

SnowEx: Grand Mesa IOP 2020

Snow Microstructure: micro-CT samples



Lauren Farnsworth and Zoe Courville

Lauren B. Farnsworth:

farnsworthlauren@gmail.com

Lauren.B.Farnsworth@usace.army.mil

Zoe R. Courville:

Zoe.R.Courville@erdc.dren.mil



SnowEx: Grand Mesa IOP 2020

Micro-CT Samples:

CASTED SAMPLE

3.FEB.2020

- Pit: "Mesa Lodge Cabin 1" (117-0 cm; 7 sample containers)

4.FEB.2020

- Pit: 3s33 (104-0 cm; 7 sample containers)
- Pit: 6s34 (75-0 cm; 5 sample containers)

5.FEB.2020

- Pit: 8c18 (100-0 cm; 6 sample containers)
- Pit: 8c11 (90-0 cm; 5 sample containers)

6.FEB.2020

- Pit: 5n15 (113-0 cm; 5 sample containers)

SNOW SAMPLE

5.FEB.2020

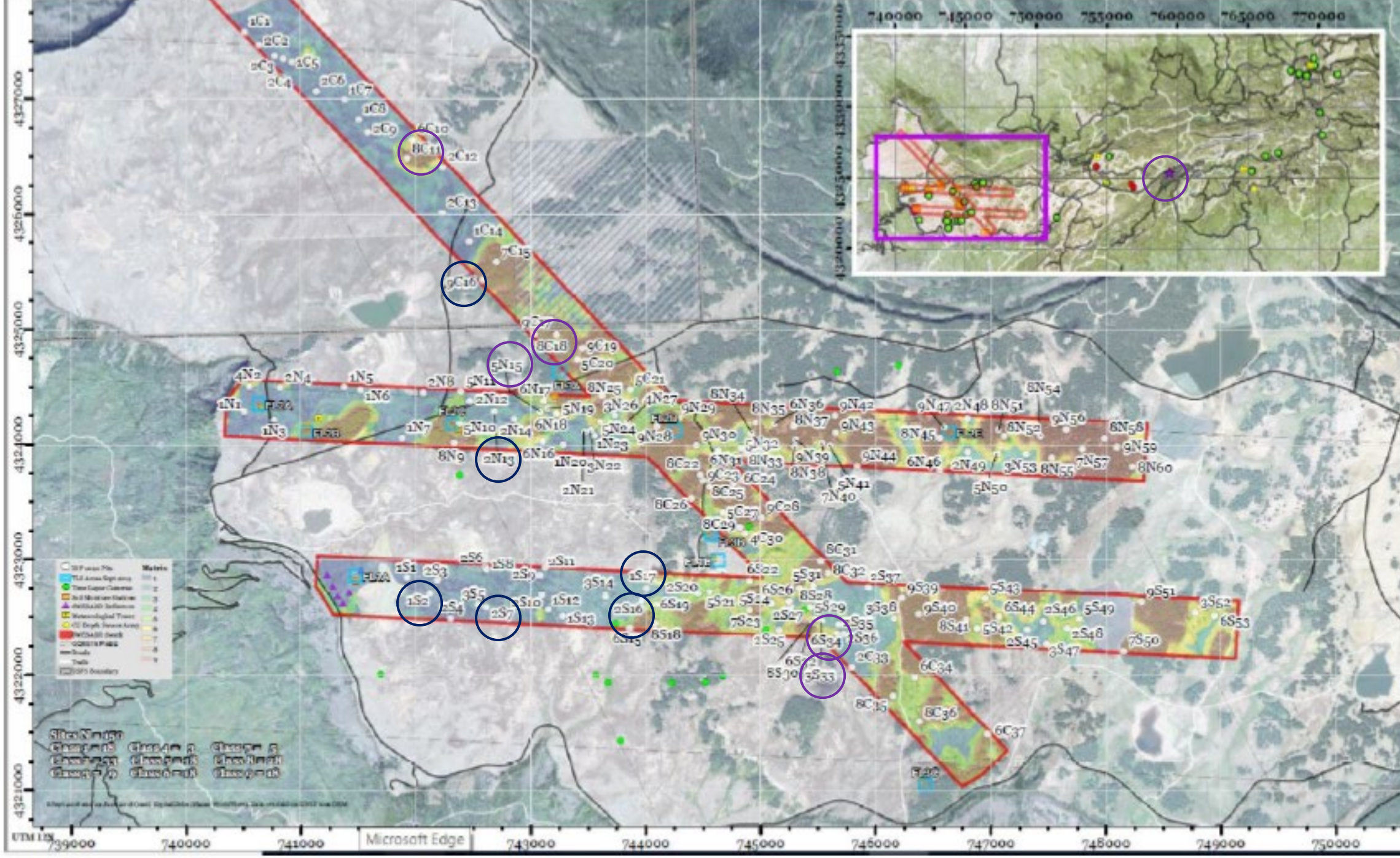
- Pit: 9c16 (110-0 cm; 7 sample containers)

6.FEB.2020

- Pit: 2n13 (139-0 cm; 8 sample containers)

8.FEB.2020

- Pit: 1s2 (85-0 cm; 6 sample containers)
- Pit: 2s7 (80-0 cm; 5 sample containers)
- Pit: 2s16 (94-0 cm; 6 sample containers)
- Pit: 1s17 (95-0 cm; 6 sample containers)



3Feb2020

- Pit: Mesa Lodge Cabin 1

4Feb2020

- Pit: 3s33
- Pit: 6s34

5Feb2020

- Pit: 8c18
- Pit: 9c16
- Pit: 8c11

6Feb2020

- Pit: 2n13
- Pit: 5n15

8Feb2020

- Pit: 1s2
- Pit: 2s7
- Pit: 2s16
- Pit: 1s17

SnowEx, Grand Mesa IOP 2020

Micro-CT Samples:

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- Pit: 5n15 (113-0 cm; 5 sample containers)

SNOW SAMPLE

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- Pit: 9c16 (110-0 cm; 7 sample containers)

6.FEB.2020

- Pit: 2n13 (139-0 cm; 8 sample containers) *

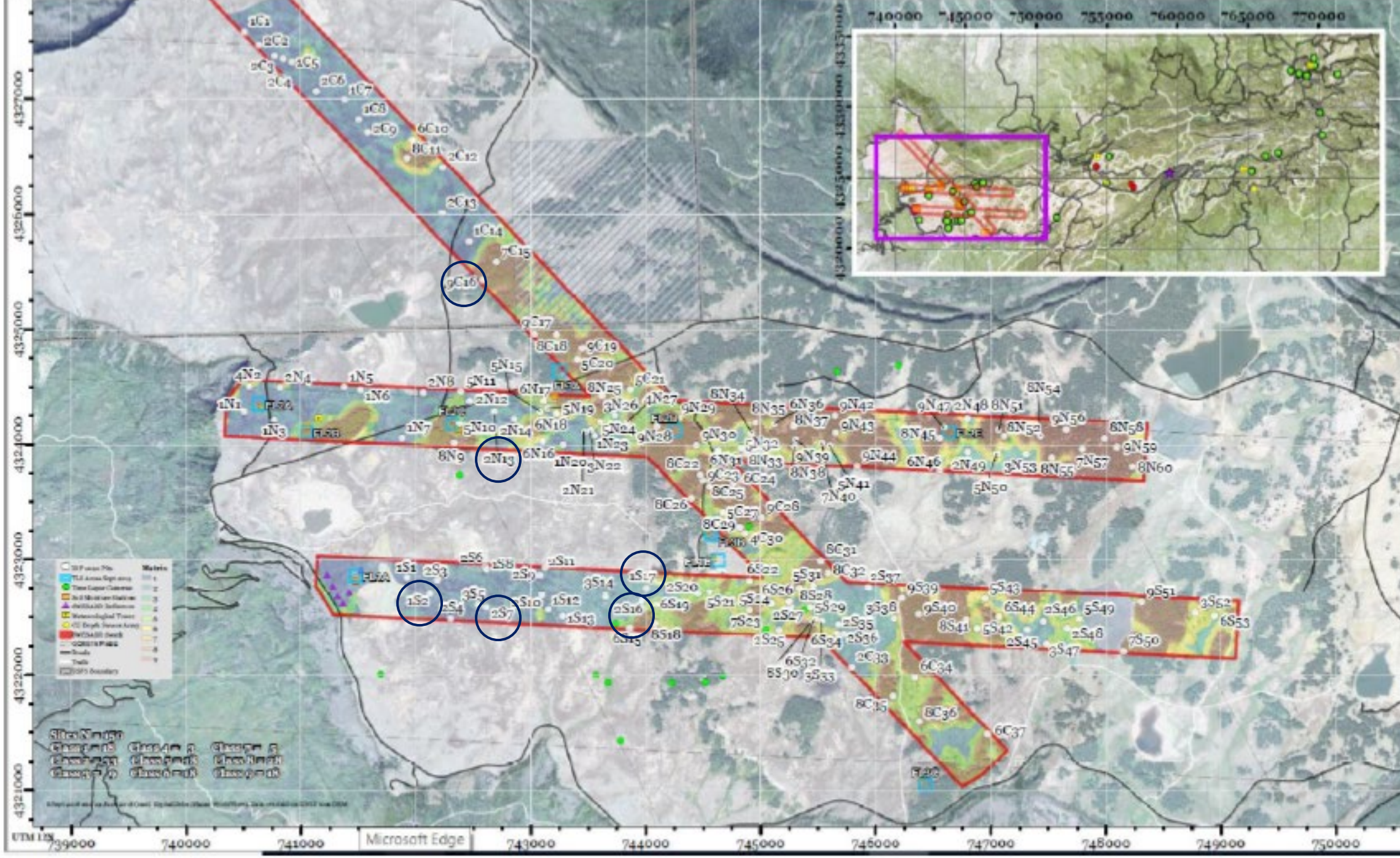
8.FEB.2020

- Pit: 1s2 (85-0 cm; 6 sample containers) *
- Pit: 2s7 (80-0 cm; 5 sample containers)
- Pit: 2s16 (94-0 cm; 6 sample containers) *
- Pit: 1s17 (95-0 cm; 6 sample containers) *

