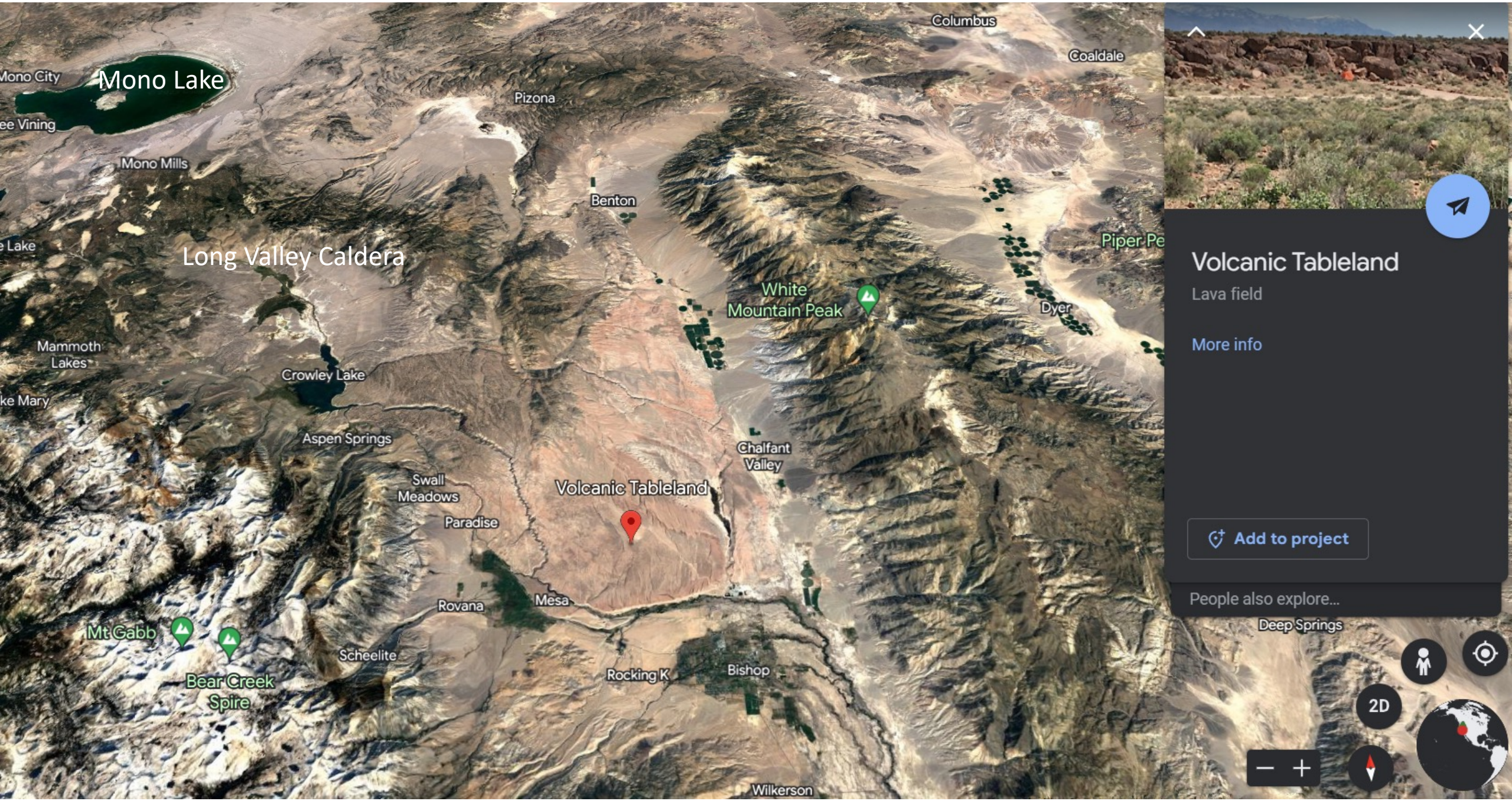


Field


Mono City
Mono Lake
Lee Vining
June Lake
Long Valley
Caldera
Benton
Mammoth
Lakes
Lake Mary
Crowley Lake
White
Mountain Peak
Aspen Springs
Swall
Meadows
Chalfant
Valley
Mt Gabb
Bear Creek
Spire
Rovana
Mesa
ono Hot
prings
Rocking K
Bishop
Google Earth

