wood.

Sand Particle Size Analysis by SedImaging in a Field Lab

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+Wood E&IS

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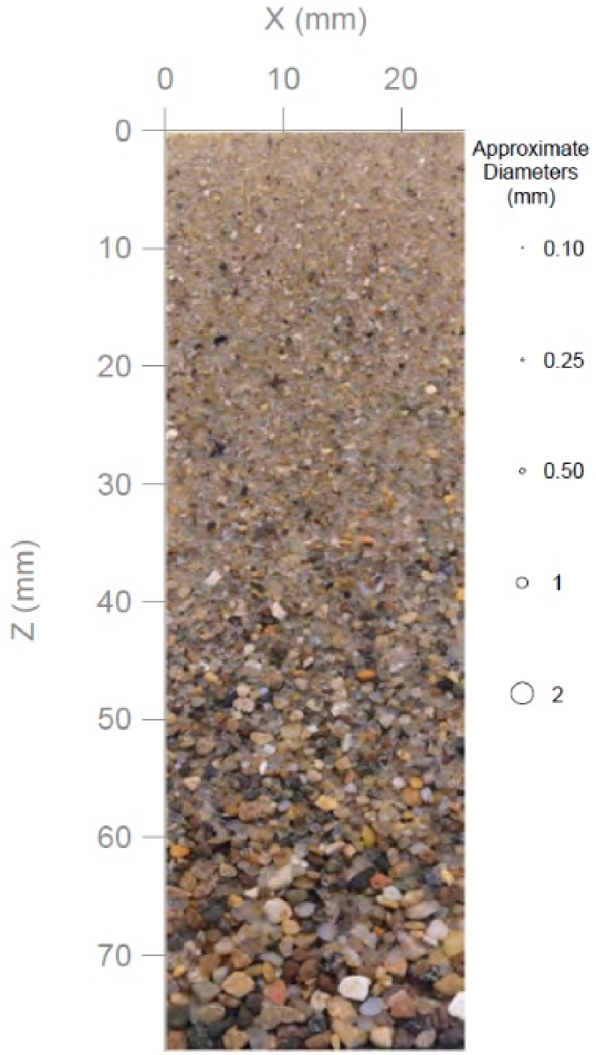

Coarse silt and fine sands

Medium-coarse sands

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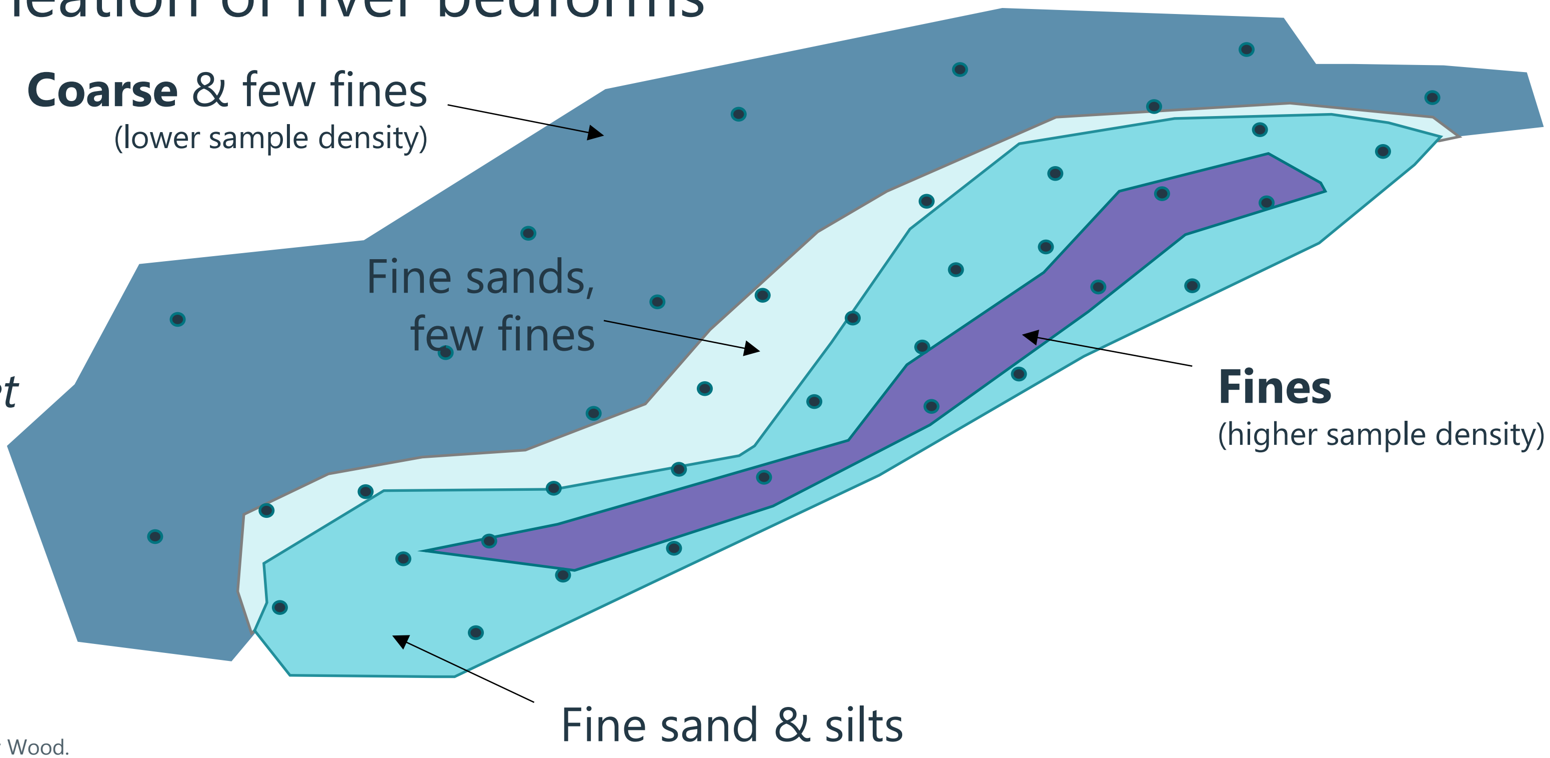
Objectives for our Project

