

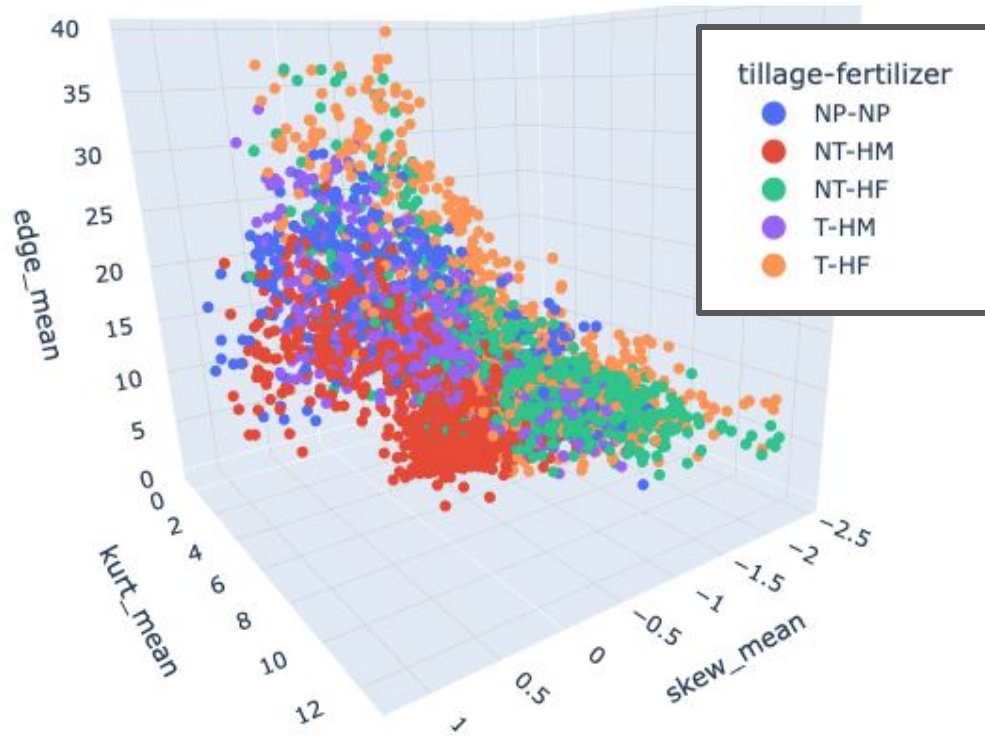
Heterogeneity Metrics 2

Sweeping all tiff stacks
5/27/23

Overview:

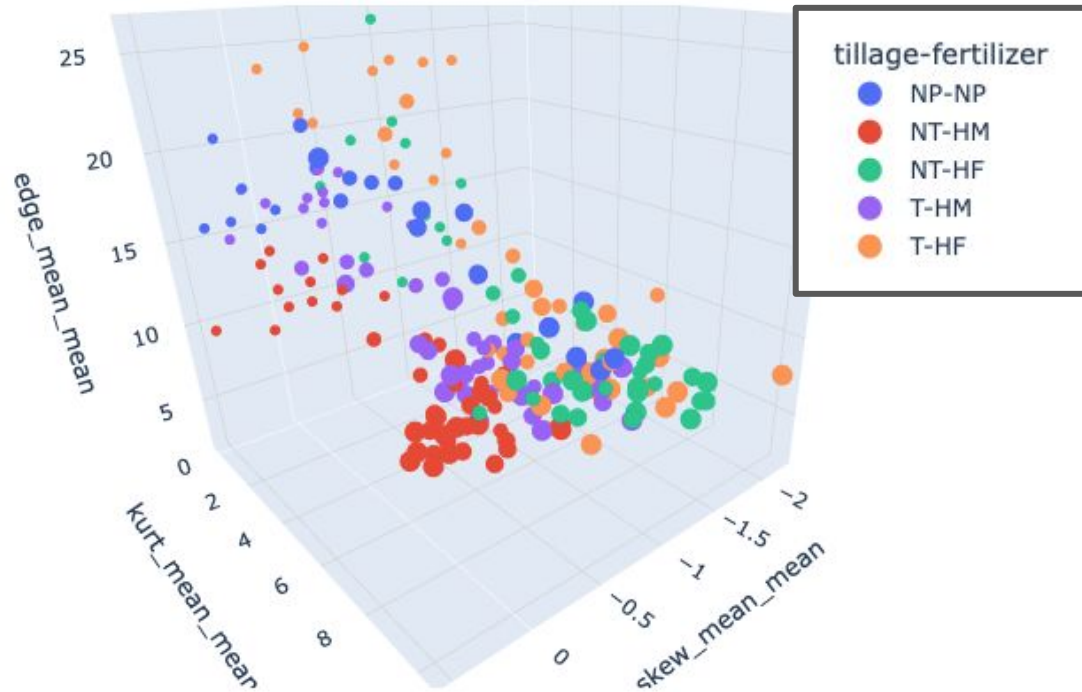
- All 54 soil samples calculated (every 50 tiff images)
- Focusing on the following metrics:
 - **Mean Sliding Window Skew**
 - **Mean Sliding Window Kurtosis**
 - **Mean Sobel Edge Convolution**
 - For sliding window metrics, focusing on 50x50 sliding window
 - Images denoised with total variation technique
- As a refresher:
 - Skewness measures distribution asymmetry
 - Positive skew -> mostly (relatively) darker pixels with some light pixels
 - Negative skew -> mostly (relatively) lighter pixels with some dark areas
 - Kurtosis measures distribution peakedness or flatness
 - Higher kurtosis -> sharper peak, more similar pixels.
 - Sobel convolution finds sharp image changes (edges)
 - Large average sobel value, more edge pixels