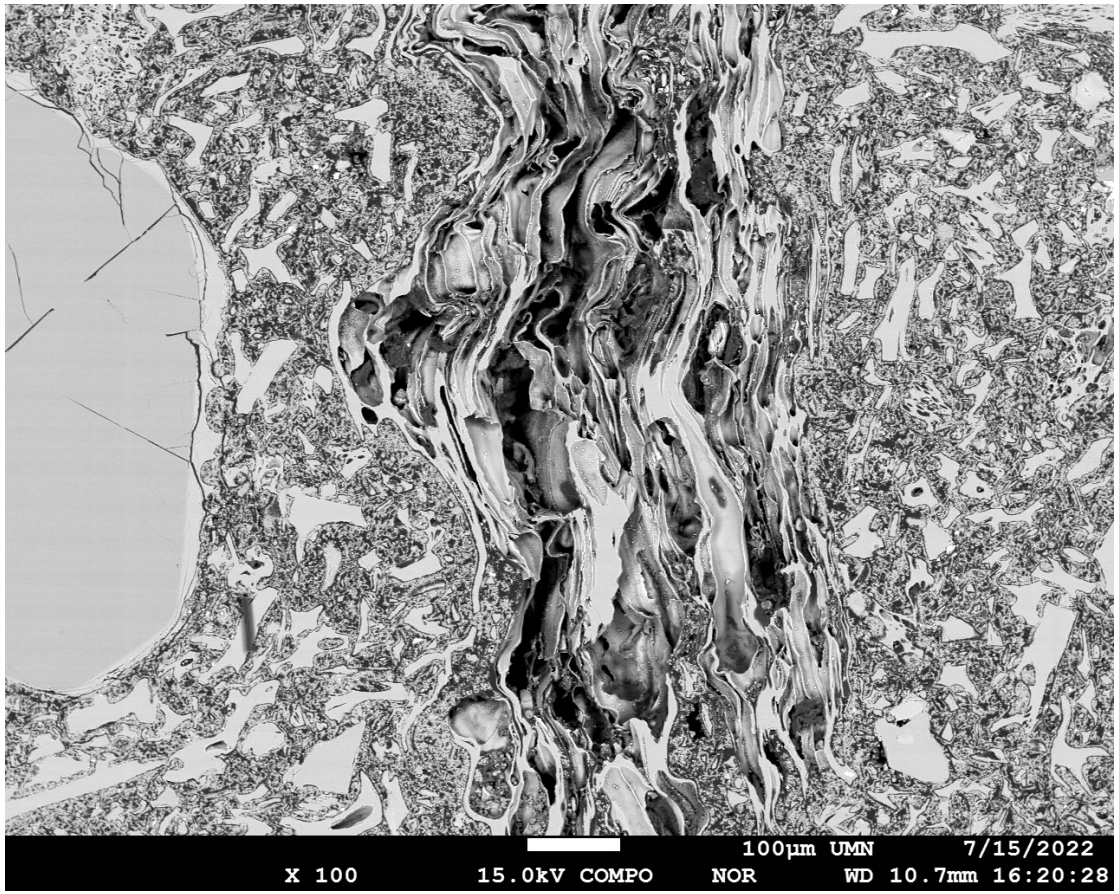
Google Earth

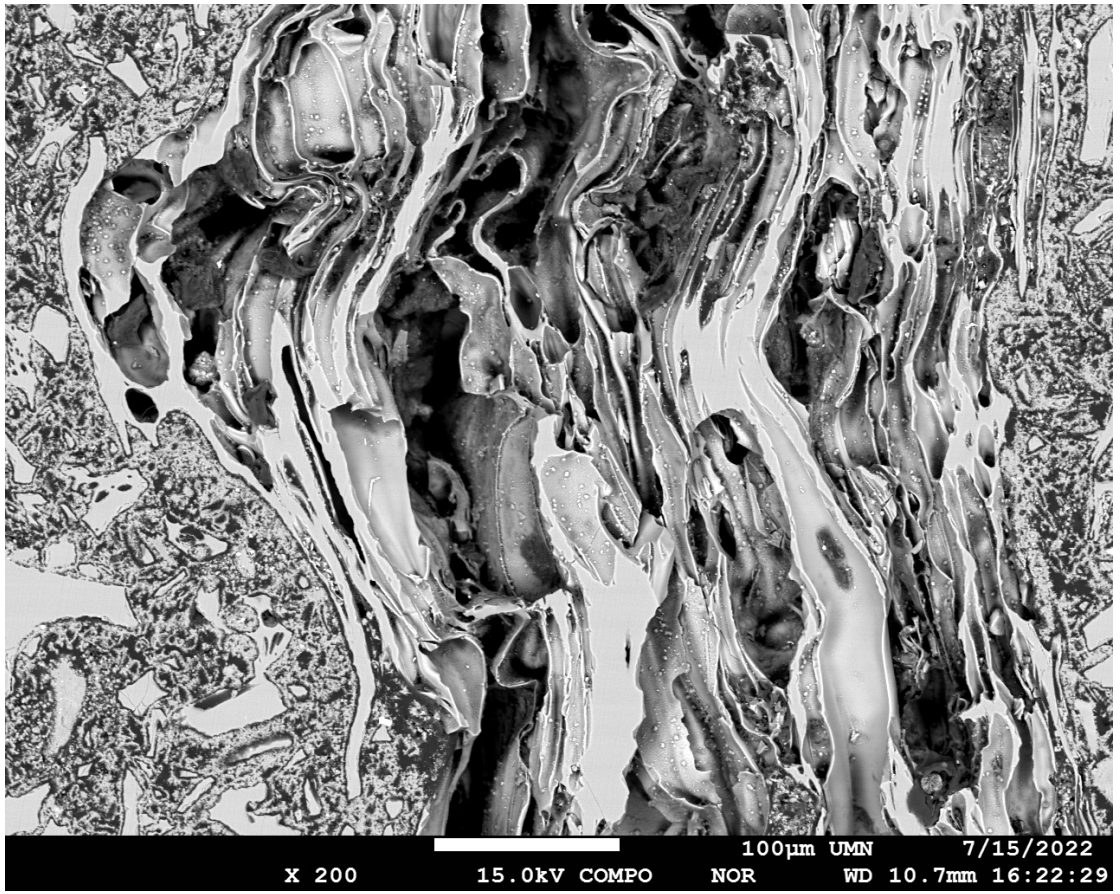
Panum Crater



Google Earth

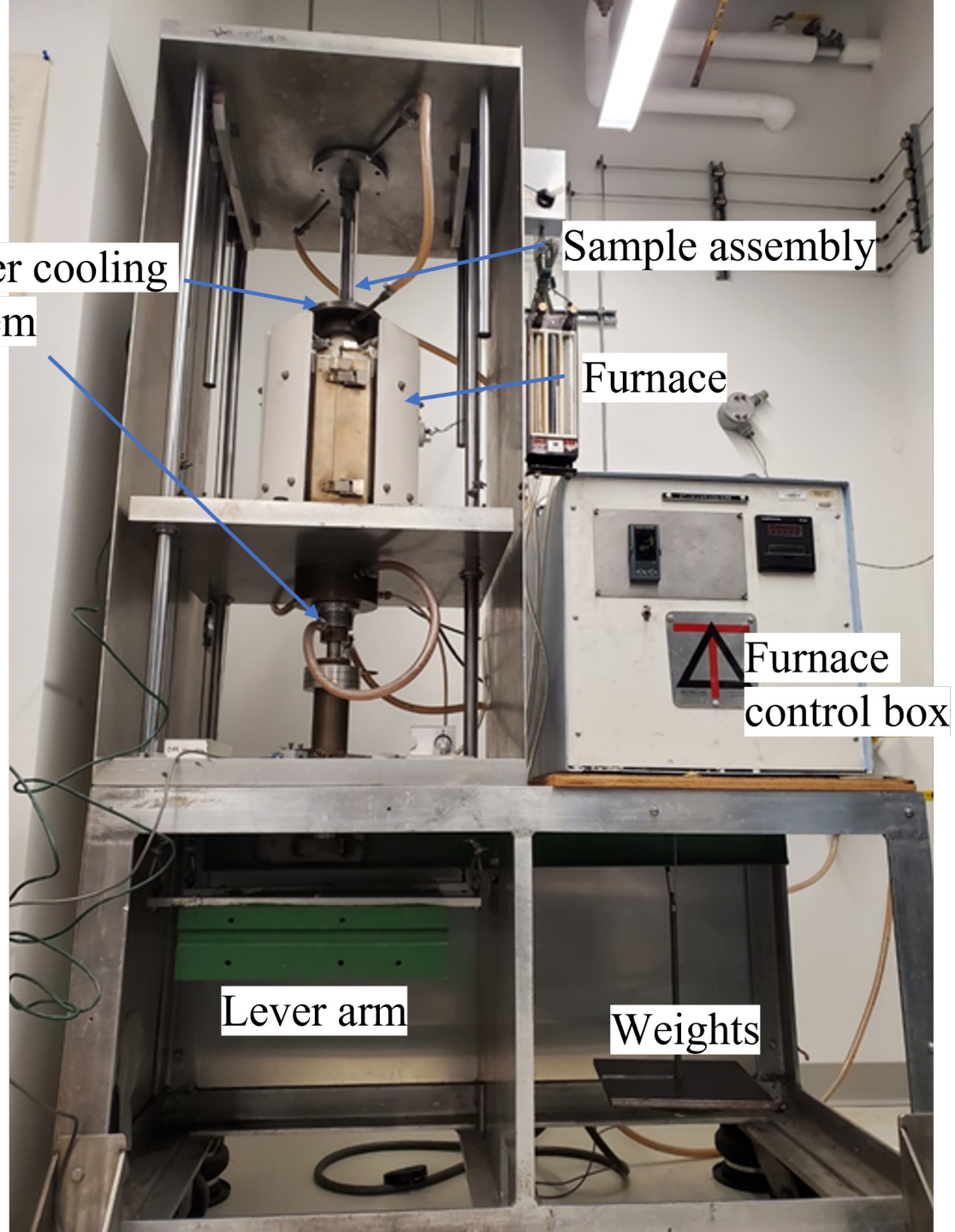
Bishop Tuff


100µm UMN 7/15/2022
X 100 15.0kV COMPO NOR WD 10.7mm 16:20:28


100µm UMN 7/15/2022
X 200 15.0kV COMPO NOR WD 10.7mm 16:22:29

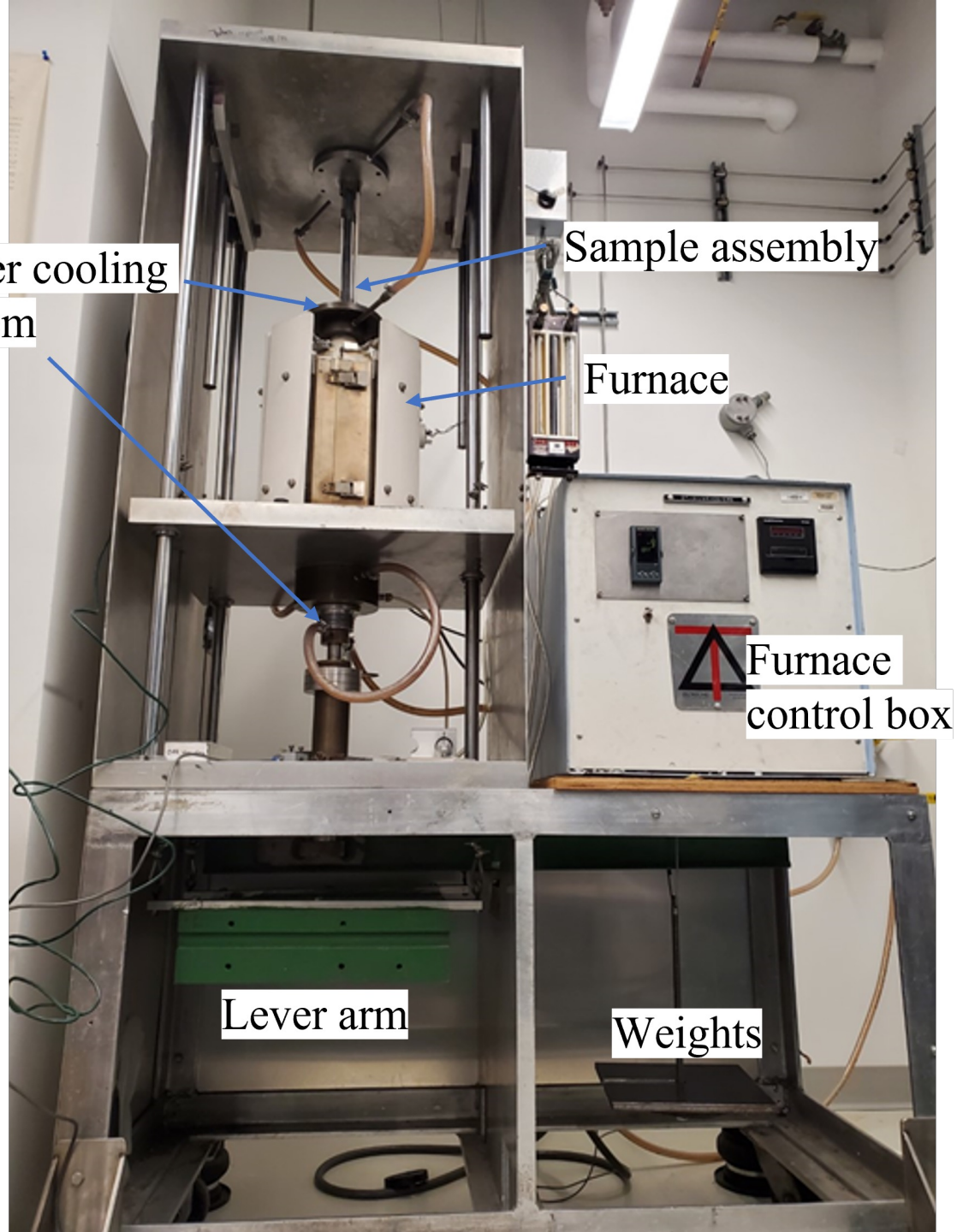
Experiments!