- Pilot a field lab method to generate *high-resolution* Particle Size Distributions (PSDs) on grab samples without a sieve set or oven
- Detect *subtle* variations in the fine sand and fines compositions
- Support delineation of river bedforms

Example only

Conceptual area and no set scale



Other Applications for FieldSed

- High-resolution, detailed PSDs – compared to sieve-based PSDs
- Image sets can also be analyzed for color, roundness, angularity, porosity
- Field lab and same-day analysis opportunities
    - Reliable QA/QC on sand materials
        - Post-dredge cover or bank restoration media
        - Filter media for caps
        - Beach media
    - Discrimination of natural particles vs. anthropogenic debris (plastics, coke/char, etc.)
    - Support for projects that might characterize sands separately from fines

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Methods

- SedImaging and FieldSed were developed at the University of Michigan
  - Prof. Roman Hryciw
  - Continually being refined
- FieldSed = SedImaging in a field lab
- Three steps
  - Pre-processing
  - Imagery
  - PSD generation

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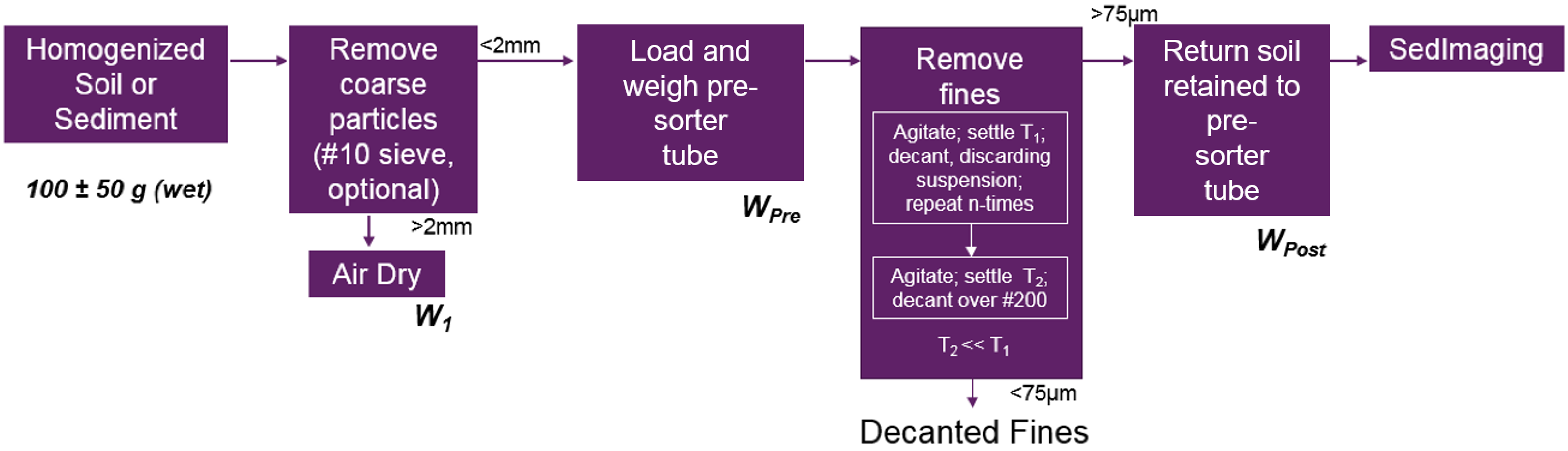
Step 1: Pre-Processing



Measurements applied for all tests:

- Specific gravity, G_S
- Container weights
- Weight pre-sorter tube with water

W_{EW}

Dry weights (calculated):

- Mass soil passing #10: $$W_{2+3} = \frac{G_S * (W_{Pre} - W_{EW})}{G_S - 1}$$
- Mass decanted fines: $$W_3 = W_{2+3} - \frac{G_S * (W_{Post} - W_{EW})}{G_S - 1}$$

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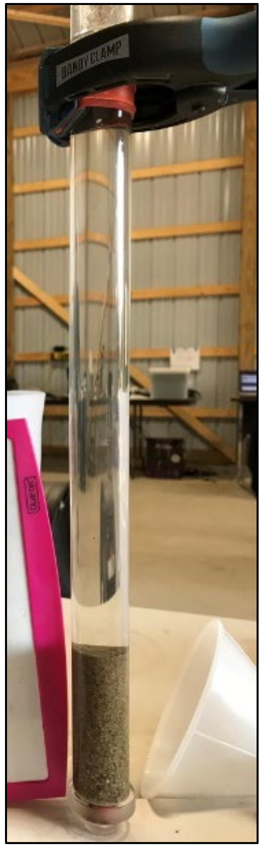
Step 1: Pre-Processing