Skewness vs Kurtosis vs Sobel Edge Metric



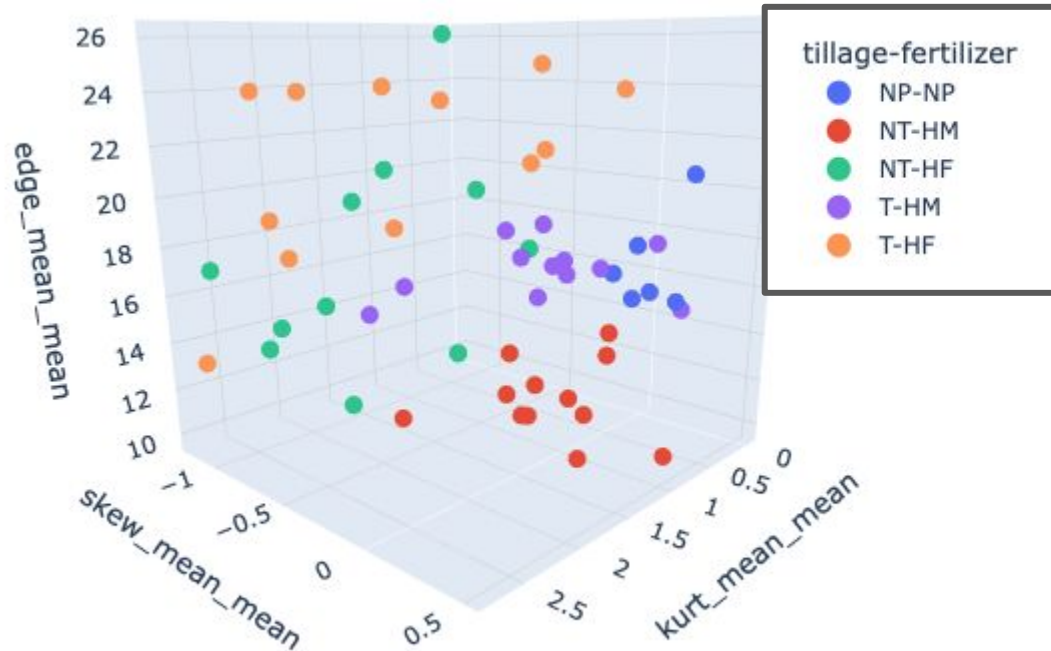
- Each point is in an individual tiff image
- Sampled every 50 tiff images as before
- Treatments seem to be fairly differentiated.
- Data seems to exist on a curved surface:
 - For low kurtosis, treatments differentiate on the sobel edge - skewness plane
 - For low sobel_edges, they seem to differentiate on the kurtosis-skewness plane
- See streamlit app to interact with data.