NOT SCANNED

SCANNED

* ANALYZED



3Feb2020

- Pit: Mesa Lodge Cabin 1

4Feb2020

- Pit: 3s33
- Pit: 6s34

5Feb2020

- Pit: 8c18
- Pit: 9c16
- Pit: 8c11

6Feb2020

- Pit: 2n13
- Pit: 5n15

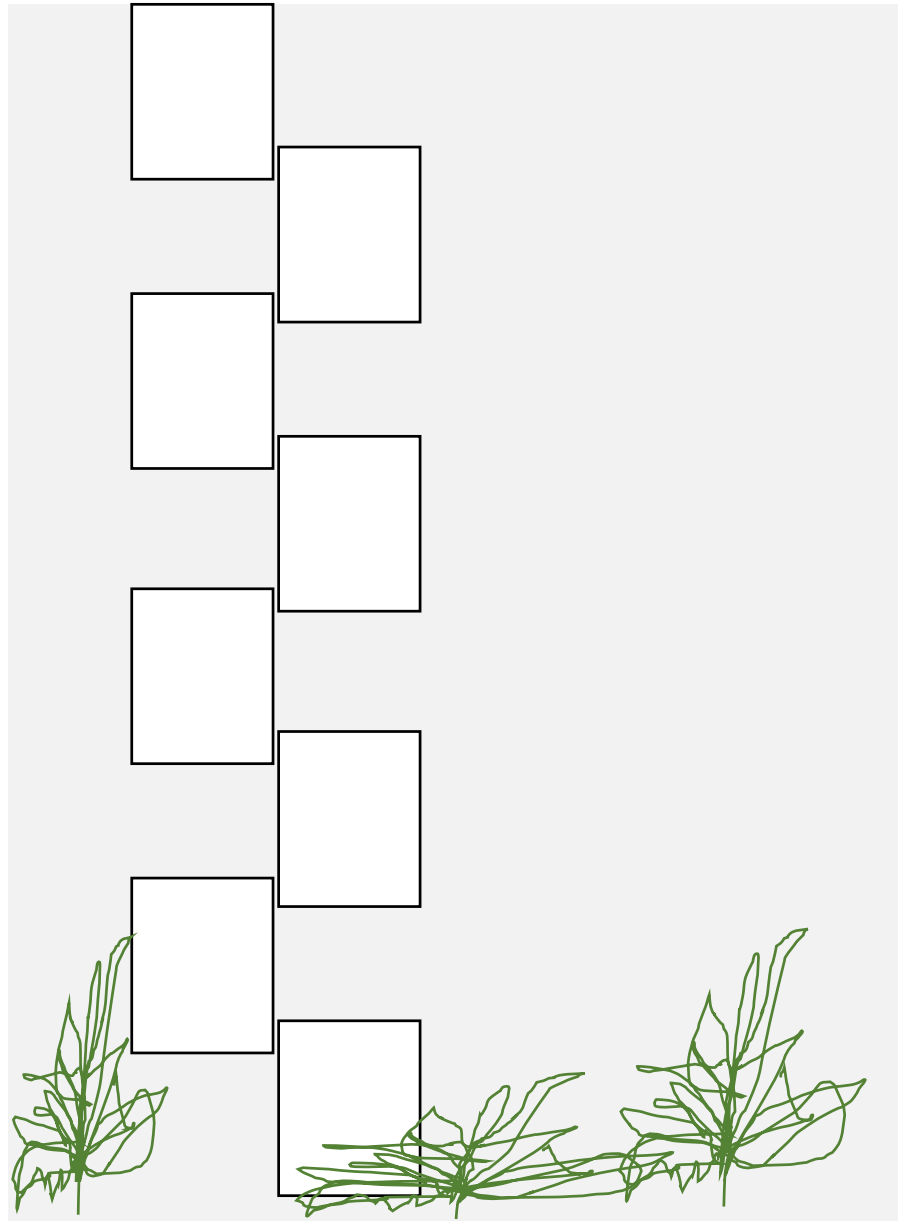
8Feb2020

- Pit: 1s2
- Pit: 2s7
- Pit: 2s16
- Pit: 1s17

Methods

- Collect samples at pit
- Cast samples in DMP/DEP and prepare for transport (lots of dry ice)
- Sub-sample in cold room (14F)
 - cut ~6 cm sample from Tupperware sample container for dime container
- Scan ~6 cm in dime container in micro-CT (3x/sample container; 3 scans/dime container)
 - Scan is 20 um “medium” resolution (17 minutes)
 - 0.6 step rotation
 - 330 ms exposure
 - 40 kV voltage
 - 200 uA current
 - No filter
- Reconstruct scan (~1500 + 2D images of scan into stack; corrections)
- Analyze ~1500+ slices (make VOI- trim edges and ROI- 11 mm, binarization- peak midpoint) 2D and 3D data
- 3D Visualization
- Use S/V ratio to calculate SSA

100cm

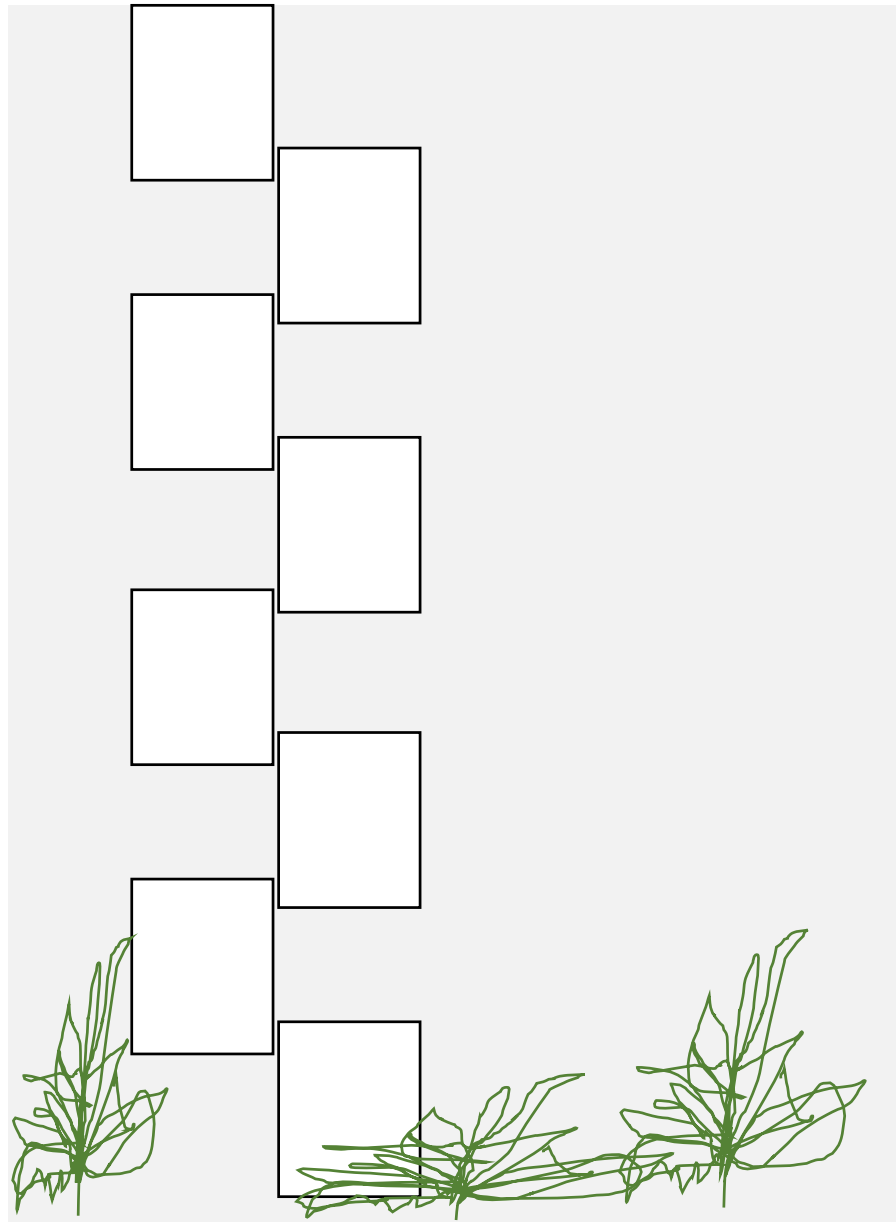


Surface

Base



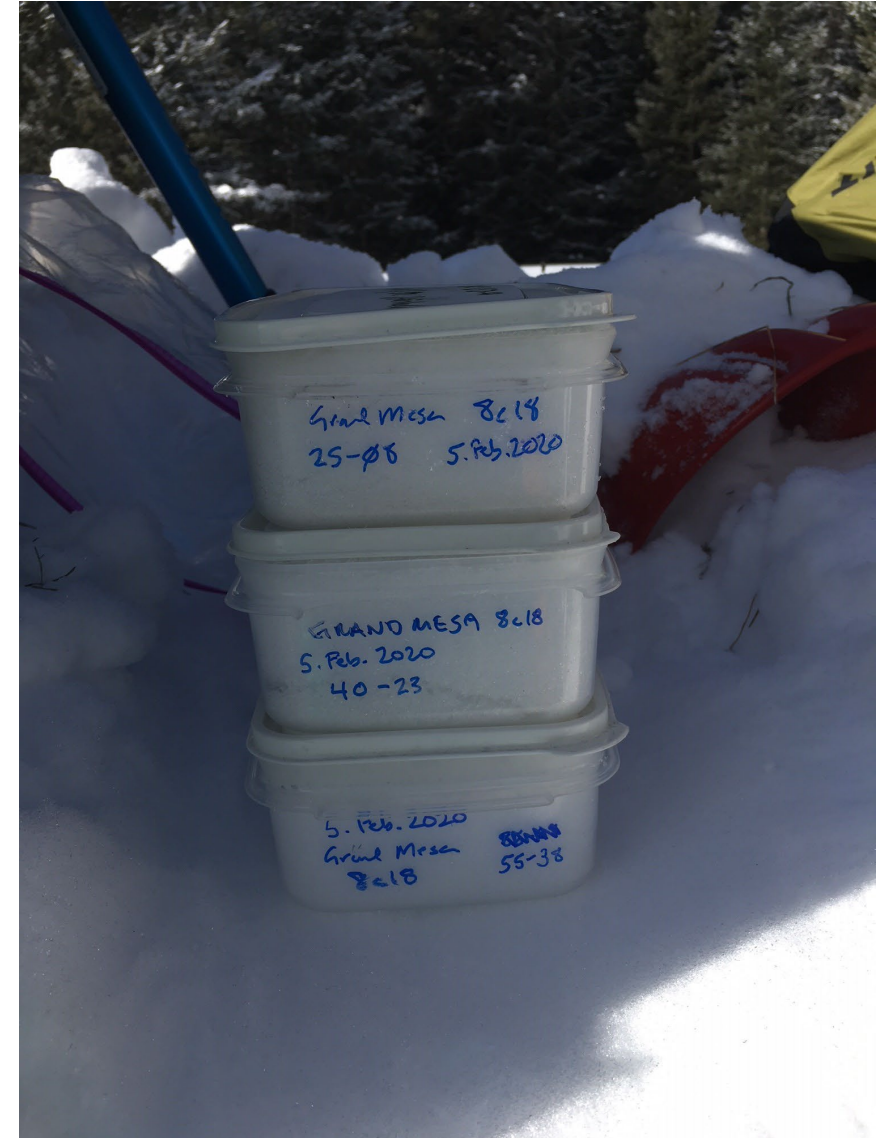
100cm



Surface

Sample container:
17 cm long
Sample overlap:
2 cm
Samples per pit:
5-8

Base



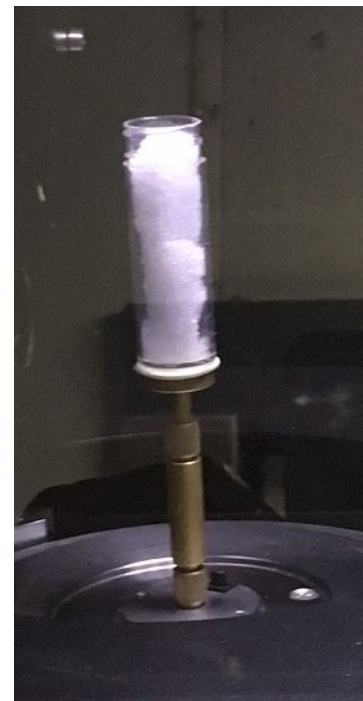
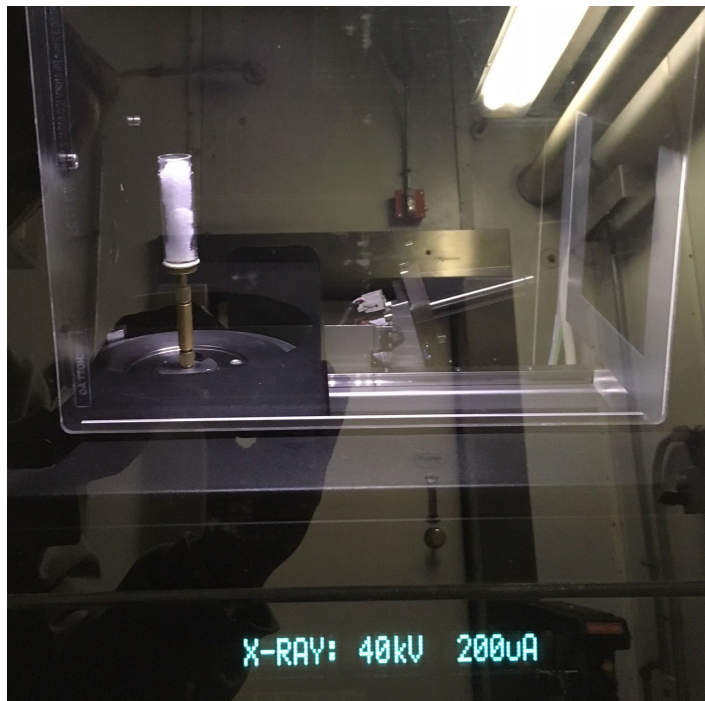
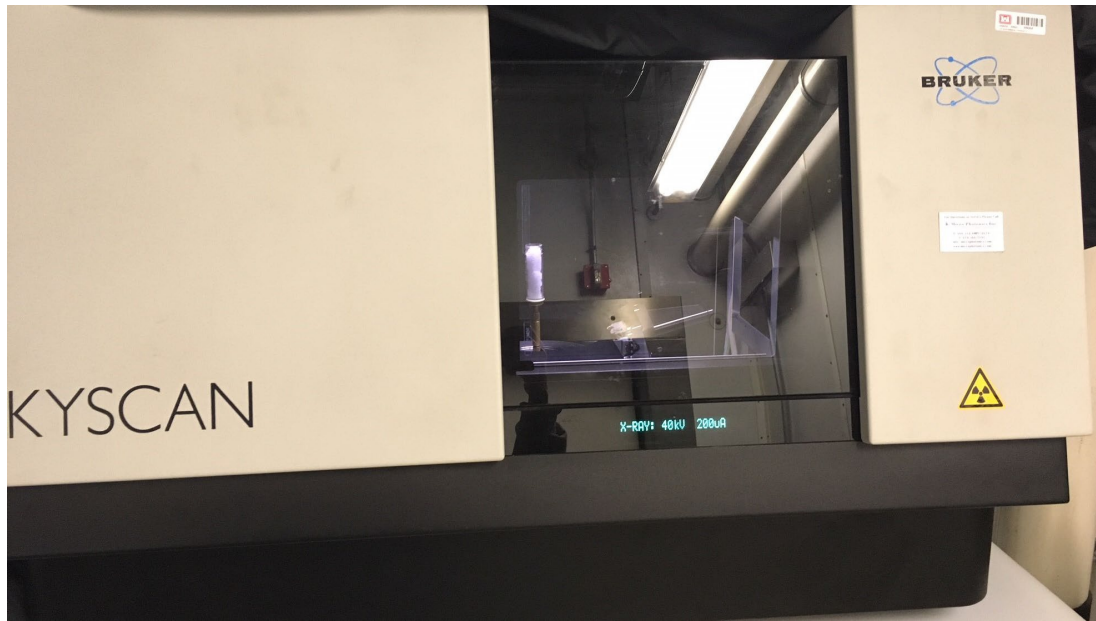
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- 3D Visualization
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Methods