- Sample in pre-sorter tube before (left) and after (right) decanting fines

Before



After

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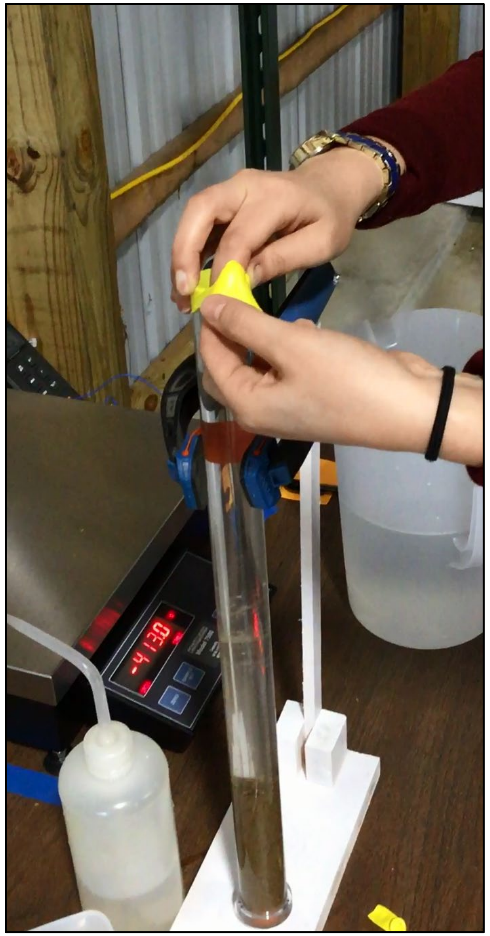
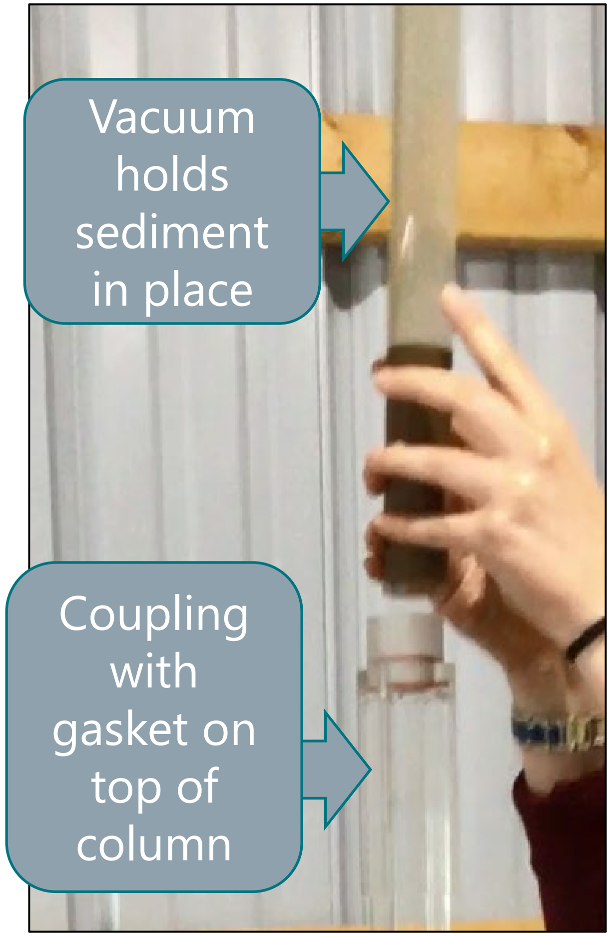
Step 2: Imagery

- Loading the sedimentation column





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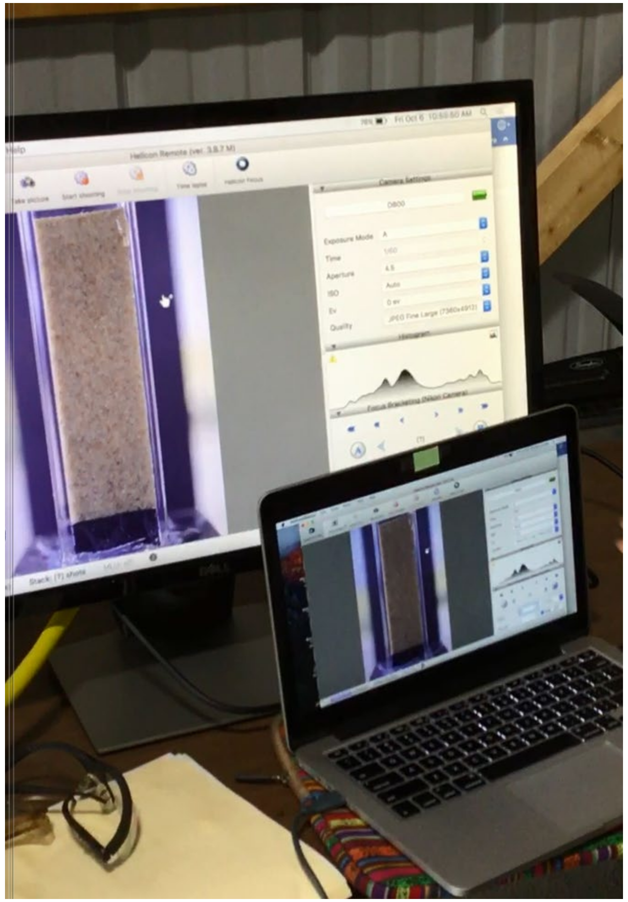
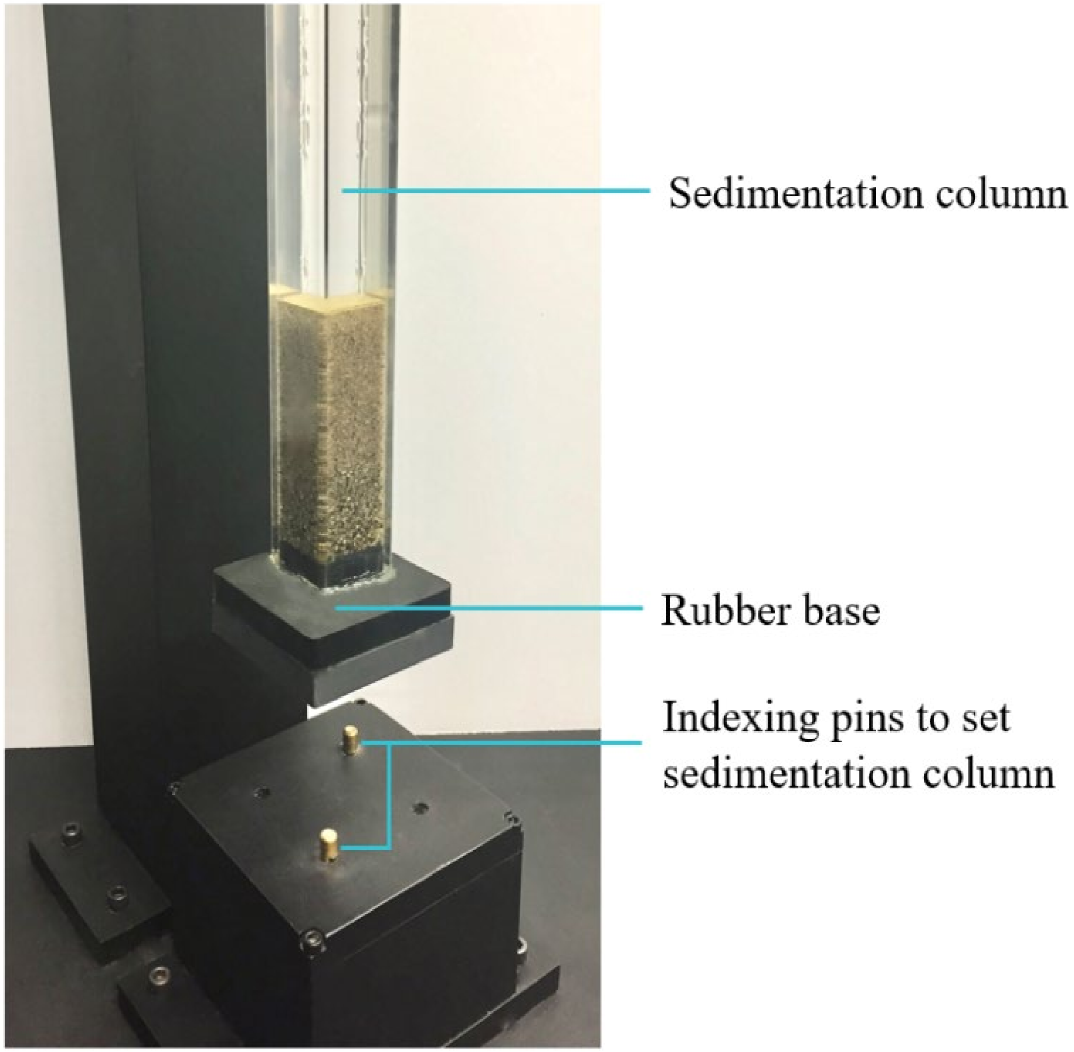
Step 2: Imagery