- Uniaxial compression (one direction)

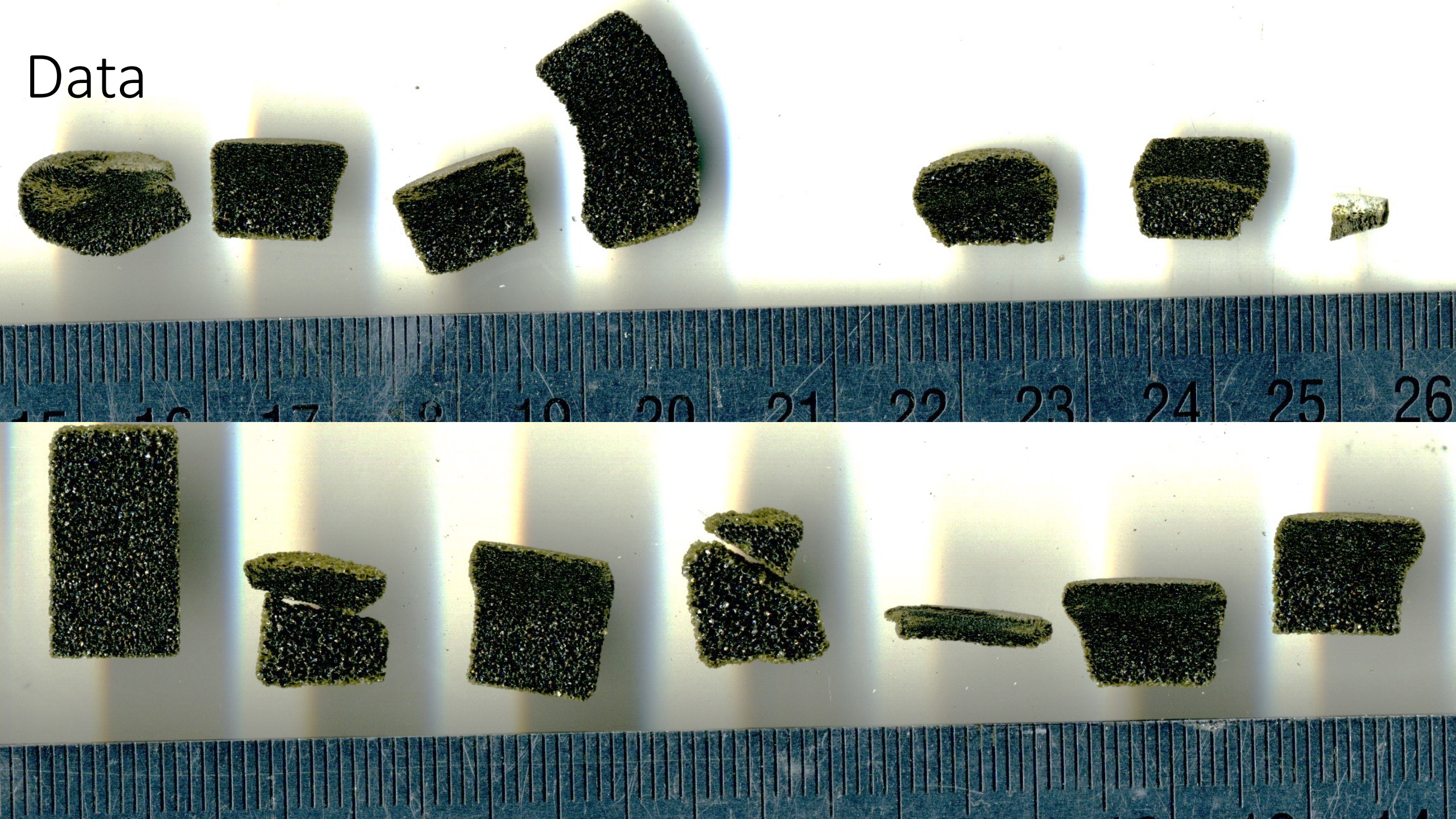


Experiments!

- Uniaxial compression (one direction)



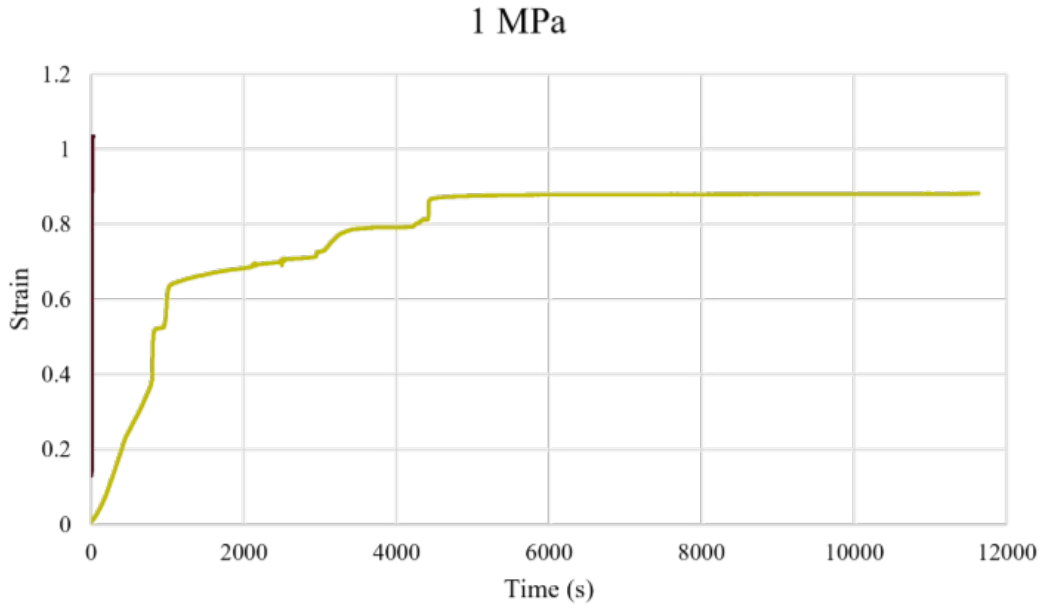
Data



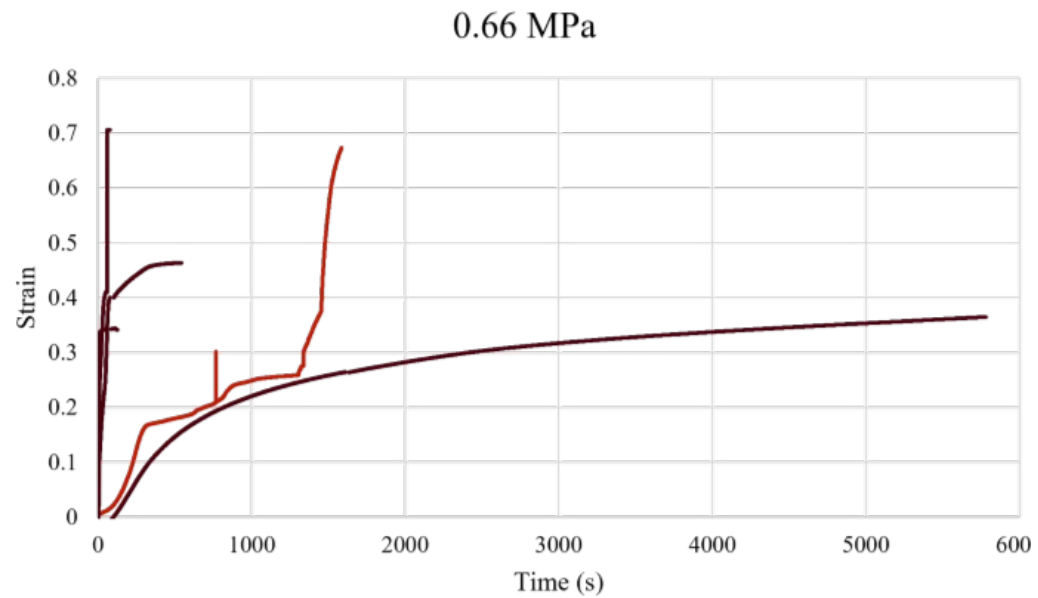
Data Analyses

- Deformation and time
- Jumps
- Oxidized area (color ratio)
- Deformation zones
- Bubble orientation
- Bubble shapes