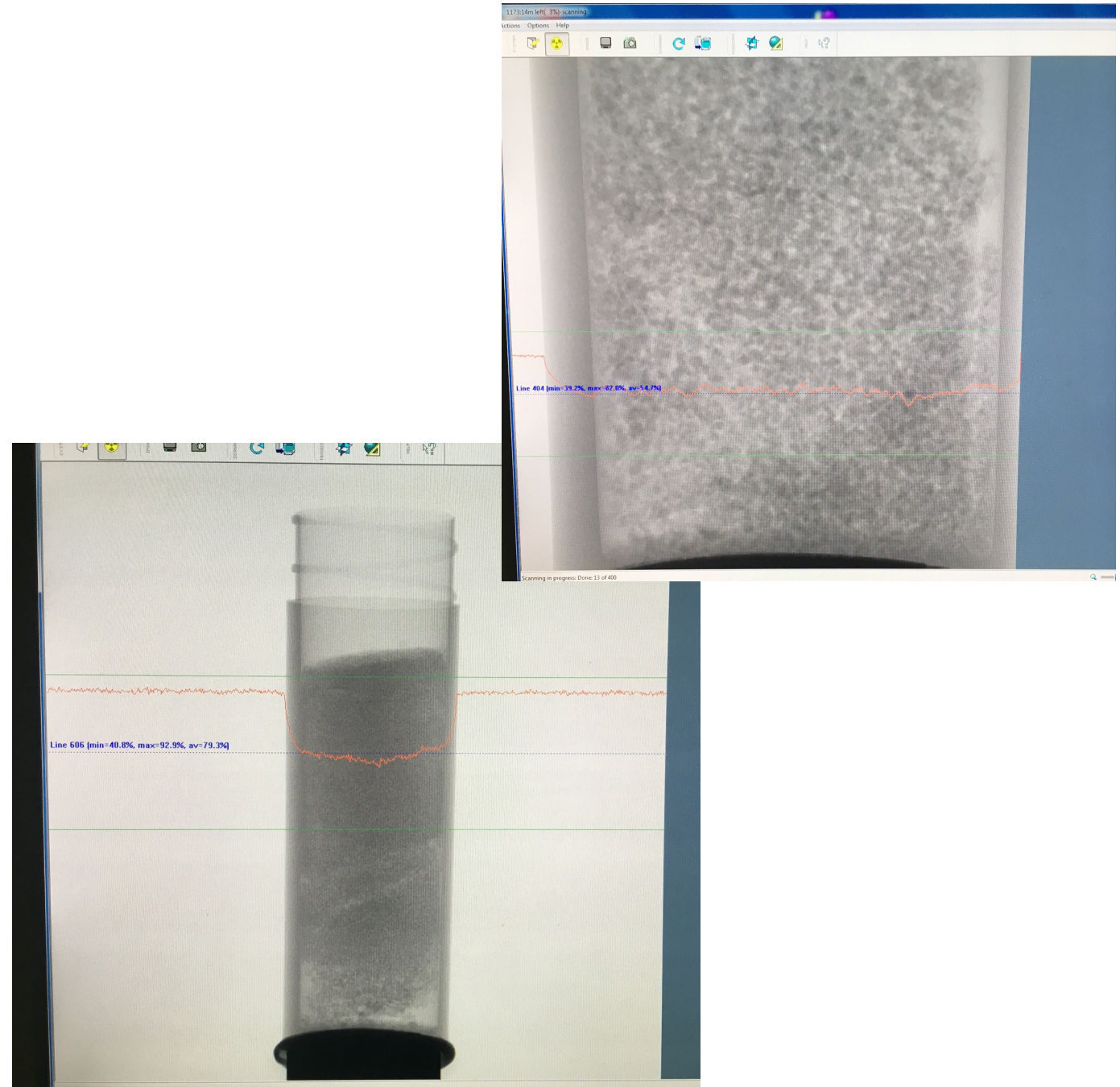
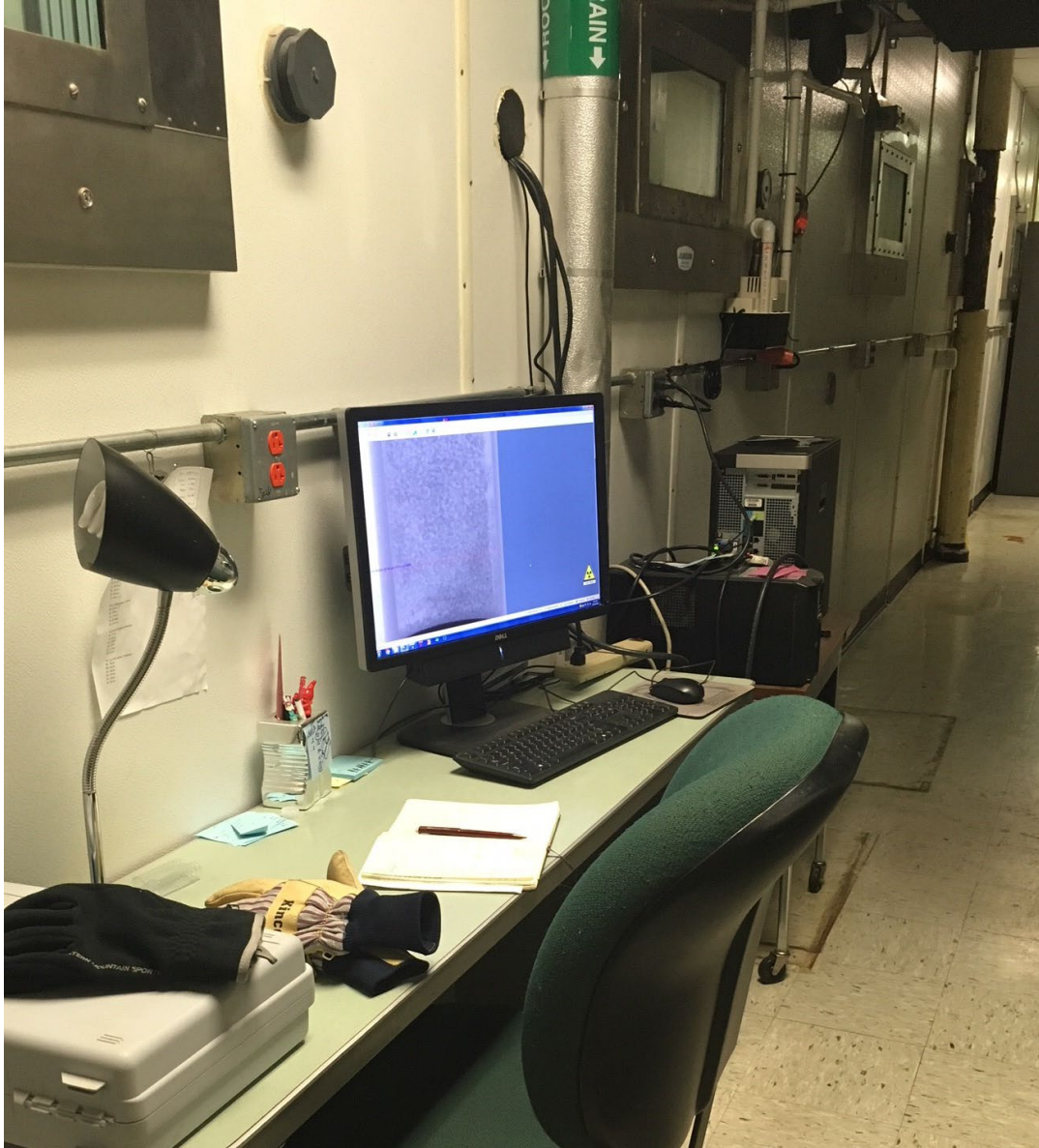
- Collect samples at pit
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- **Sub-sample in cold room (14F)**
 - cut ~6 cm sample from Tupperware sample container for dime container
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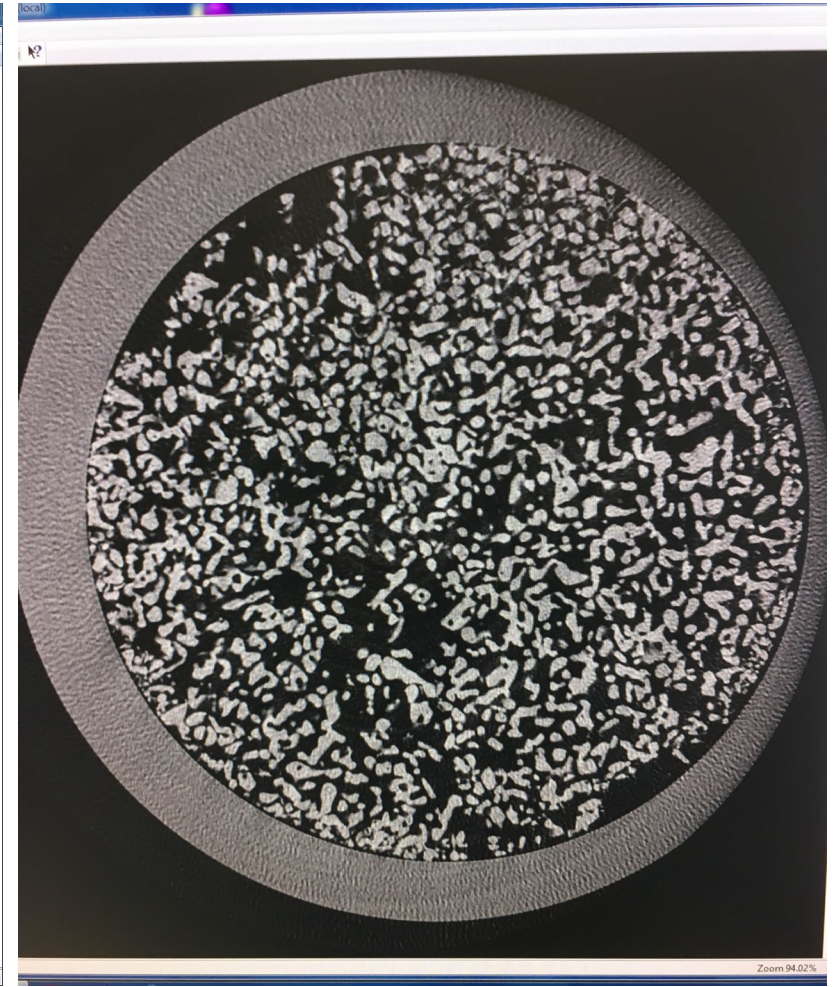
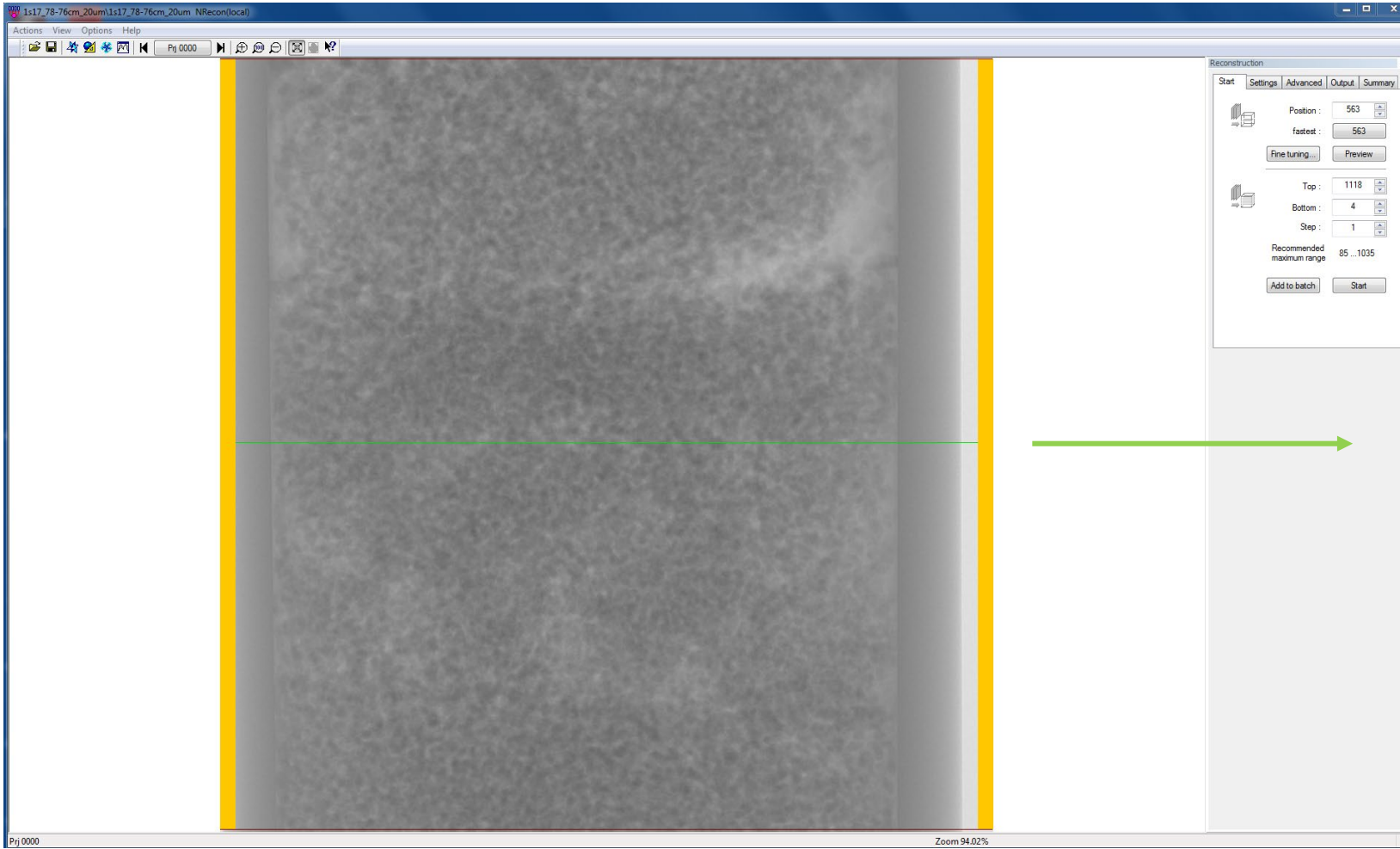
Skyscan Bruker Micro-CT