- After settling, the column is moved to the imaging station
- Software used to
  - Set focus
  - Take multiple images
  - Focus stacking





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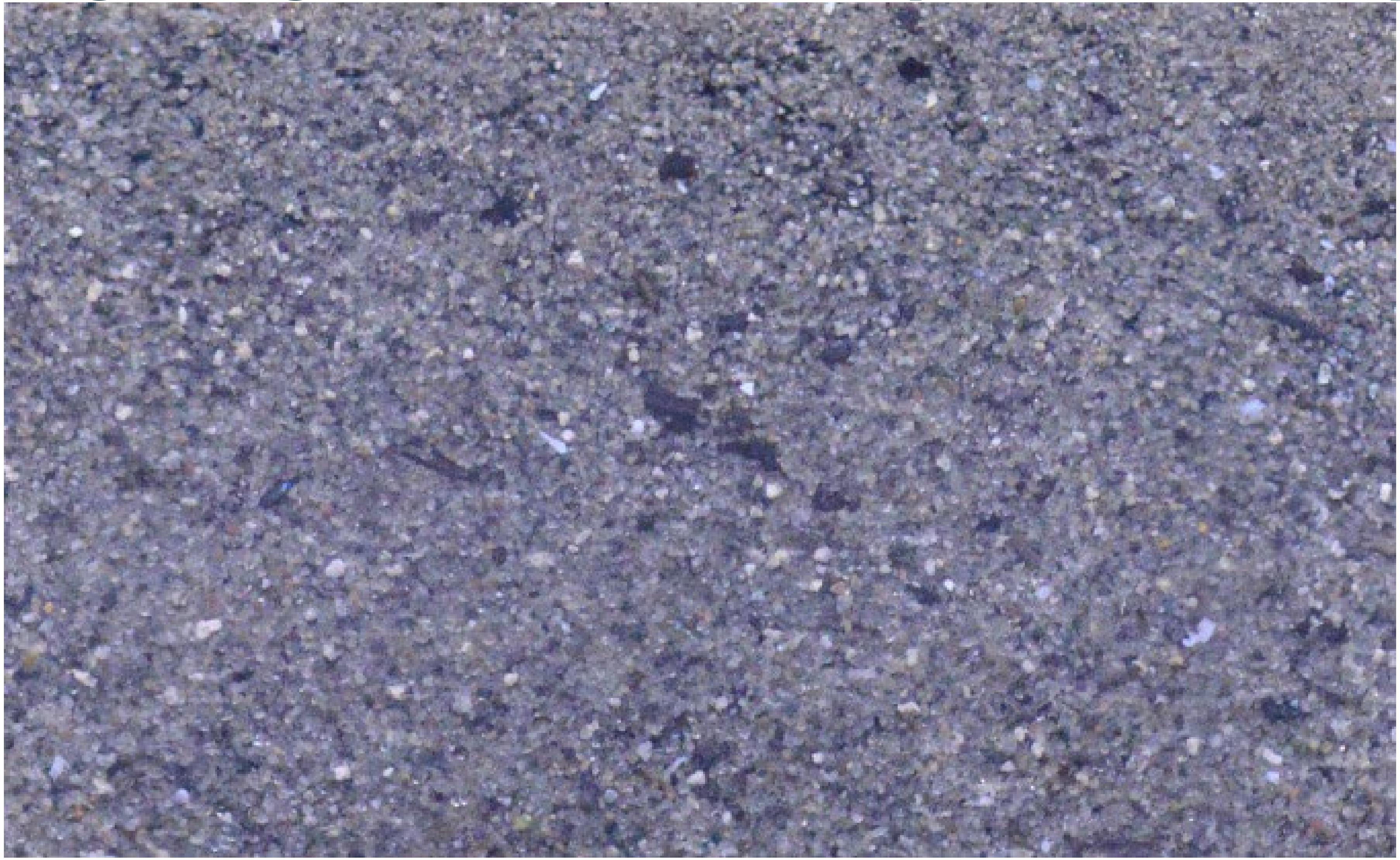
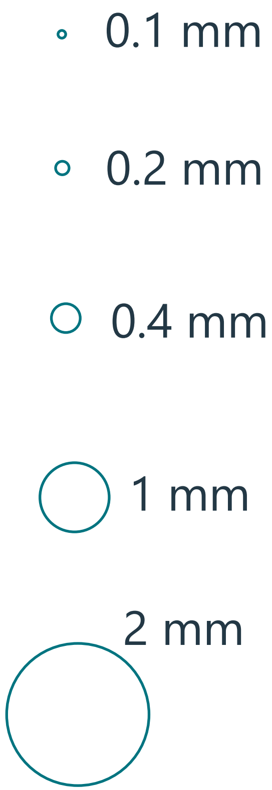
Resulting image of a fine sand (part 1 of 6, top)