Skewness vs Kurtosis vs Sobel Edge Metric



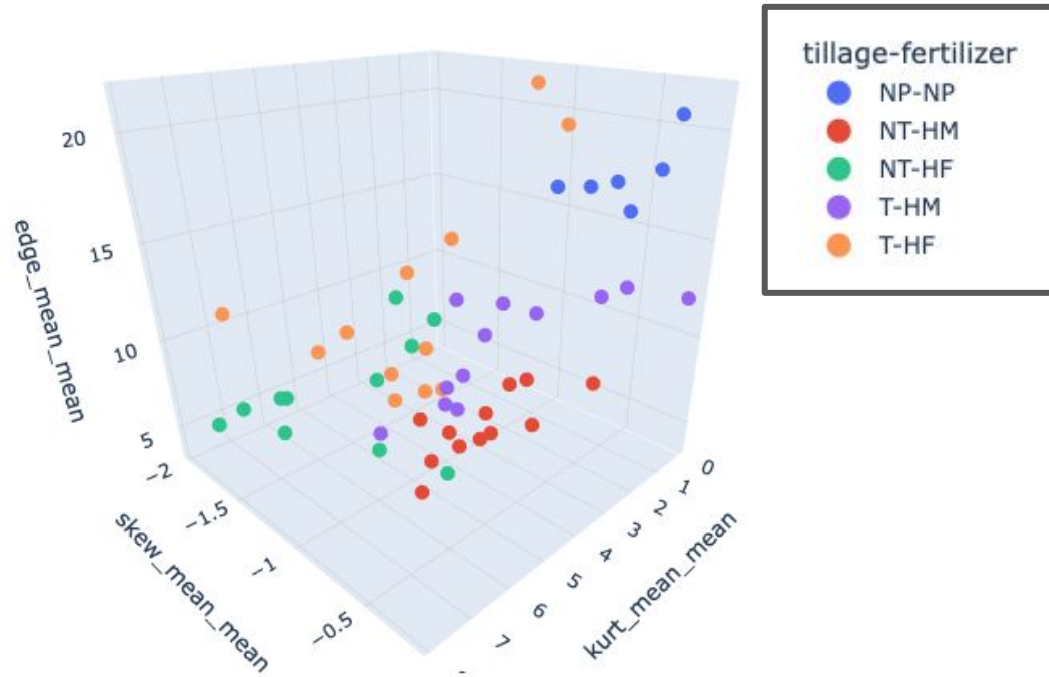
- Each point is an average value for a specific soil sample (tiff stack) in one of four depth bins, the smaller markers are more shallow depth bins.
- Depth bins:
 - 0 - 3.3 cm
 - 3.3 - 6.6 cm
 - 6.6 - 9.9 cm
 - 9.9 - 12.9 cm