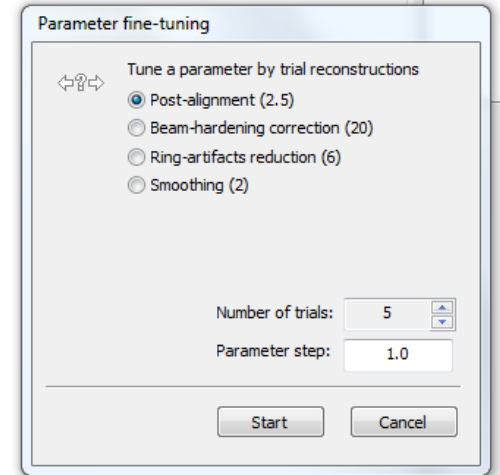
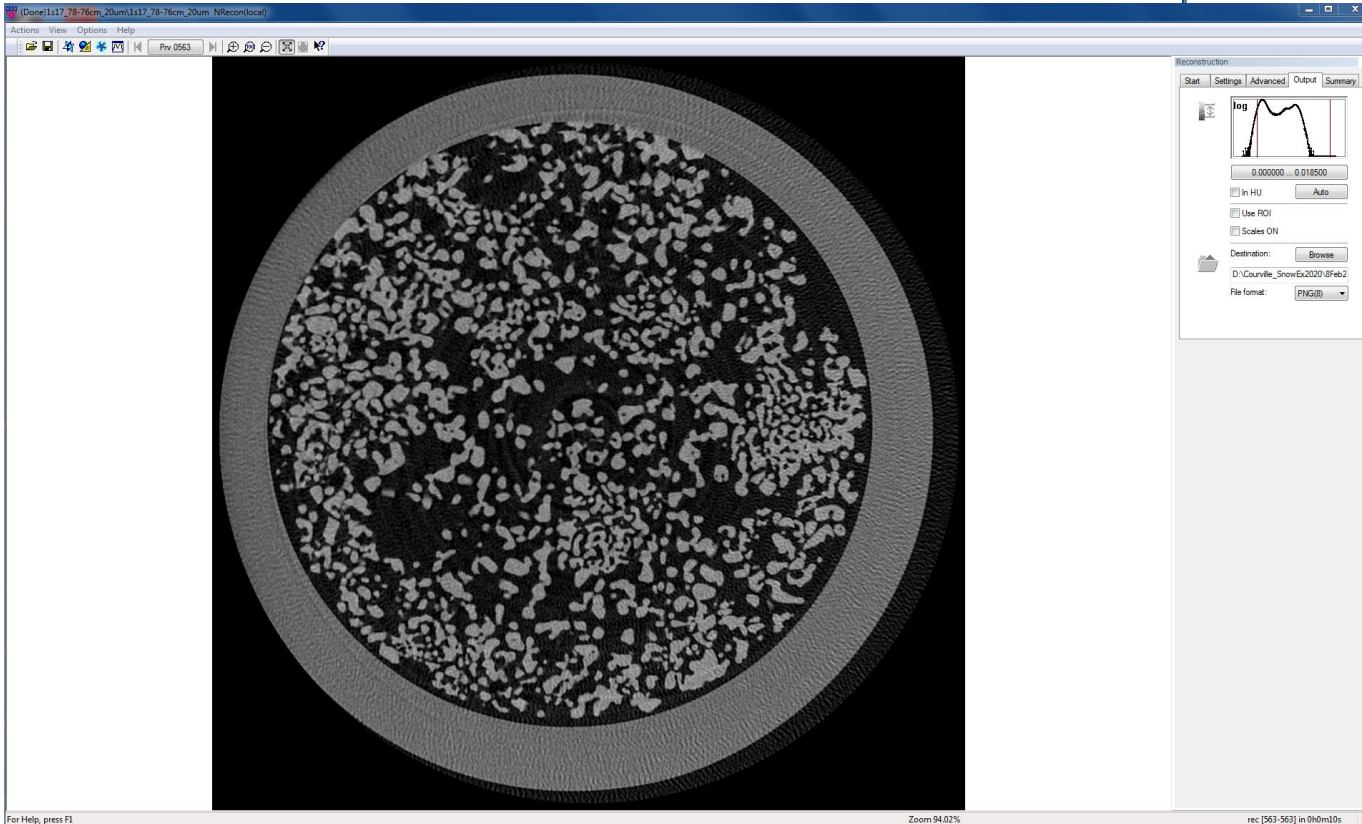
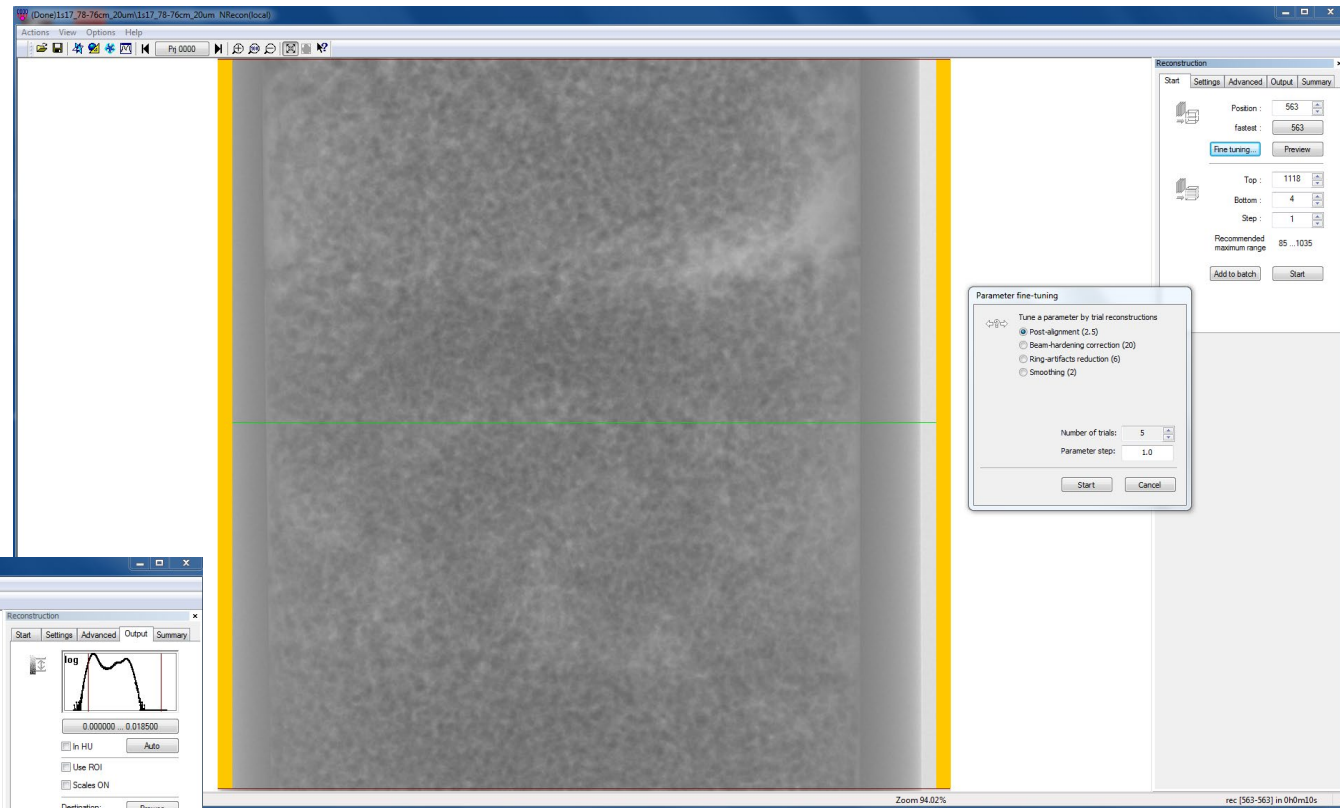
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NRecon