Resulting image (2 of 6)

0.1 mm

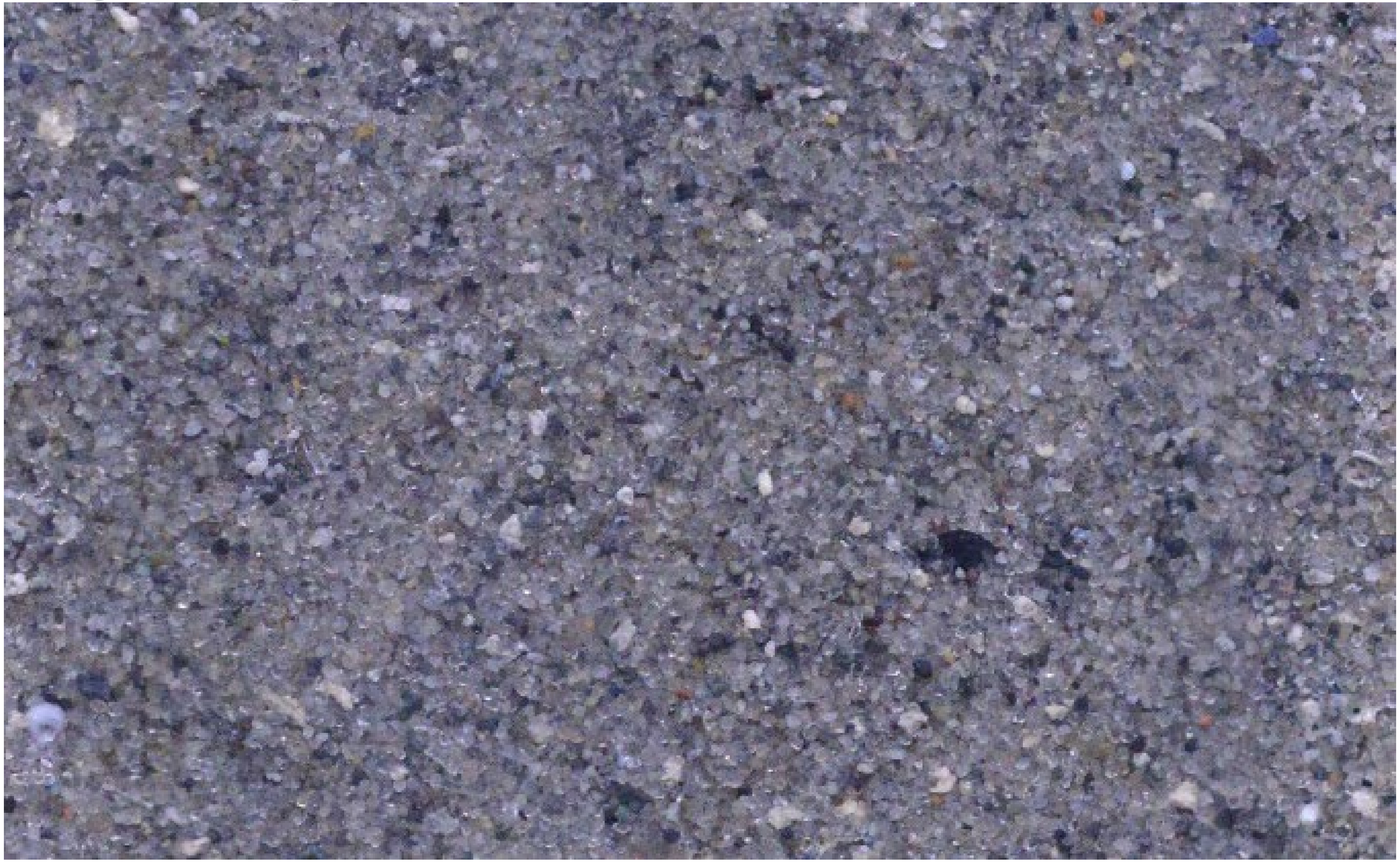
0.2 mm

0.4 mm

1 mm

2 mm

Resulting image (3 of 6)