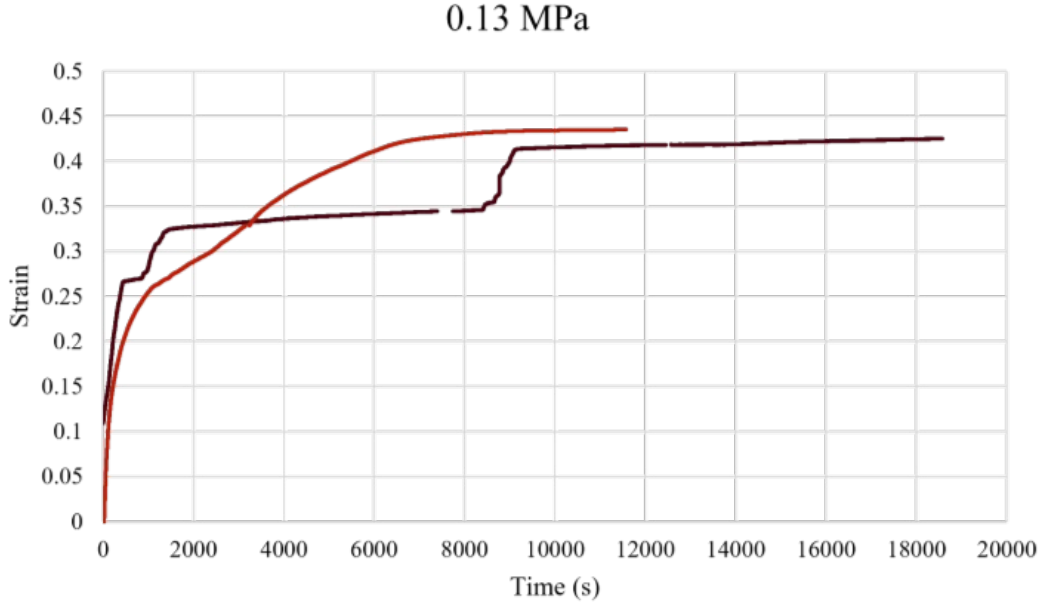
A



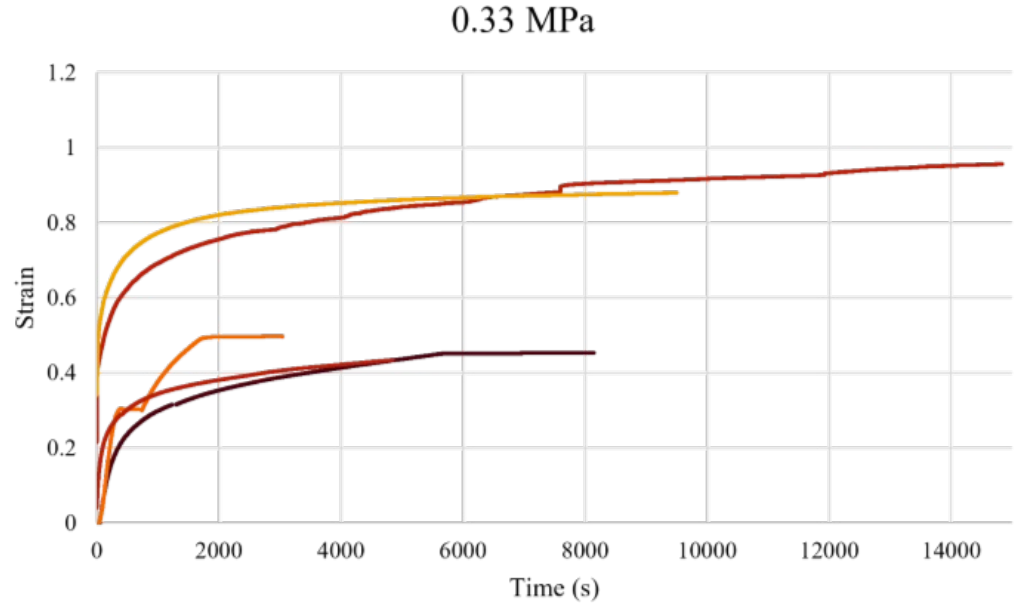
B



C

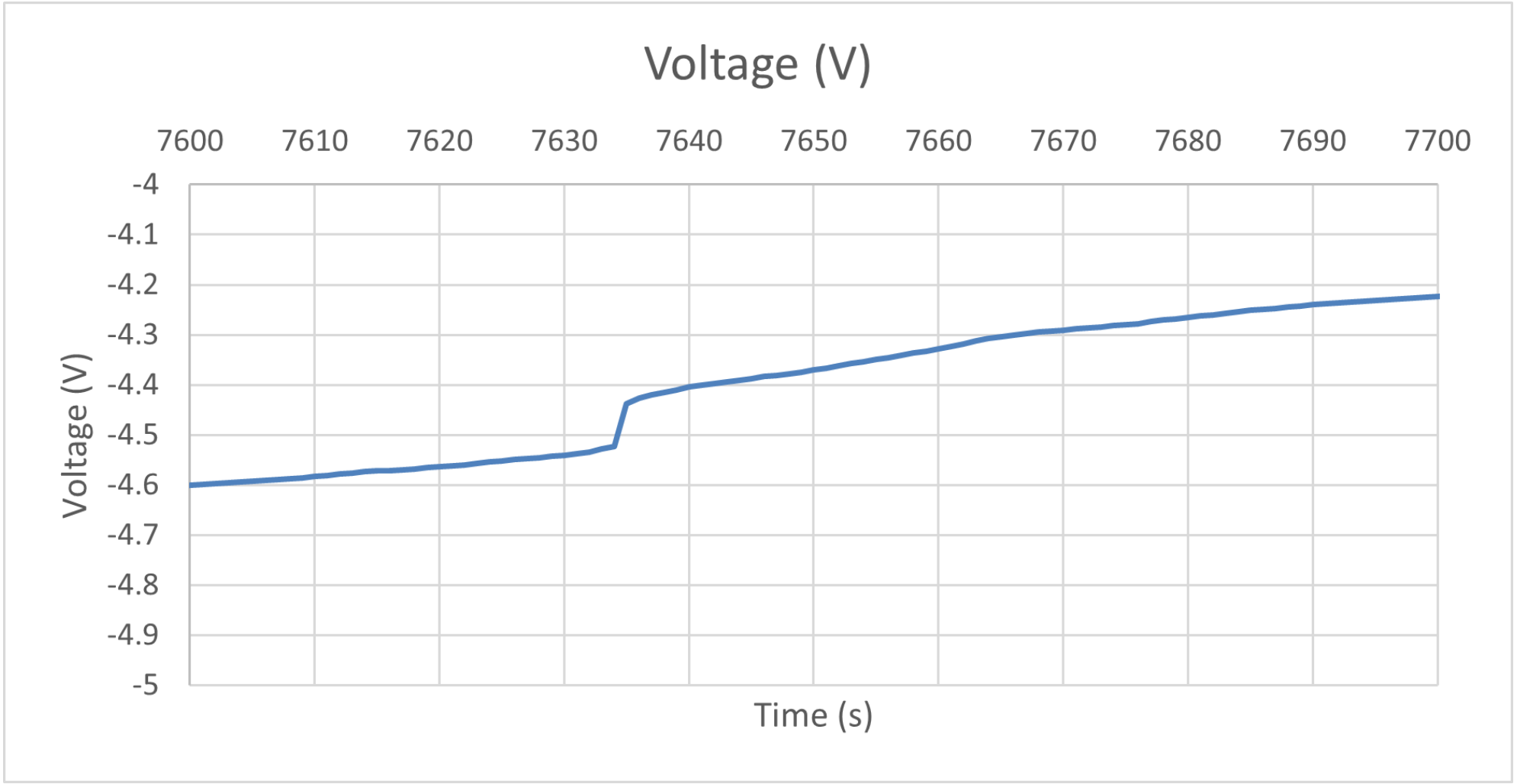


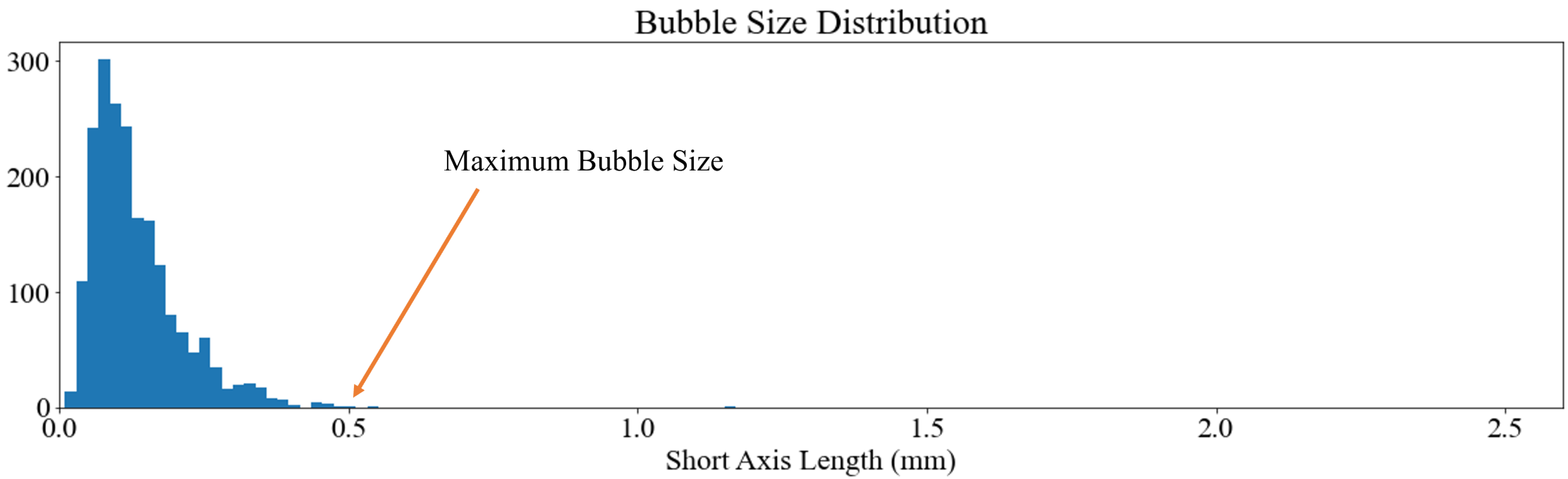
D

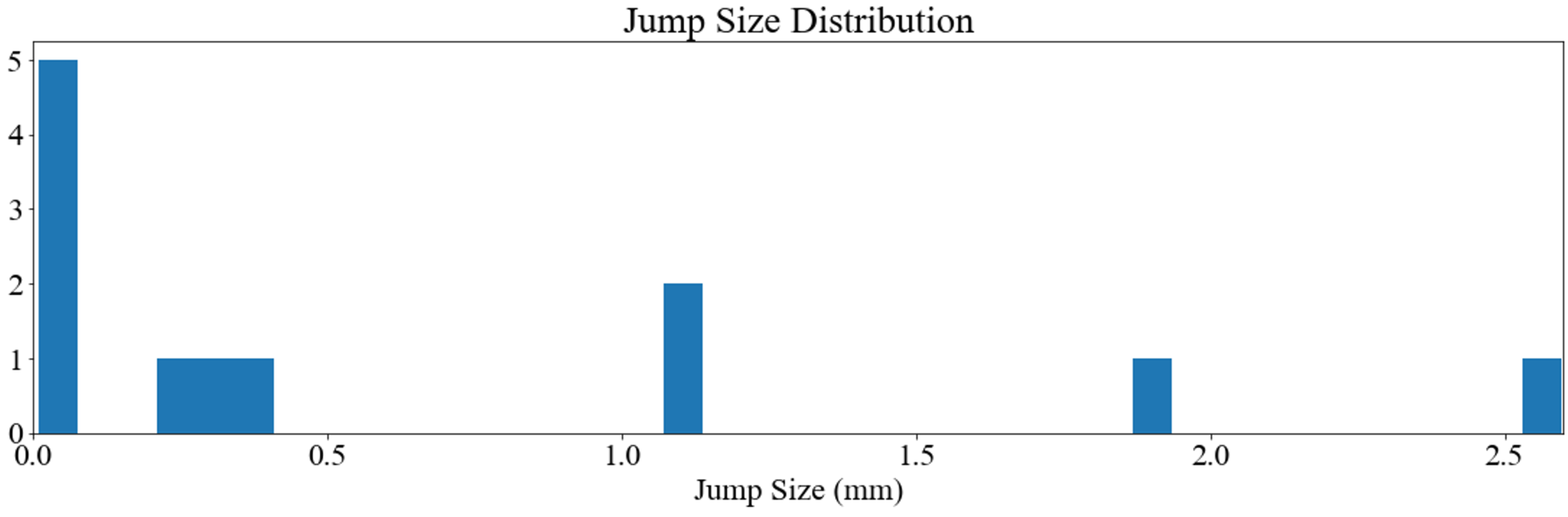


720°C 590°C 580°C 570°C 560°C

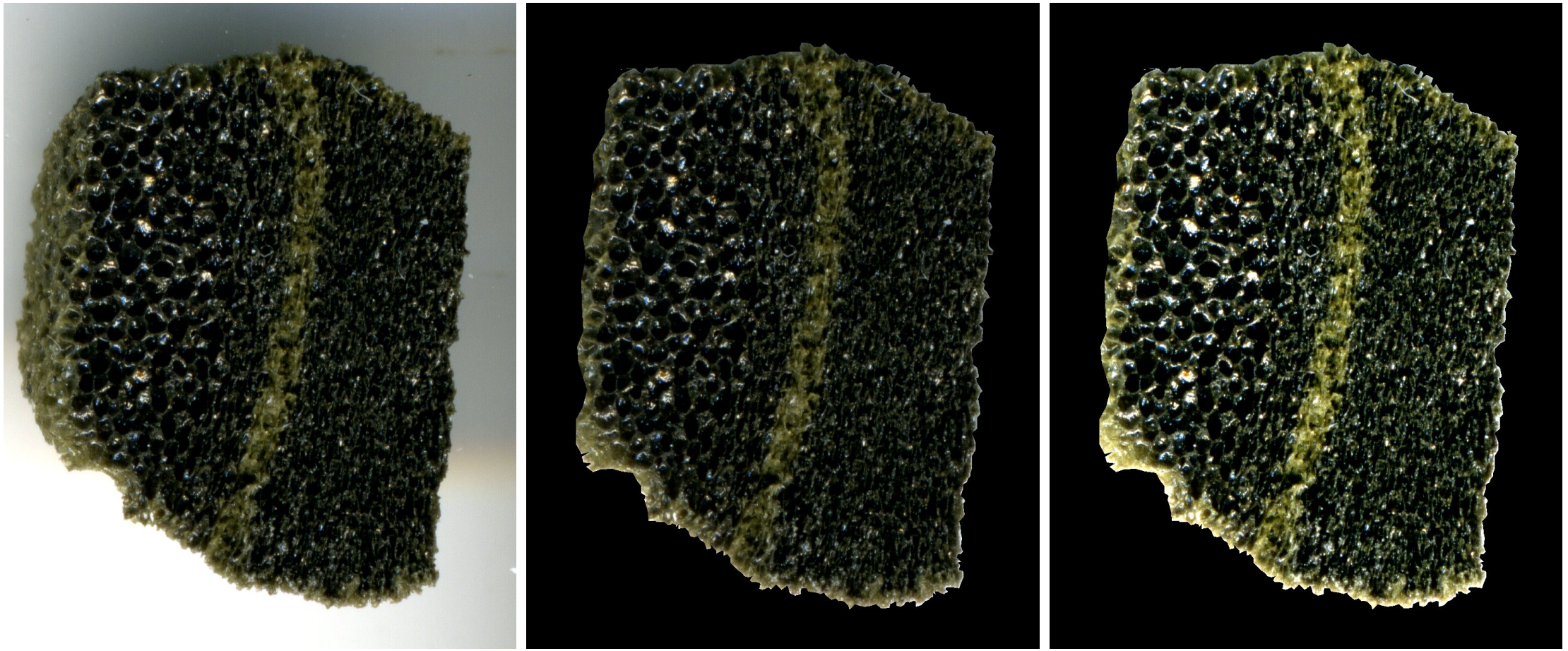