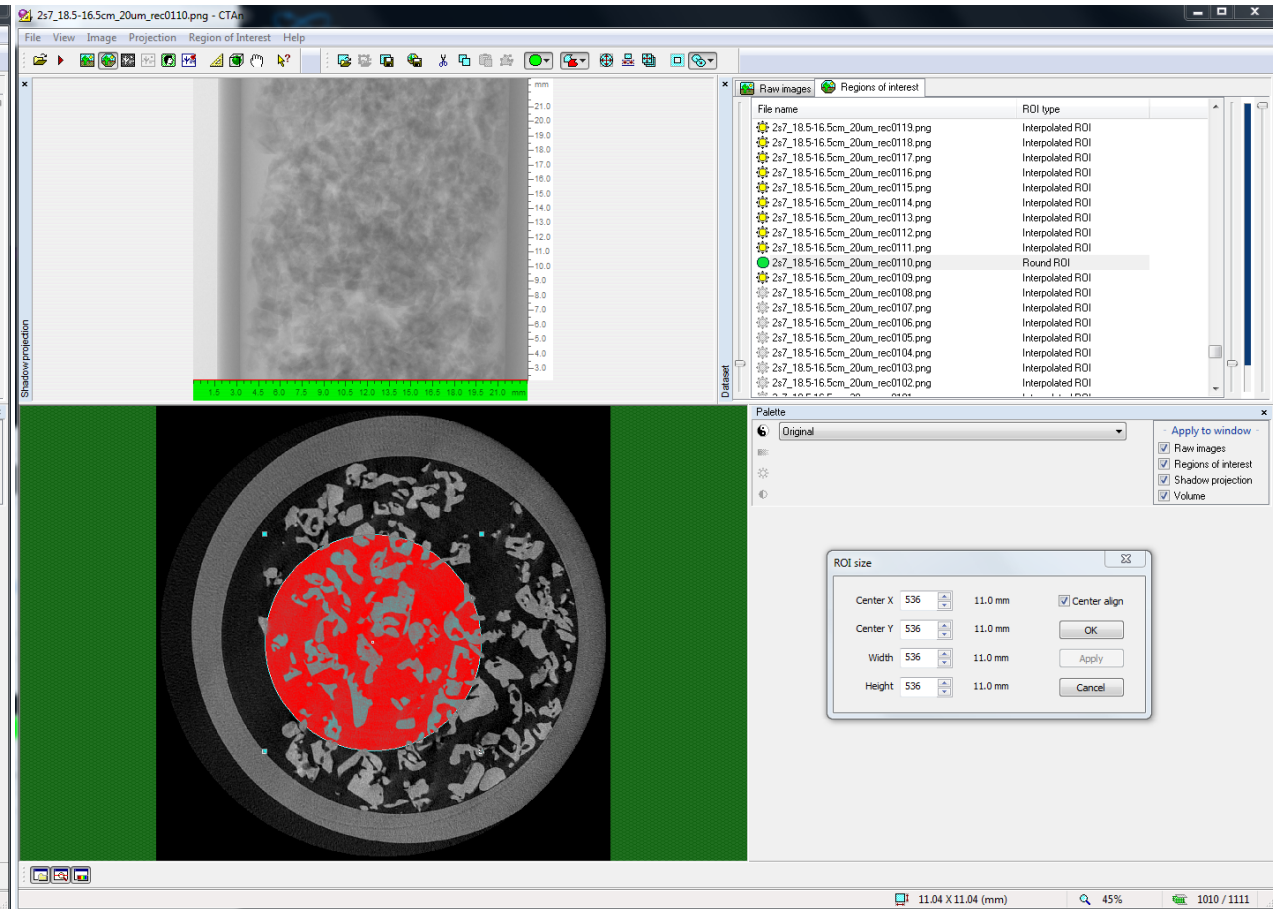
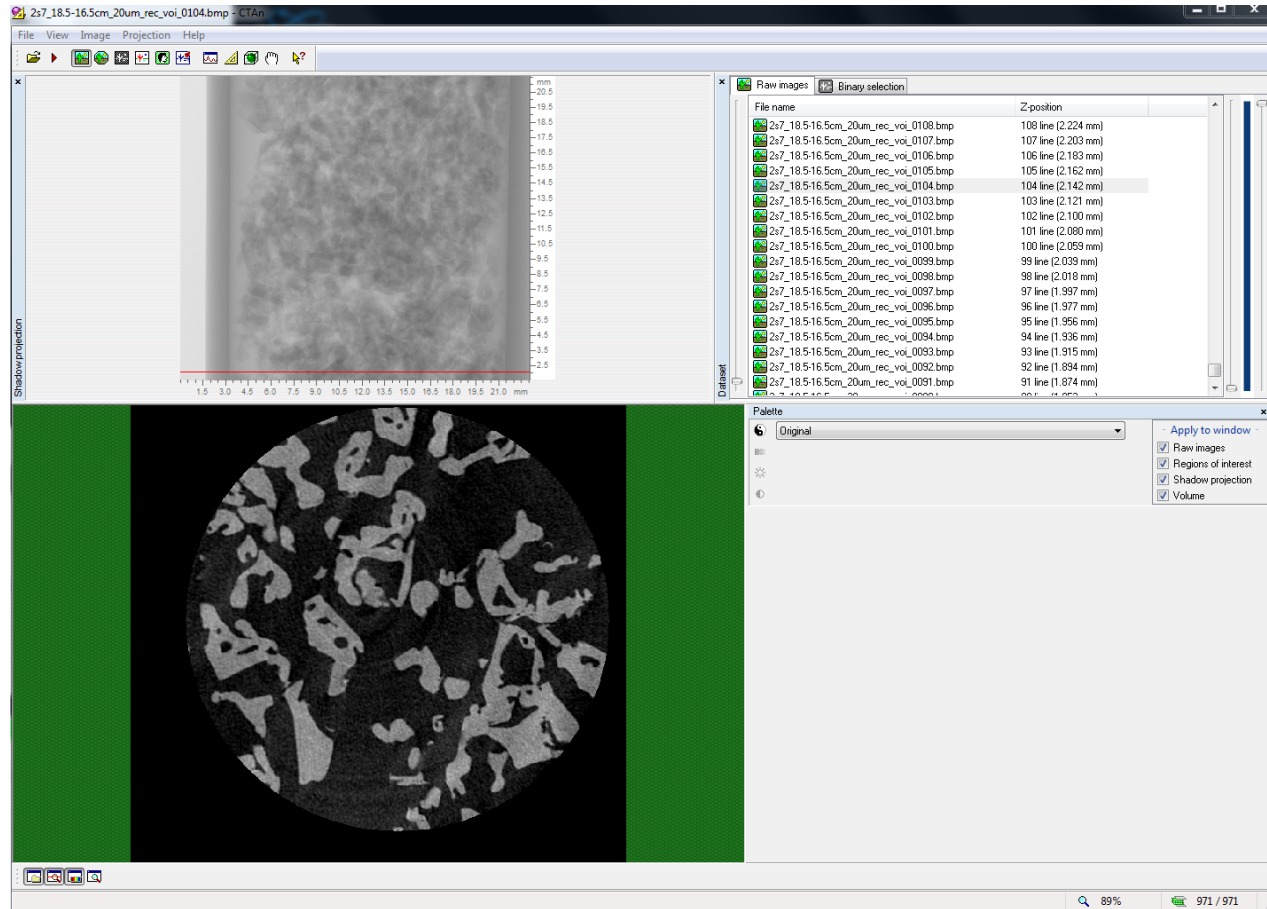
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CTAn



CTAn

The screenshot displays the CTAn software interface, which is used for quantitative analysis of micro-CT data. The interface is divided into several panels:

- Top Left:** A grayscale micro-CT image of a bone cross-section. A coordinate box indicates $x = 11.919$ and $y = 19.576$ mm.
- Top Right:** A second grayscale image, likely a different slice or a processed view of the same data.
- Bottom Left:** A circular view showing the segmented bone structure, with a green background representing the non-bone regions.
- Bottom Right:** A binary (black and white) image of the segmented bone structure.

Key components of the interface include:

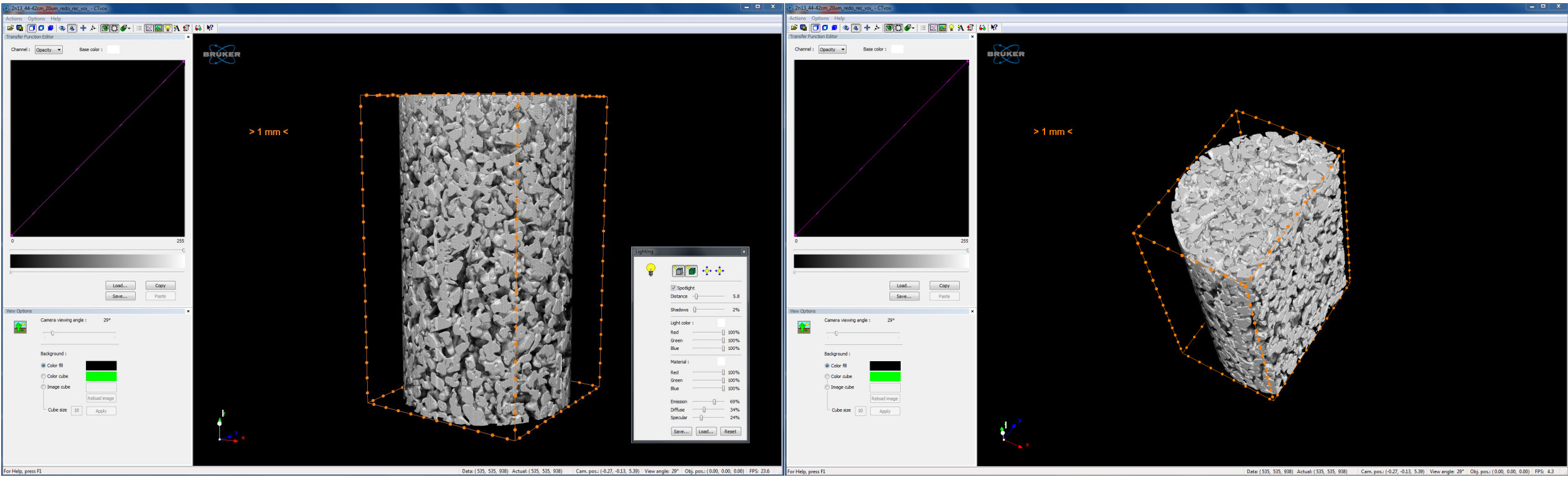
- Raw images / Regions of interest:** A list of image files and their corresponding Z-positions (in mm).
- Binay selection:** A list of binary images and their corresponding Z-positions.
- Palette:** A control panel for applying different processing settings to the images.
- Histogram:** A graph showing the distribution of grayscale values, with a vertical line indicating a threshold.
- Table:** A table summarizing the analysis results, including the percentage of bone, area, and bone mineral density.