0.1 mm

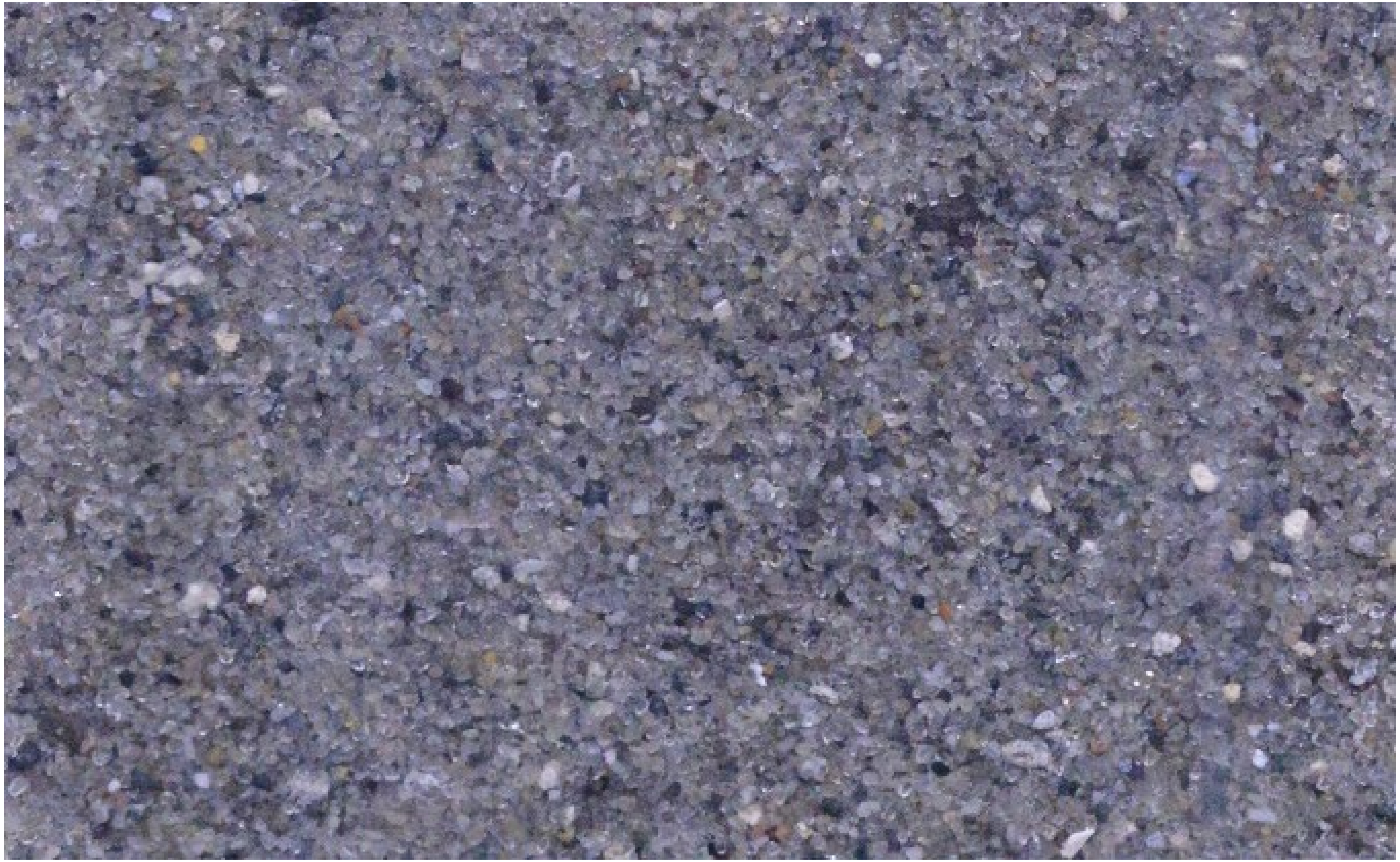
0.2 mm

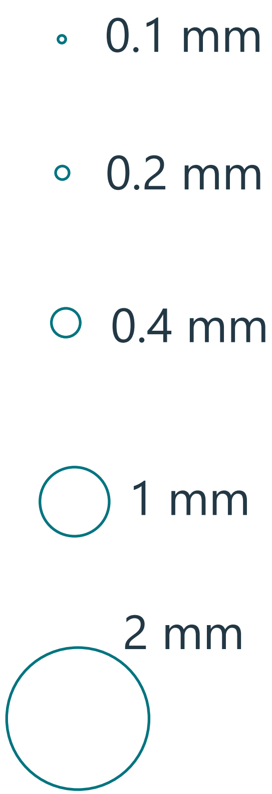
0.4 mm

1 mm

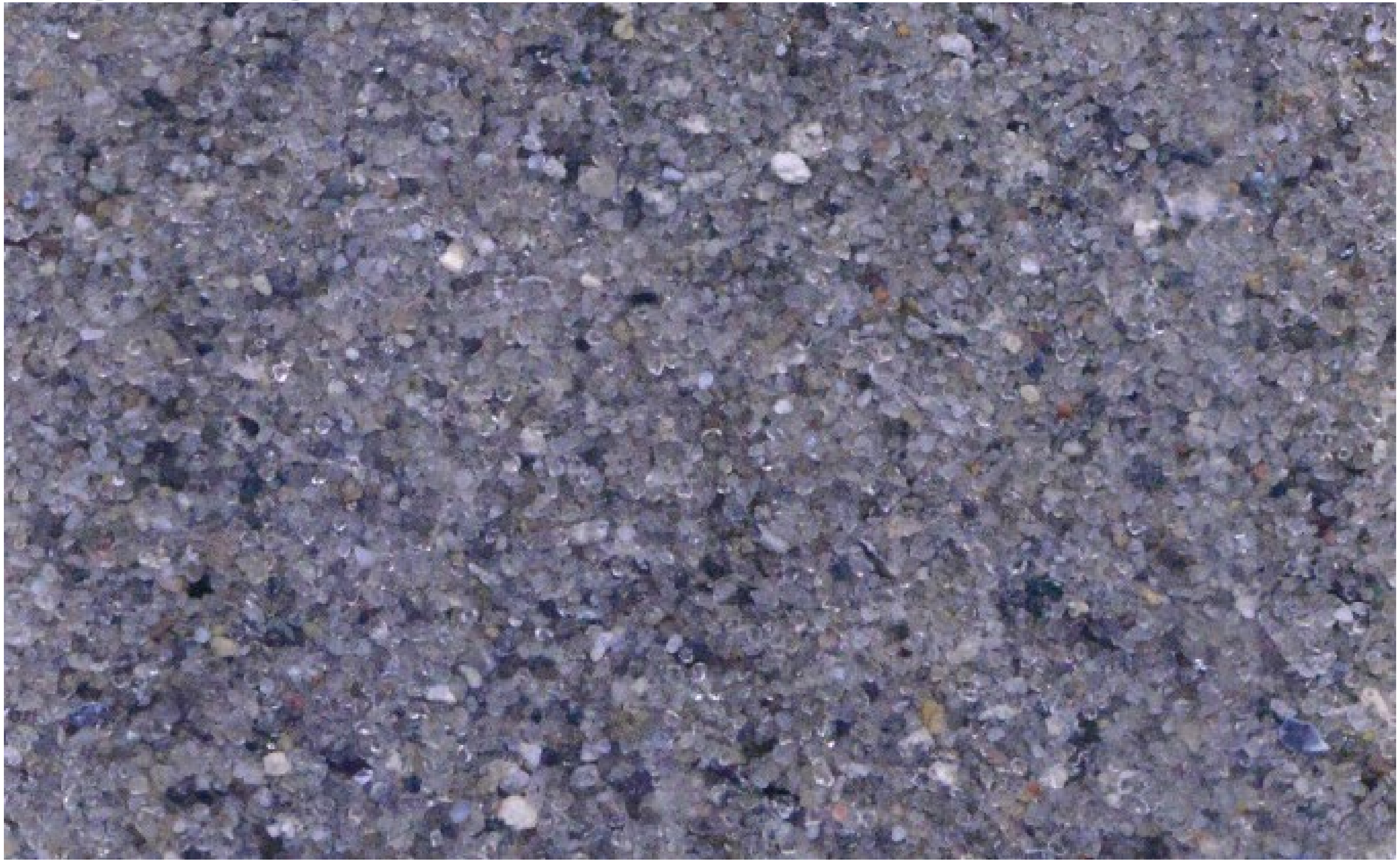
2 mm

Resulting image (4 of 6)