Jump Size


Voltage (V)
7600
7610
7620
7630
7640
7650
7660
7670
7680
7690
7700
-4
-4.1
-4.2
-4.3
-4.4
-4.5
-4.6
-4.7
-4.8
-4.9
-5
Voltage (V)
Time (s)

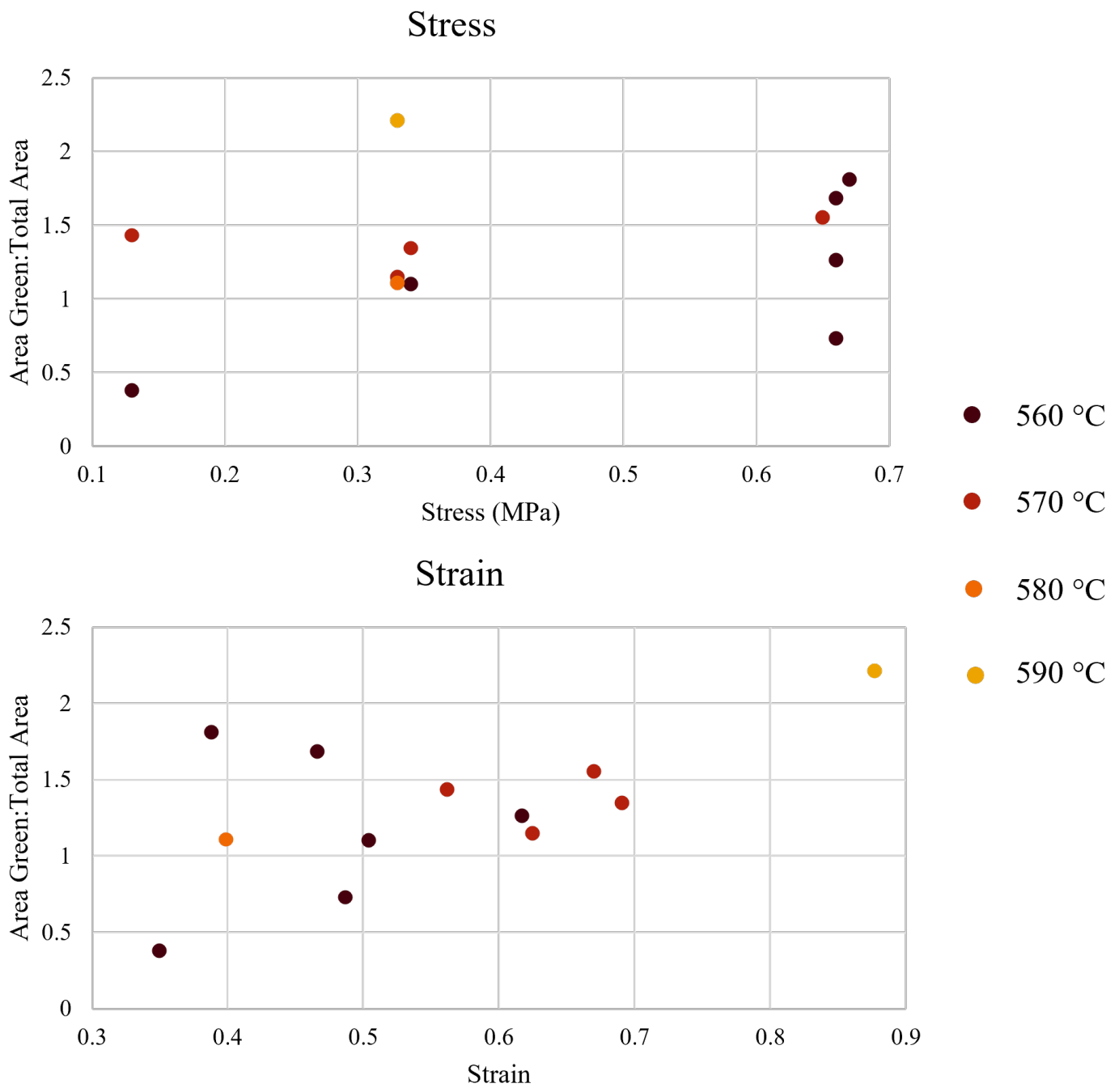

Bubble Size Distribution
300
200
100
0
Maximum Bubble Size
0.0
0.5
1.0
1.5
2.0
2.5
Short Axis Length (mm)