Index (%)	Area (mm ²)	Total (%)	Selected (%)
0 0.0%	61946.88448	41.590%	-
1 0.4%	928.36005	0.623%	-
2 0.8%	1046.78942	0.703%	-
3 1.2%	1167.64946	0.784%	-
4 1.5%	1295.14738	0.870%	-
5 2.0%	1423.19396	0.955%	-
6 2.4%	1552.50576	1.042%	-

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CTVox



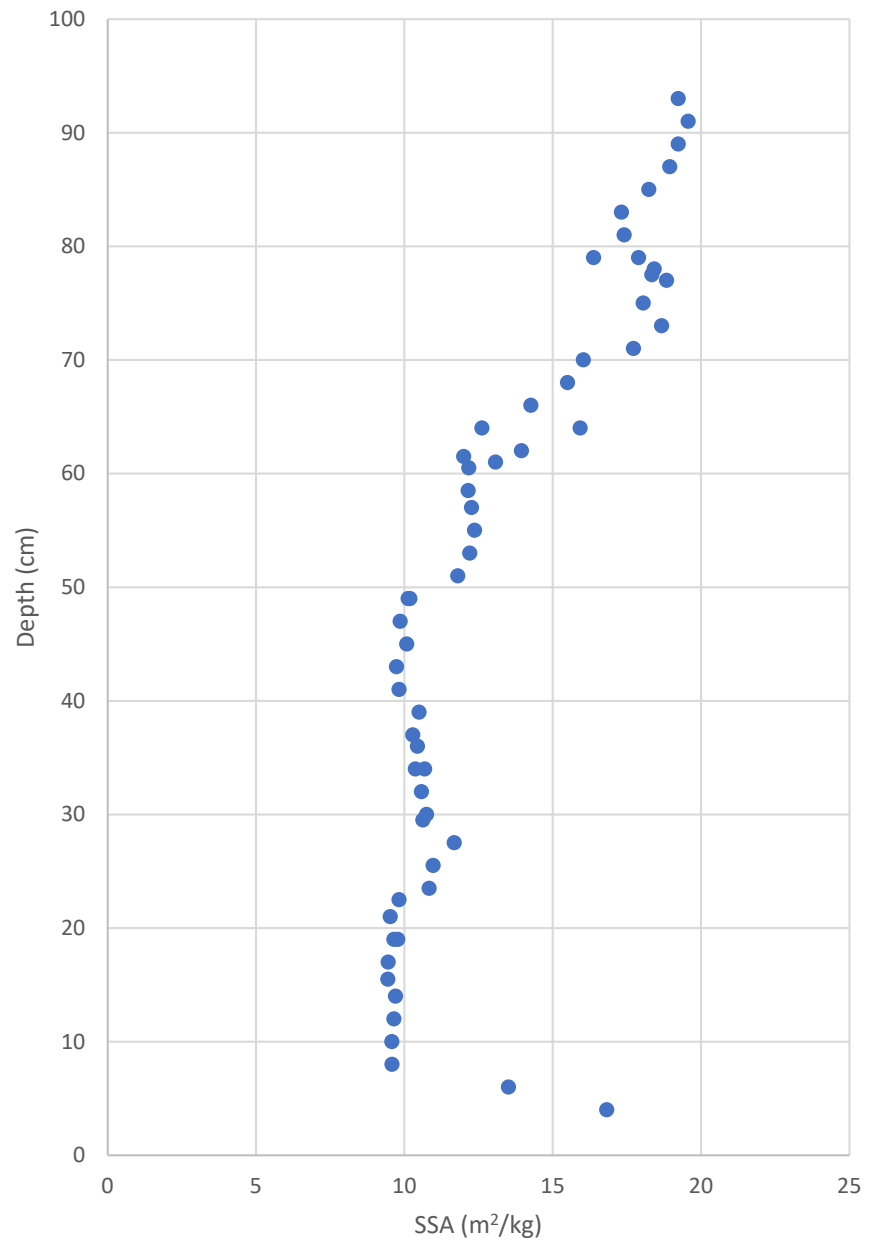
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Micro-CT statistics

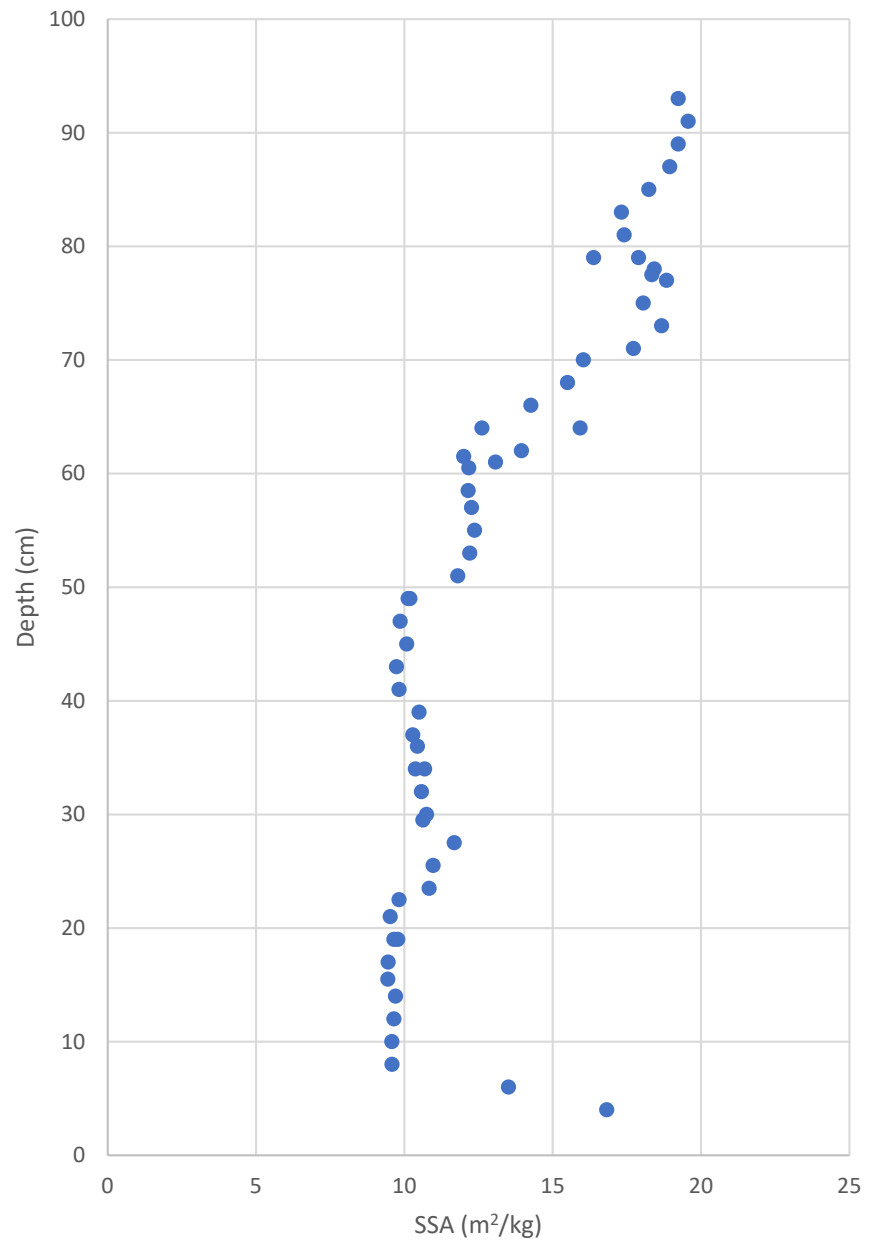
- 2D (per cross sectional slice) or 3D data (per the total volume of the sample)
 - Total porosity
 - closed porosity
 - open porosity
 - surface to volume ratio (S/V: which we can convert to SSA)
 - mean grain size per sample volume,
 - mean grain size over the height of the sample (per 2D cross section)
 - anisotropy