Resulting image (5 of 6)



0.1 mm

0.2 mm

0.4 mm

1 mm

2 mm

Resulting image (6 of 6, bottom)

0.1 mm

0.2 mm

0.4 mm

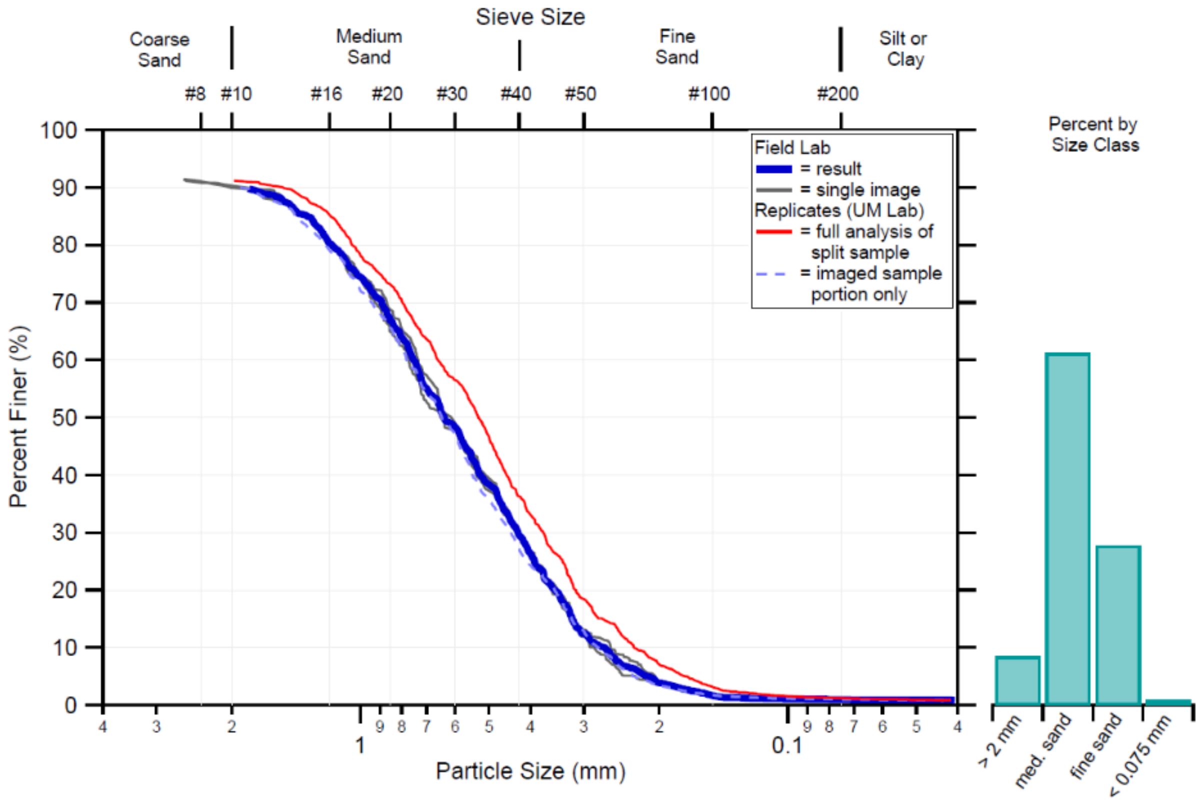
1 mm

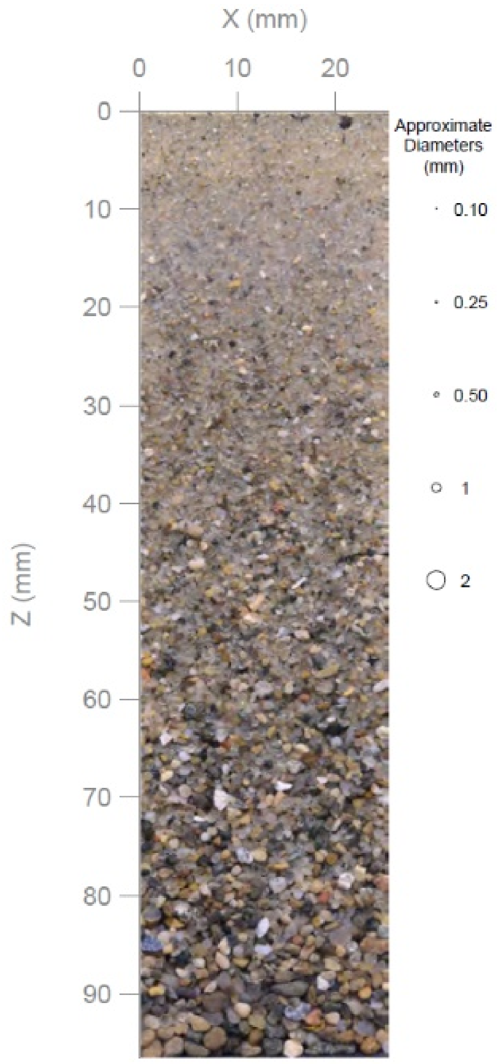
2 mm

Step 3: PSD Generation

- Algorithm to obtain unadjusted PSD for each photographed side of the column
- PSD “snapped” to oversized (> 2 mm) and undersized (< 0.075 mm) grains
- Each adjusted PSD (one for each photographed side of the column) was then averaged into one composite PSD

Result Examples and Replicate Analysis





Effective Diameters (mm)		Coefficients	Summary of Particle Size Distribution		
D_{10}: 0.27	D_{50}: 0.64	C_u: 2.8	< 2 mm	= 90.2%	medium sand or finer
D_{20}: 0.35	D_{60}: 0.75	C_c: 0.9	< 0.420 mm	= 29.2%	fine sand or finer
D_{30}: 0.43	D_{80}: 1.16		< 0.075 mm	= 0.9%	fines, total
				= 0.1%	fines, as imaged
				= 0.9%	fines, decanted