Jump Size Distribution
5
4
3
2
1
0
0.0
0.5
1.0
1.5
2.0
2.5
Jump Size (mm)

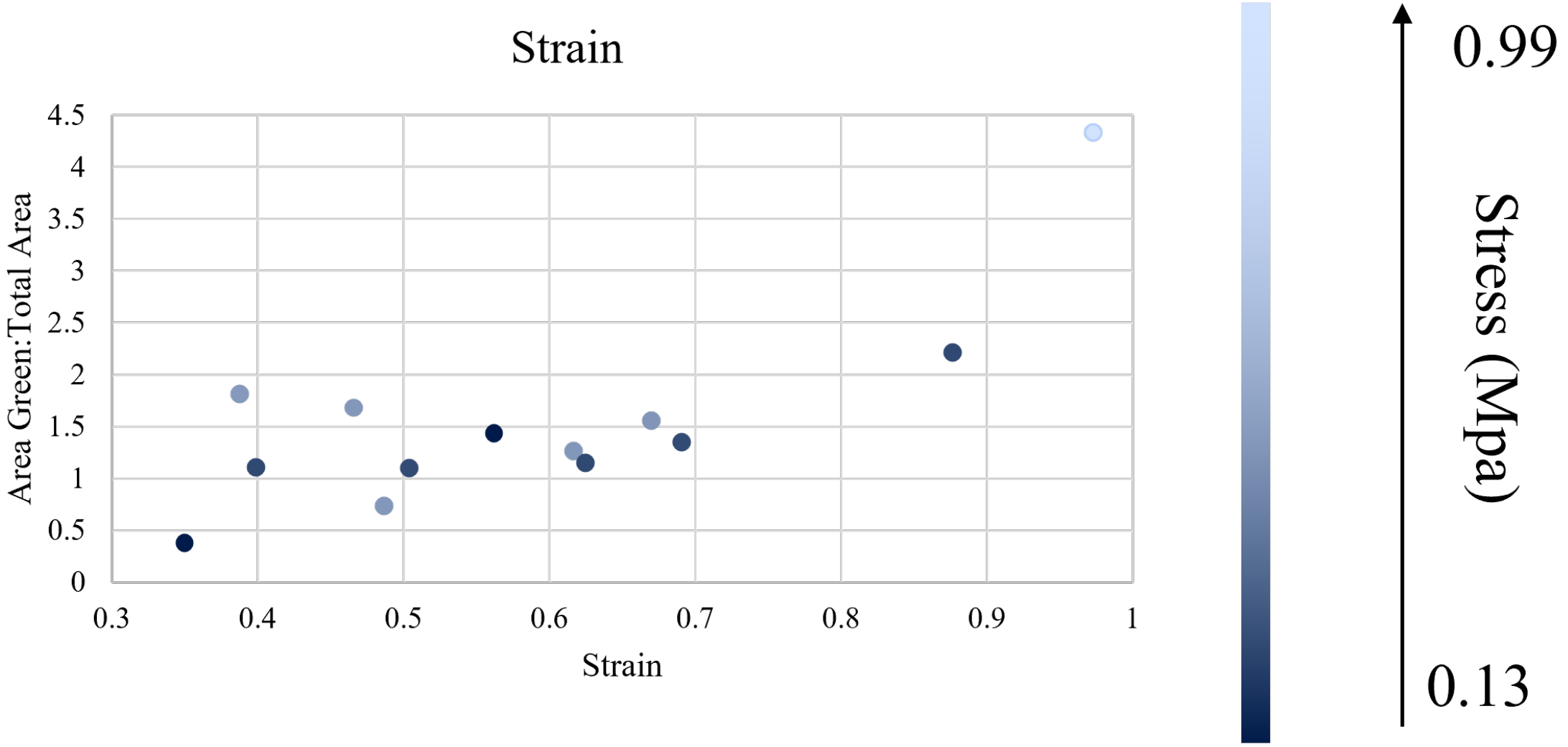
Color ratio



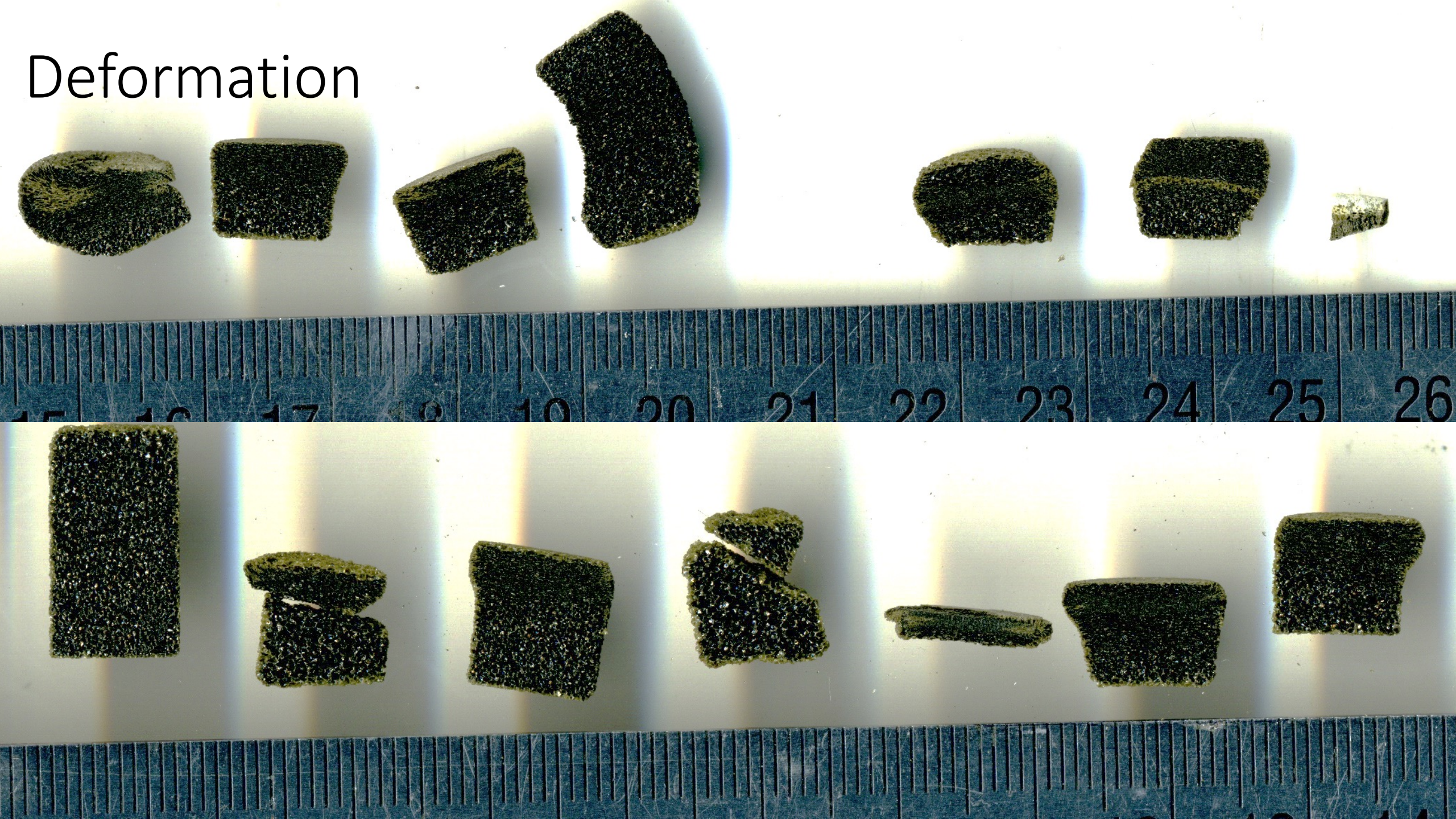
Color ratio


Stress
Area Green:Total Area
2.5
2
1.5
1
0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Stress (MPa)
Strain
Area Green:Total Area
2.5
2
1.5
1
0.5
0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Strain
560 °C
570 °C
580 °C
590 °C