Pit: 1s17_8Feb2020_SSA

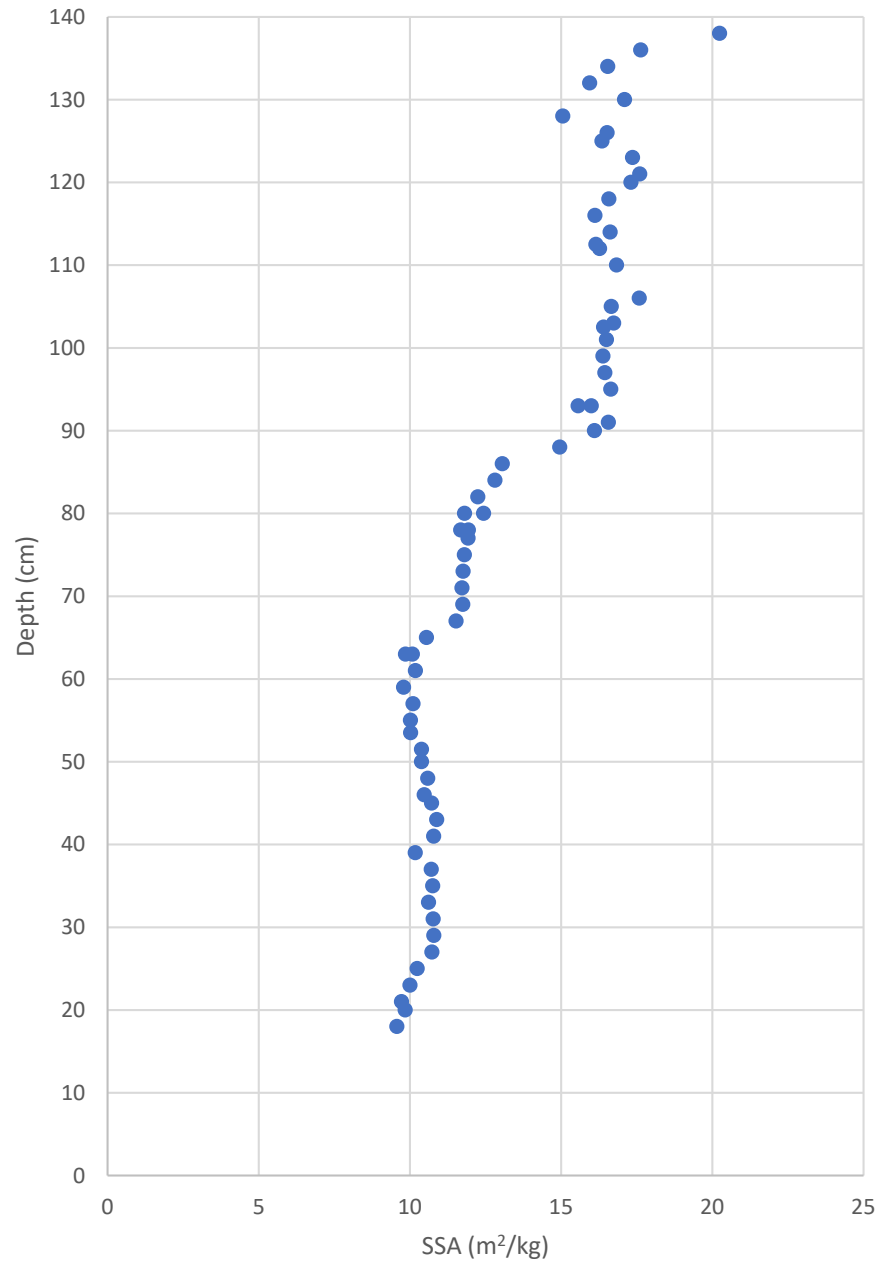


Pit: 1s17_8Feb2020_SSA

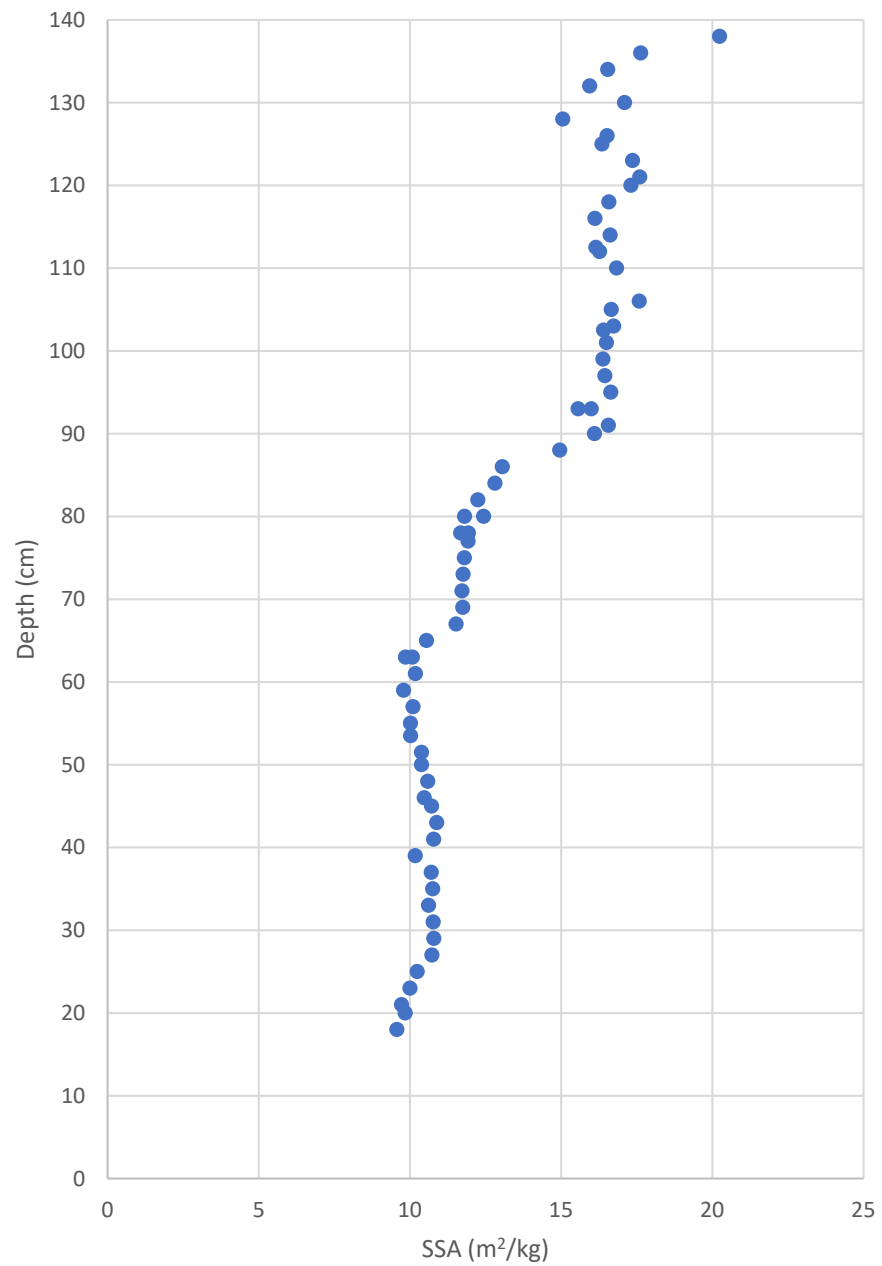
92-90cm



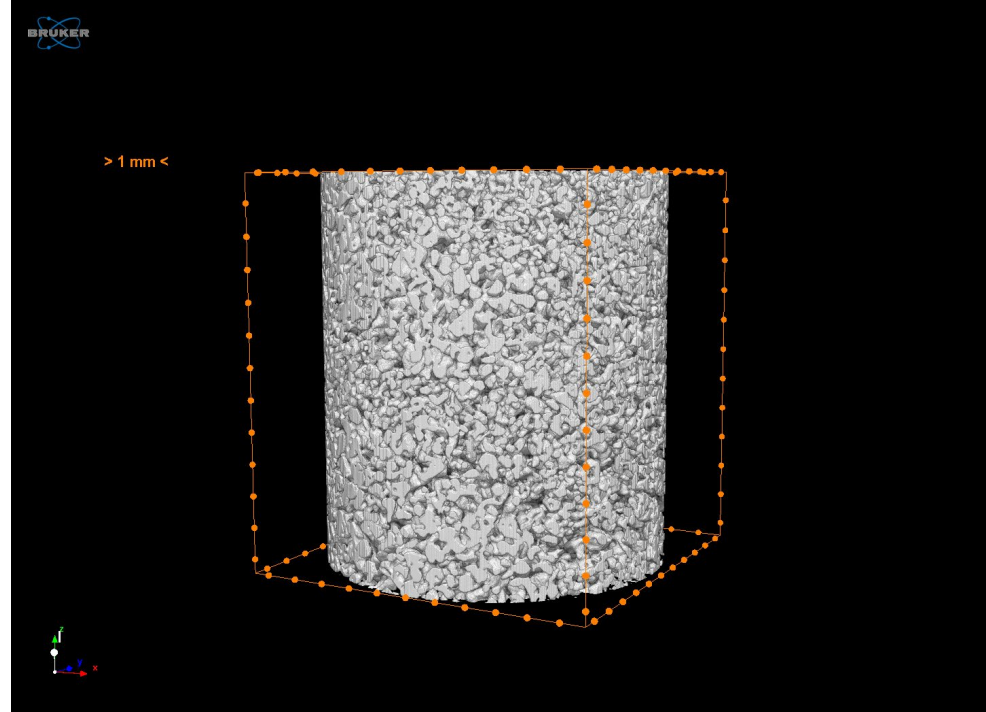
Pit: 2n13_6Feb2020_SSA



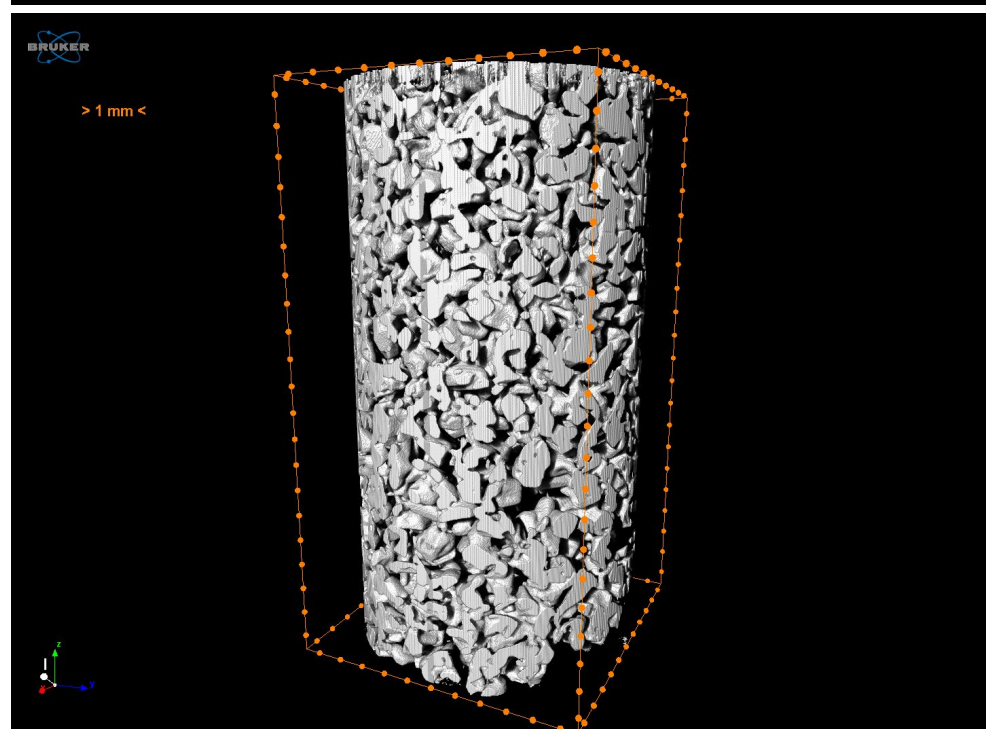
Pit: 2n13_6Feb2020_SSA



139-137cm



19-17cm



QUESTIONS

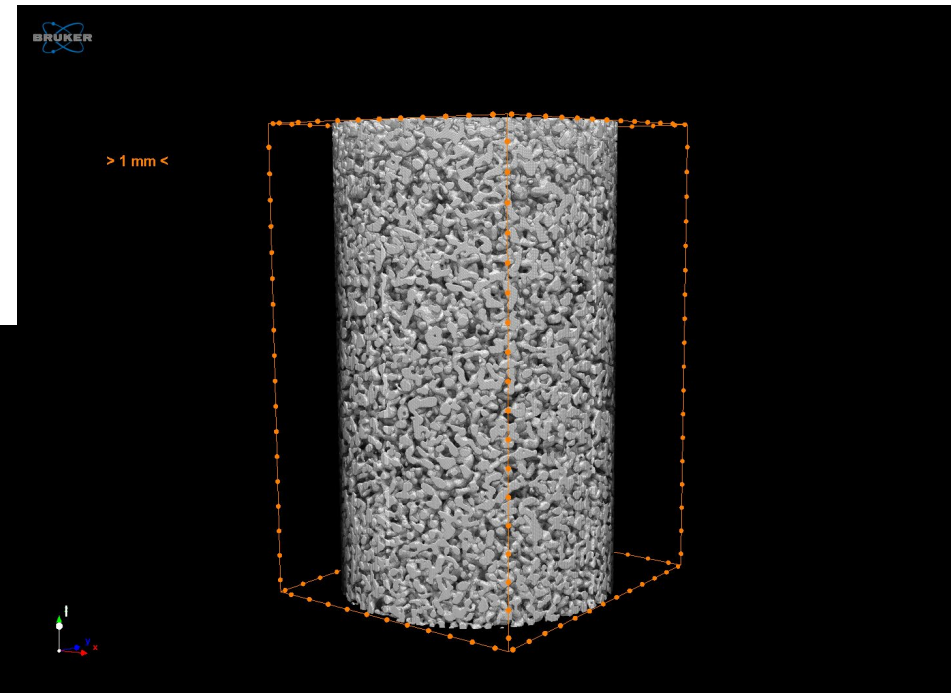
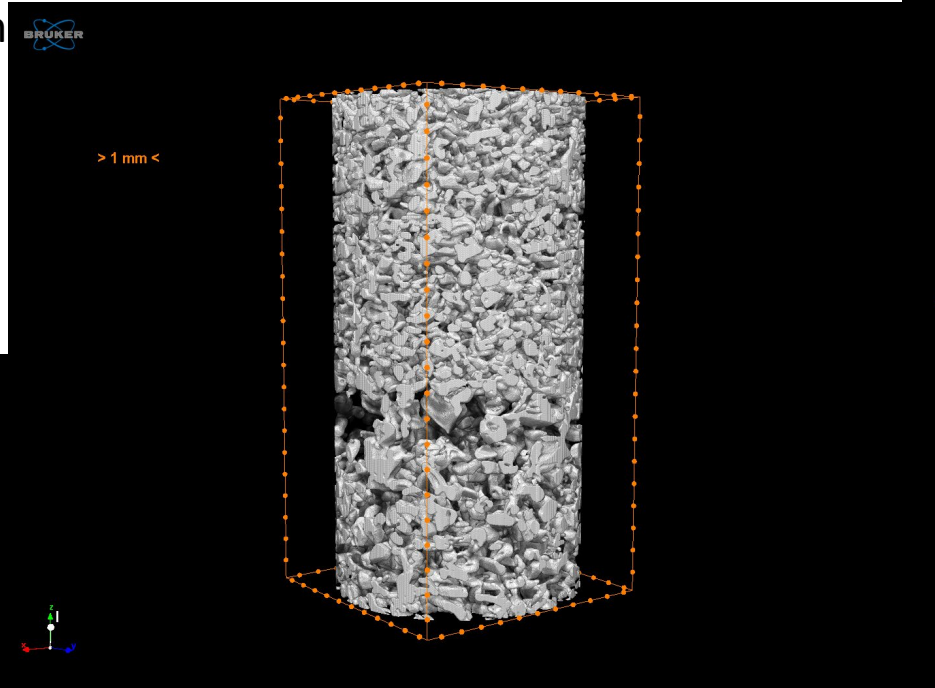
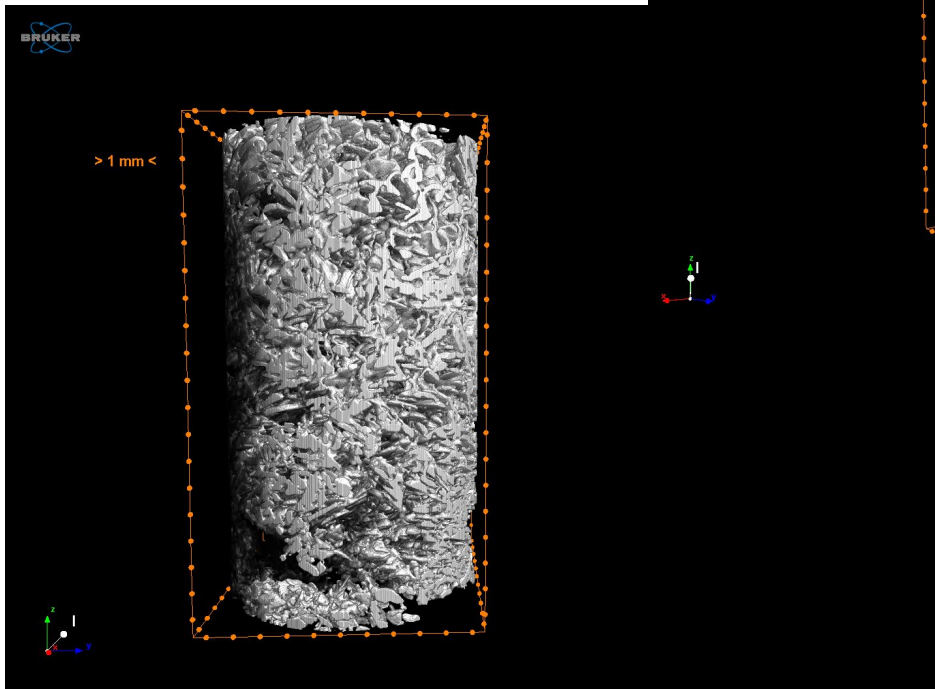