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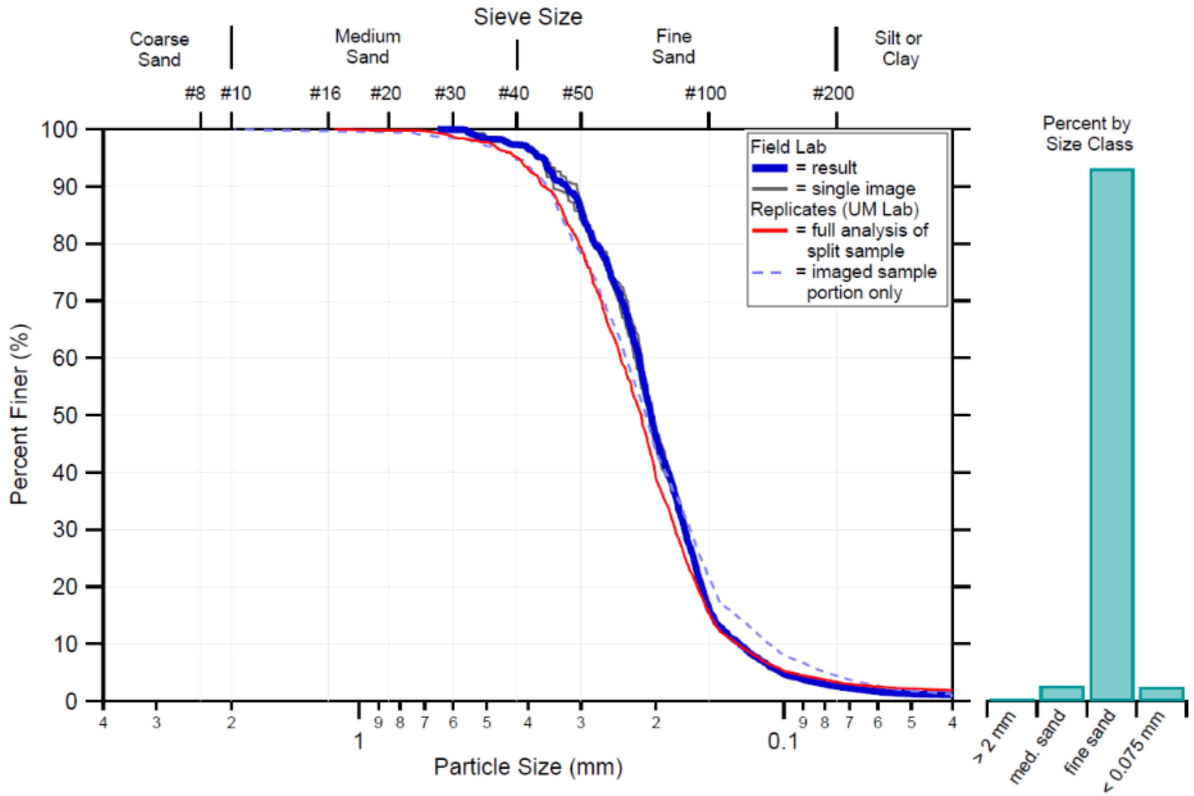
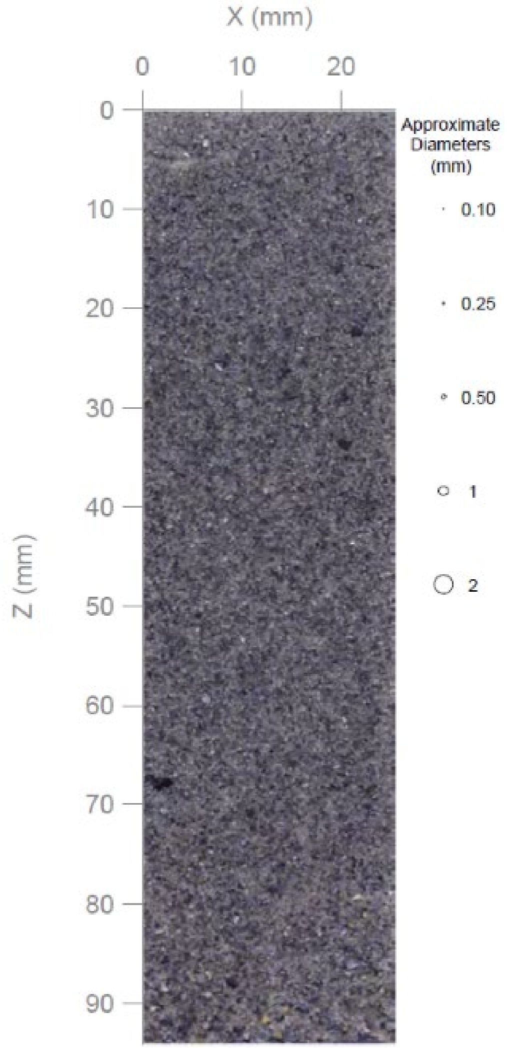
Result Examples and Replicate Analysis





Effective Diameters (mm)		Coefficients	Summary of Particle Size Distribution		
D_{10}: 0.13	D_{50}: 0.21	C_u: 1.7	< 2 mm	= 100.0%	medium sand or finer
D_{20}: 0.16	D_{60}: 0.22	C_c: 1.1	< 0.420 mm	= 97.3%	fine sand or finer
D_{30}: 0.17	D_{80}: 0.28		< 0.075 mm	= 2.6%	fines, total
				= 1.5%	fines, as imaged
				= 1.1%	fines, decanted

Benefits of FieldSed

- Quantitative field measurement
- High-resolution
- Reduces uncertainty of classifications based solely on visual inspection
- Time and money savings
  - No offsite shipping
  - No oven drying
  - Not a full sieve set
  - Multiple sedimentation columns in parallel
  - Potential for same-day results
- Several applications (e.g., particle forensics, field-based QA/QC)

Questions?