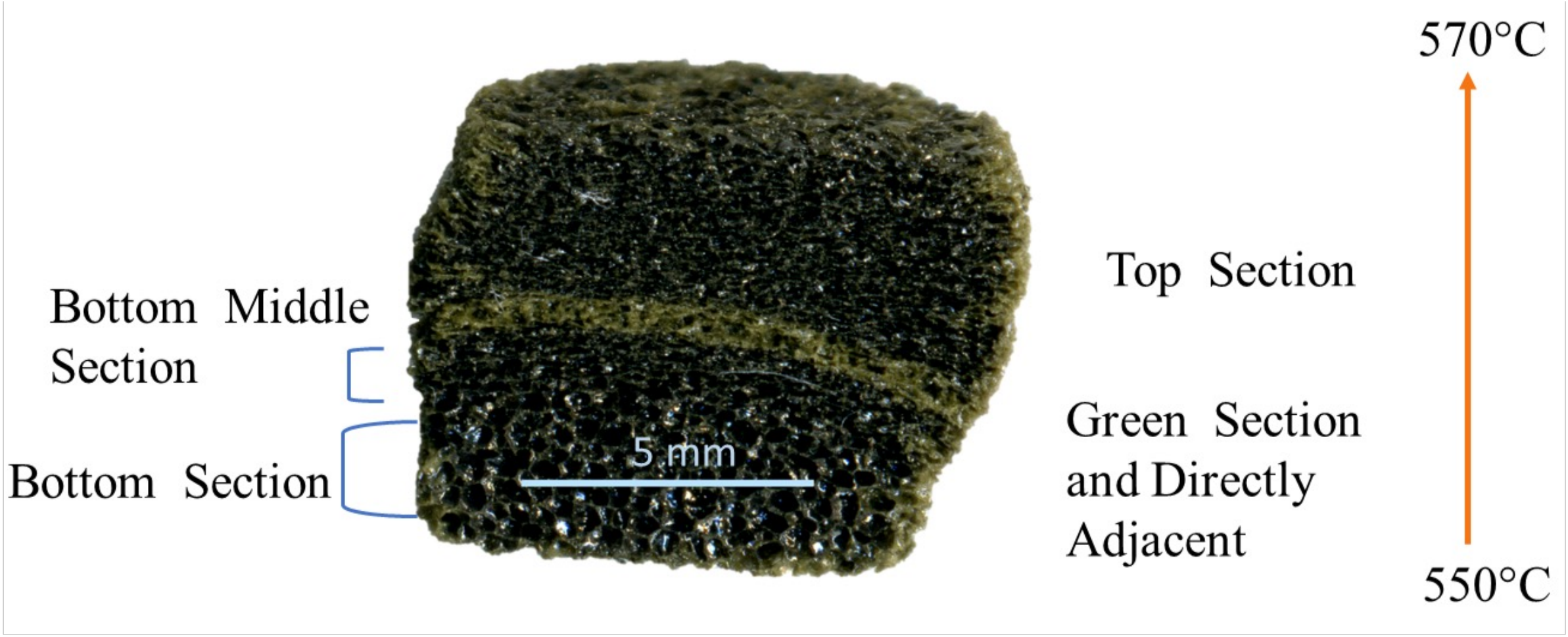
Color ratio


Strain
Area Green:Total Area
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Strain
0.99
Stress (Mpa)
0.13