1s17

74-72cm

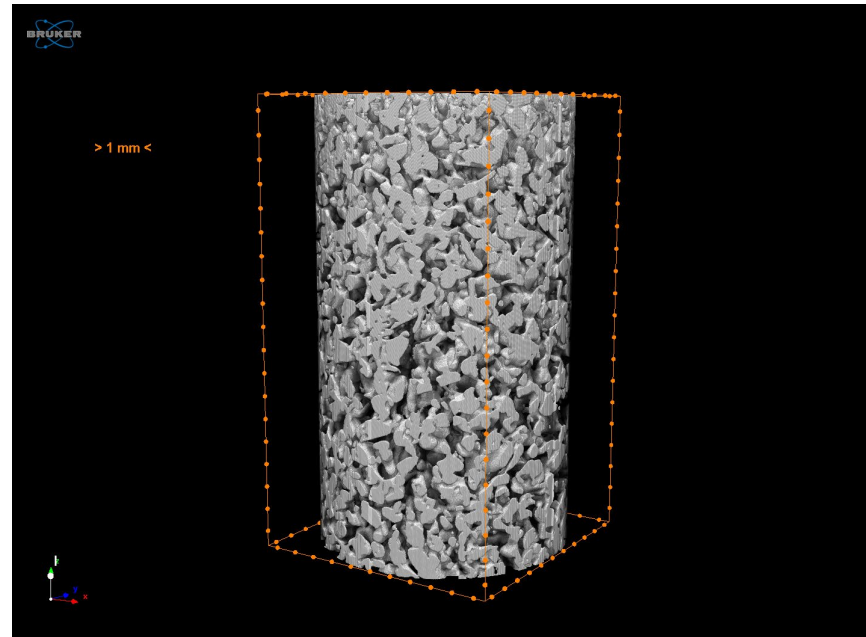
67-65cm

5-3cm

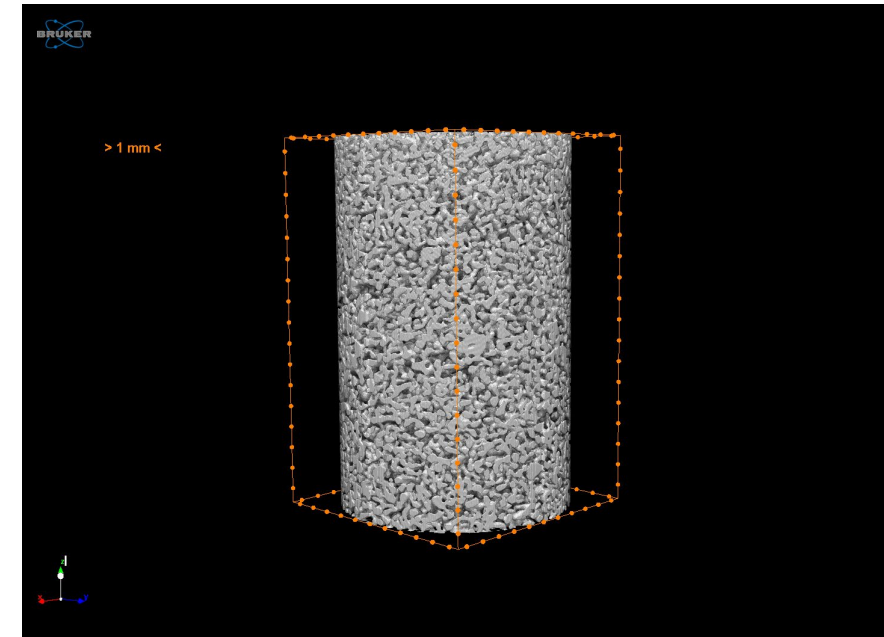


2n13

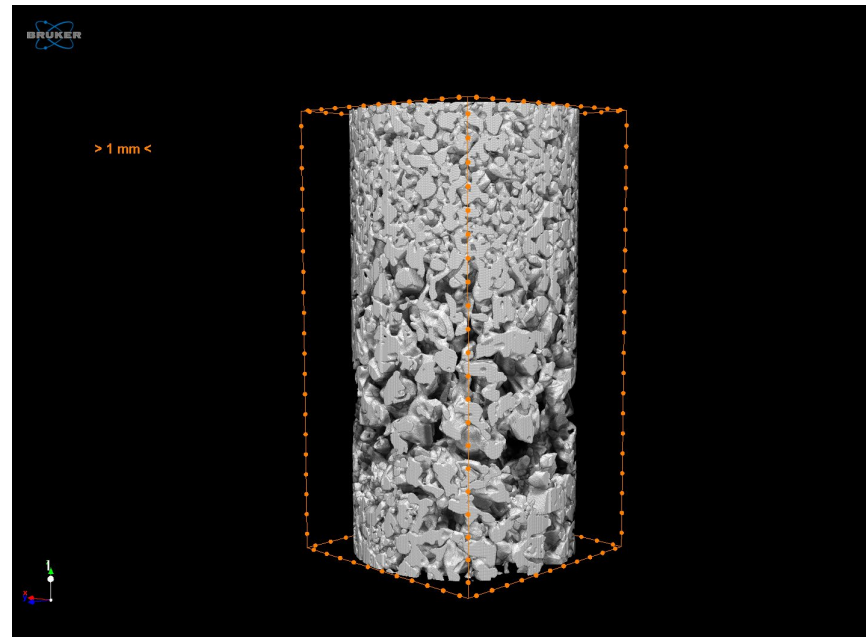
44-42cm



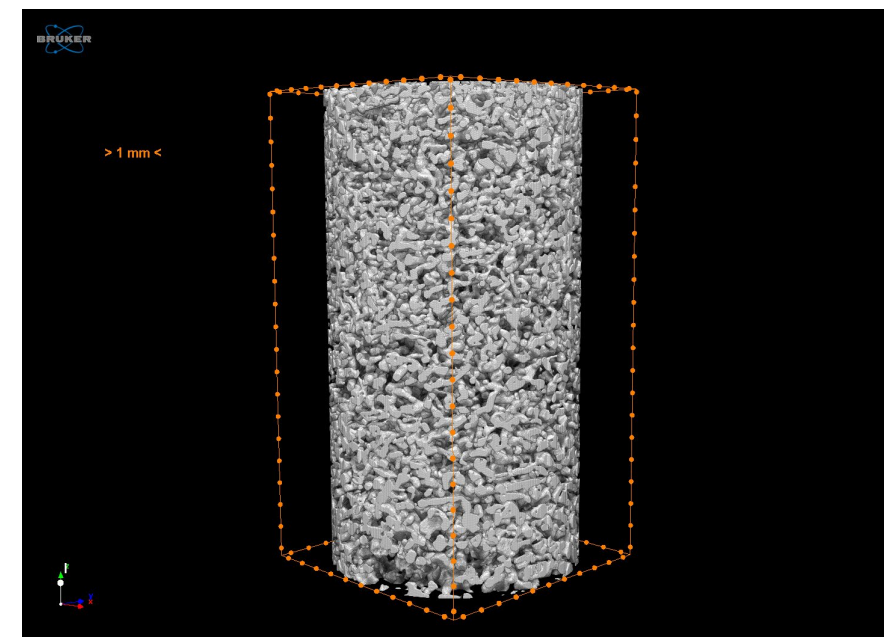
104-102cm



66-64cm



124-122cm



Date Collected	Pit Number	Sample
3.FEB.2020	"Mesa Lodge Cabin 1"	117 - 100 cm
		105 - 88 cm
		93 - 76 cm
		78 - 61 cm
		63 - 46 cm
		48 - 30 cm
		32 - 15 cm
4.FEB.2020	3s33	104 - 87 cm
		89 - 72 cm
		74 - 57 cm
		59 - 42 cm
		44 - 27 cm
		29 - 12 cm
		17 - 0 cm
	6s34	75 - 58 cm
		60 - 43 cm
		45 - 28 cm
		30 - 13 cm
		17 - 0 cm

Date Collected	Pit Number	Sample
5.FEB.2020	8c18	100 - 83 cm
		85 - 68 cm
		70 - 53 cm
		55 - 38 cm
		40 - 23 cm
		25 - 08 cm
		9c16
		95 - 78 cm
		80 - 63 cm
		65 - 48 cm
	50 - 33 cm	
	35 - 18 cm	
	20 - 3cm	
	Pit: 8c11	90 - 73 cm
		75 - 58 cm
		60 - 43 cm
		45 - 38 cm
		40 - 23 cm

Date Collected	Pit Number	Sample	
6.FEB.2020	2n13	139 - 122 cm	
		124 - 107 cm	
		109 - 92 cm	
		94 - 77 cm	
		79 - 62 cm	
		64 - 47 cm	
		49 - 32 cm	
		34 - 17 cm	
		5n15	113 - 96 cm
			98 - 81 cm
		83 - 66 cm	
		68 - 51 cm	
		53 - 36 cm	
8.FEB.2020	1s2	85 - 68 cm	
		70 - 53 cm	
		55 - 38 cm	
		40 - 23 cm	
		25 - 08 cm	
		17 - 0 cm	
		2s7	80 - 63 cm
		65 - 48 cm	
		50 - 33 cm	
		35 - 13 cm	
		20 - 03 cm	
		2s16	94 - 77 cm
			79 - 62 cm
			64 - 47 cm
			49 - 32 cm
			34 - 17 cm
			19 - 02 cm
	1s17	95 - 78 cm	
		80 - 63 cm	
		65 - 48 cm	
		50 - 33 cm	
		35 - 18 cm	
		20 - 03 cm	

Date Collected	Pit Number	Sample	Casted/snow
3.FEB.2020	"Mesa Lodge Cabin 1"	117 -100 cm	casted
		105 - 88 cm	casted
		93 - 76 cm	casted
		78 - 61 cm	casted
		63 - 46 cm	casted
		48 - 30 cm	casted
		32 - 15 cm	casted
4.FEB.2020	3s33	104 - 87 cm	casted
		89 - 72 cm	casted
		74 - 57 cm	casted
		59 - 42 cm	casted
		44 - 27 cm	casted
		29 - 12 cm	casted
	17 - 0 cm	casted	
	6s34	75 - 58 cm	casted
		60 - 43 cm	casted
		45 - 28 cm	casted
30 - 13 cm		casted	
		17 - 0 cm	casted

Date Collected	Pit Number	Sample	Casted/snow
5.FEB.2020	8c18	100 - 83 cm	casted
		85 - 68 cm	casted
		70 - 53 cm	casted
		55 - 38 cm	casted
		40 - 23 cm	casted
		25 - 08 cm	casted
	9c16	110 - 93 cm	snow
		95 - 78 cm	snow
		80 - 63 cm	snow
		65 - 48 cm	snow
		50 - 33 cm	snow
		35 - 18 cm	snow
	Pit: 8c11	20 - 3cm	snow
		90 - 73 cm	casted
		75 - 58 cm	casted
		60 - 43 cm	casted
		45 - 38 cm	snow?
		40 -23 cm	snow?

Date Collected	Pit Number	Sample	Casted/snow	
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		124 - 107 cm	snow	
		109 - 92 cm	snow	
		94 - 77 cm	snow	
		79 - 62 cm	snow	
		64 - 47 cm	snow	
		49 - 32 cm	snow	
		34 - 17 cm	snow	
		5n15	113 - 96 cm	casted
			98 - 81 cm	casted
83 - 66 cm	casted			
68- 51 cm	casted			
53 -36 cm	casted			
8.FEB.2020	1s2	85 - 68 cm	snow	
		70 - 53 cm	snow	
		55 - 38 cm	snow	
		40 - 23 cm	snow	
		25 - 08 cm	snow	
		17 - 0 cm	snow	
	2s7	80 - 63 cm	snow	
		65 - 48 cm	snow	
		50 - 33 cm	snow	
		35 - 13 cm	snow	
		20 - 03 cm	snow	
	2s16	94 - 77 cm	snow	
		79 - 62 cm	snow	
		64 - 47 cm	snow	
		49 - 32 cm	snow	
		34 - 17 cm	snow	
		19 - 02 cm	snow	
1s17	95 - 78 cm	snow		
	80 - 63 cm	snow		
	65 - 48 cm	snow		
	50 - 33 cm	snow		
	35 - 18 cm	snow		
		20 - 03 cm	snow	