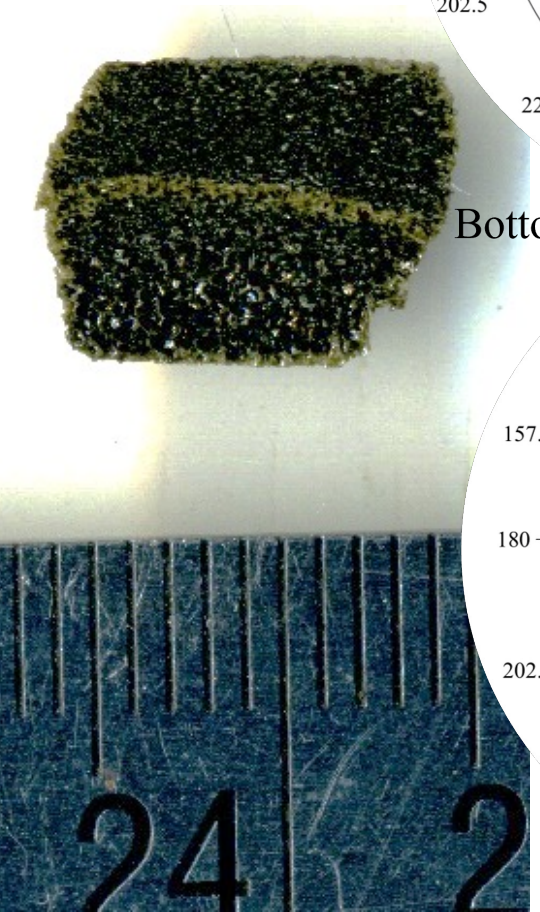
Deformation



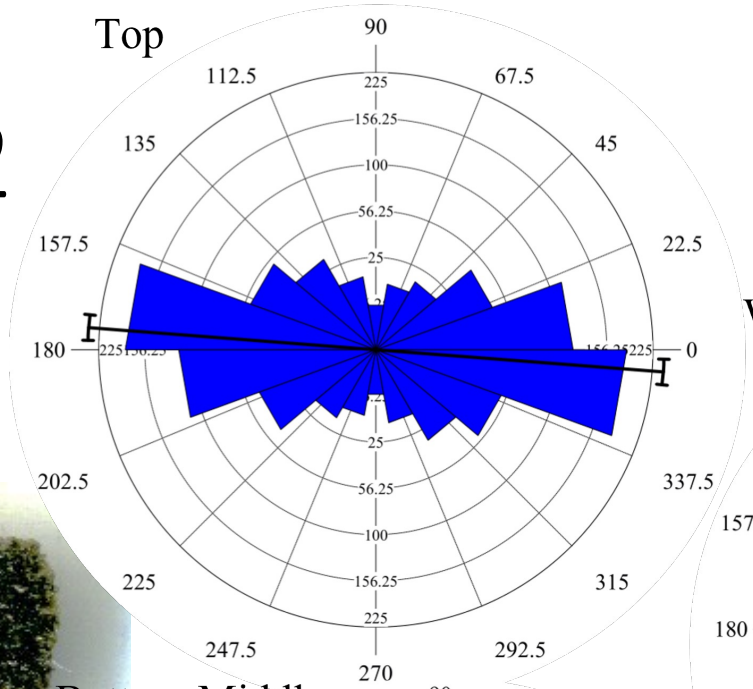
Deformation



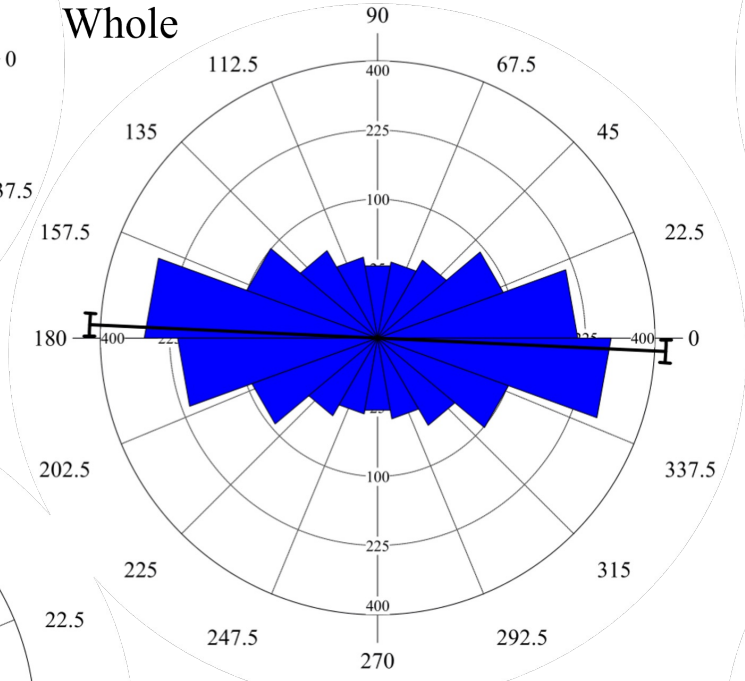
C1-2



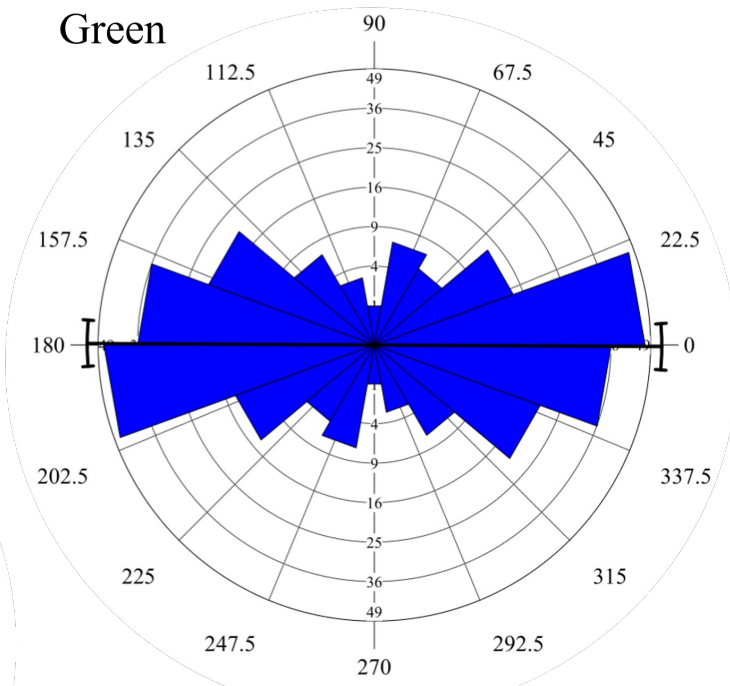
Top



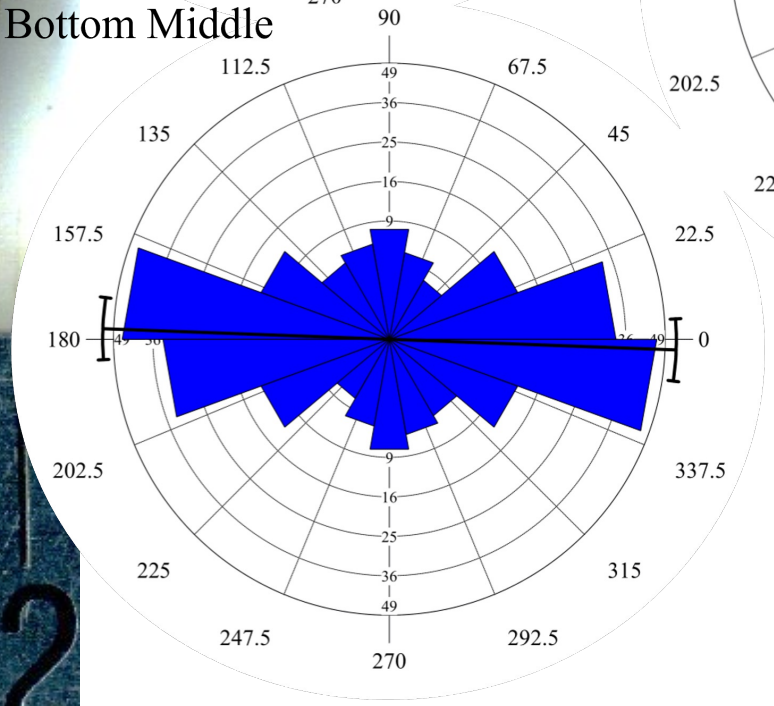
Whole



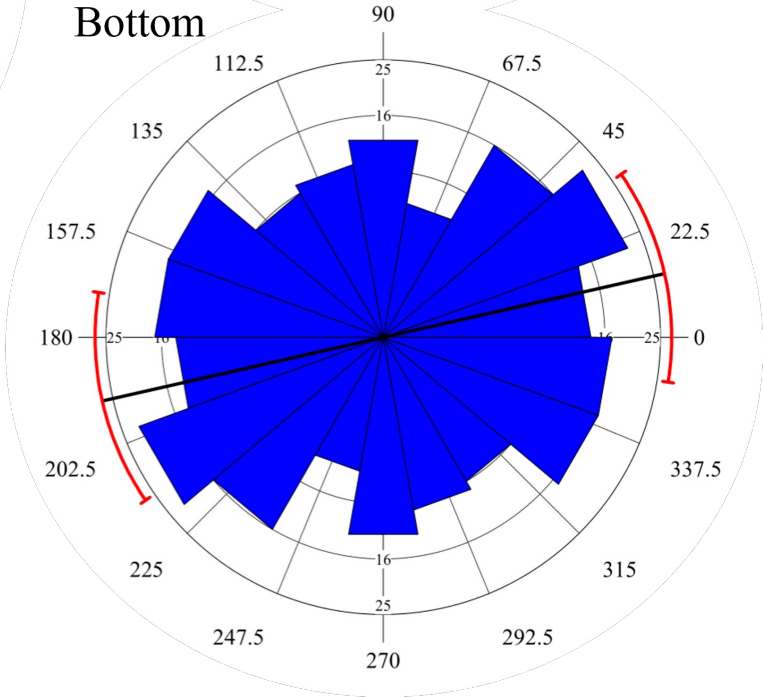
Green



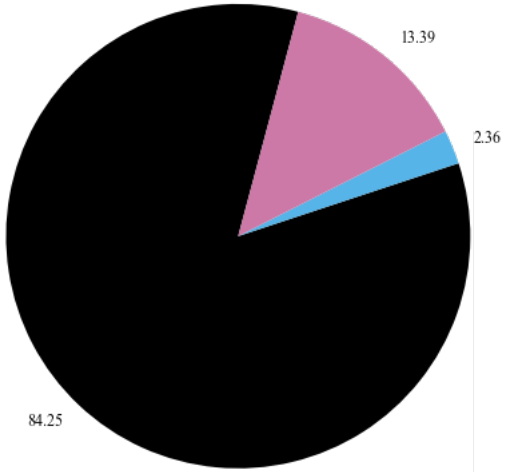
Bottom Middle

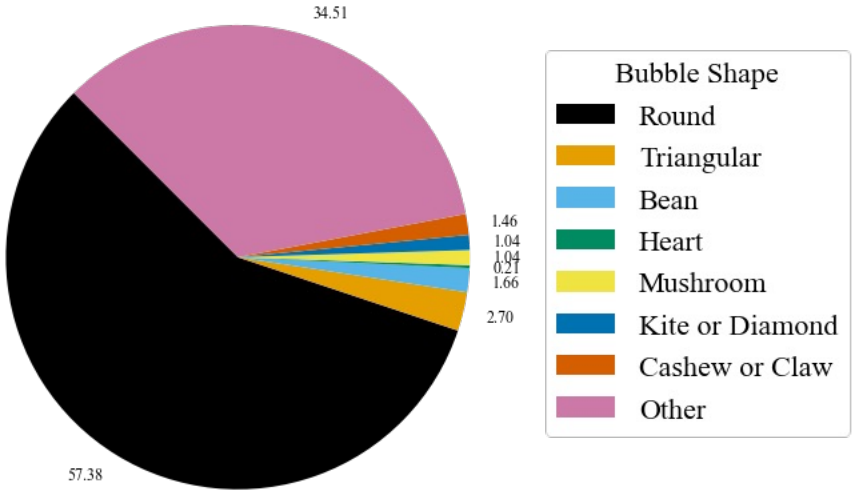


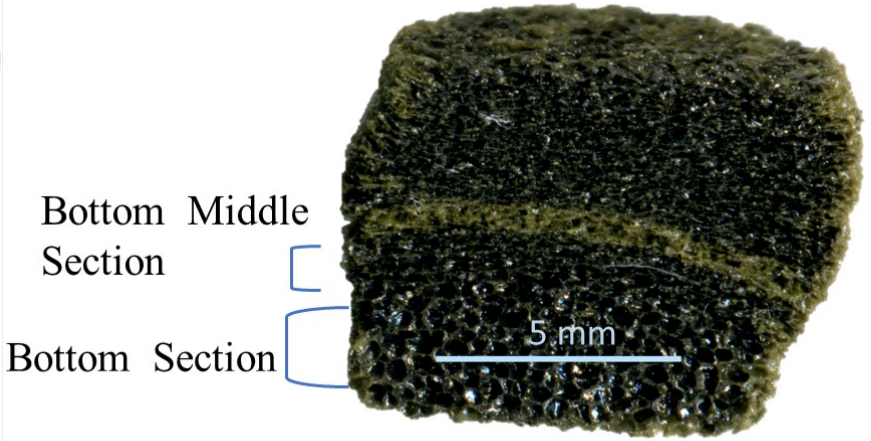
Bottom



Bubble Shape

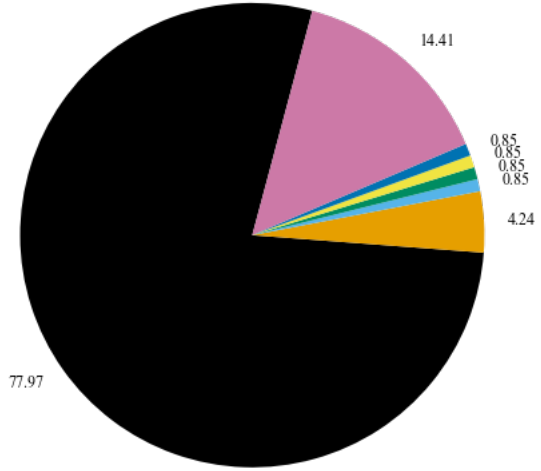






Top Section

Green Section and Directly Adjacent



Conclusions

- Deformation is more ductile at higher temperatures when stress is the same.
- Some jumps in deformation occur due to collapse of planes of bubbles.
- When strain is similar for two points, the point with the lower stress has a lower ratio of green area to total area.
- Bubble size decreases with increased strain.
- Compaction bands form perpendicular to the direction of compression.
- The long axis of deformed bubbles lies parallel or subparallel to the compaction band of the sample and perpendicular to the direction of compression.
- Bubble shape complexity increases with increasing strain.

Thanks

- RORD group
- Amy Ryan
- Amanda Dillman
- Lars Hansen
- Dr. Judge

Selected Sources

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