Skewness vs Kurtosis vs Sobel Edge Metric



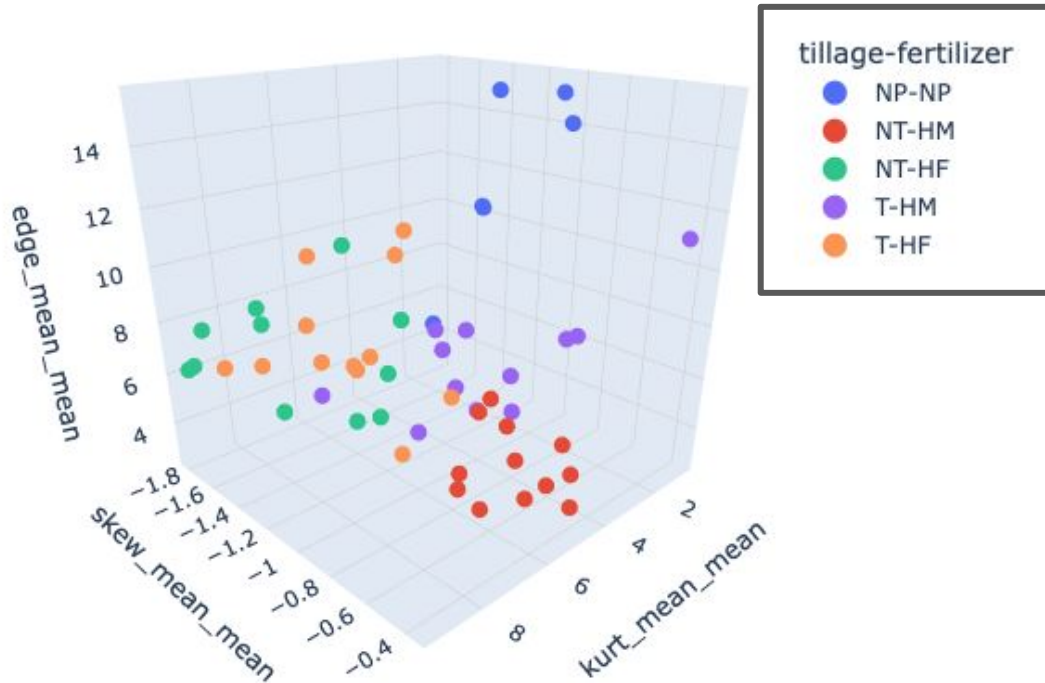
- Each point is an average value for a specific soil sample (tiff stack) in one of four depth bins, the smaller makers are more shallow depth bins.
- Depth bins:
 - **0 - 3.3 cm**
 - 3.3 - 6.6 cm
 - 6.6 - 9.9 cm
 - 9.9 - 12.9 cm

Skewness vs Kurtosis vs Sobel Edge Metric



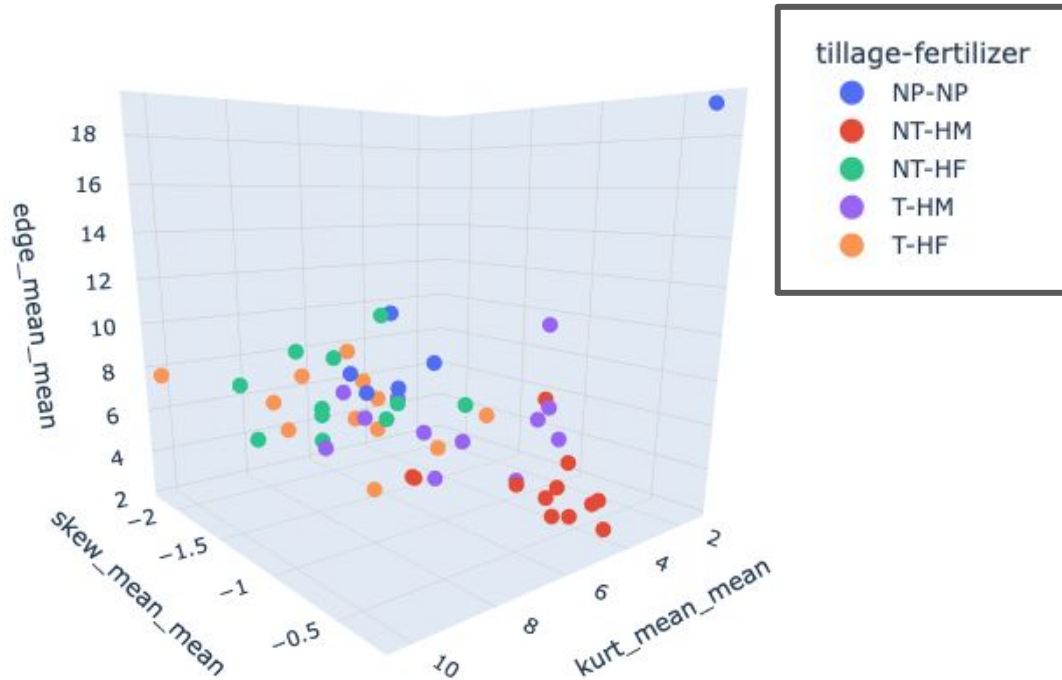
- Each point is an average value for a specific soil sample (tiff stack) in one of four depth bins, the smaller makers are more shallow depth bins.
- Depth bins:
 - 0 - 3.3 cm
 - **3.3 - 6.6 cm**
 - 6.6 - 9.9 cm
 - 9.9 - 12.9 cm

Skewness vs Kurtosis vs Sobel Edge Metric



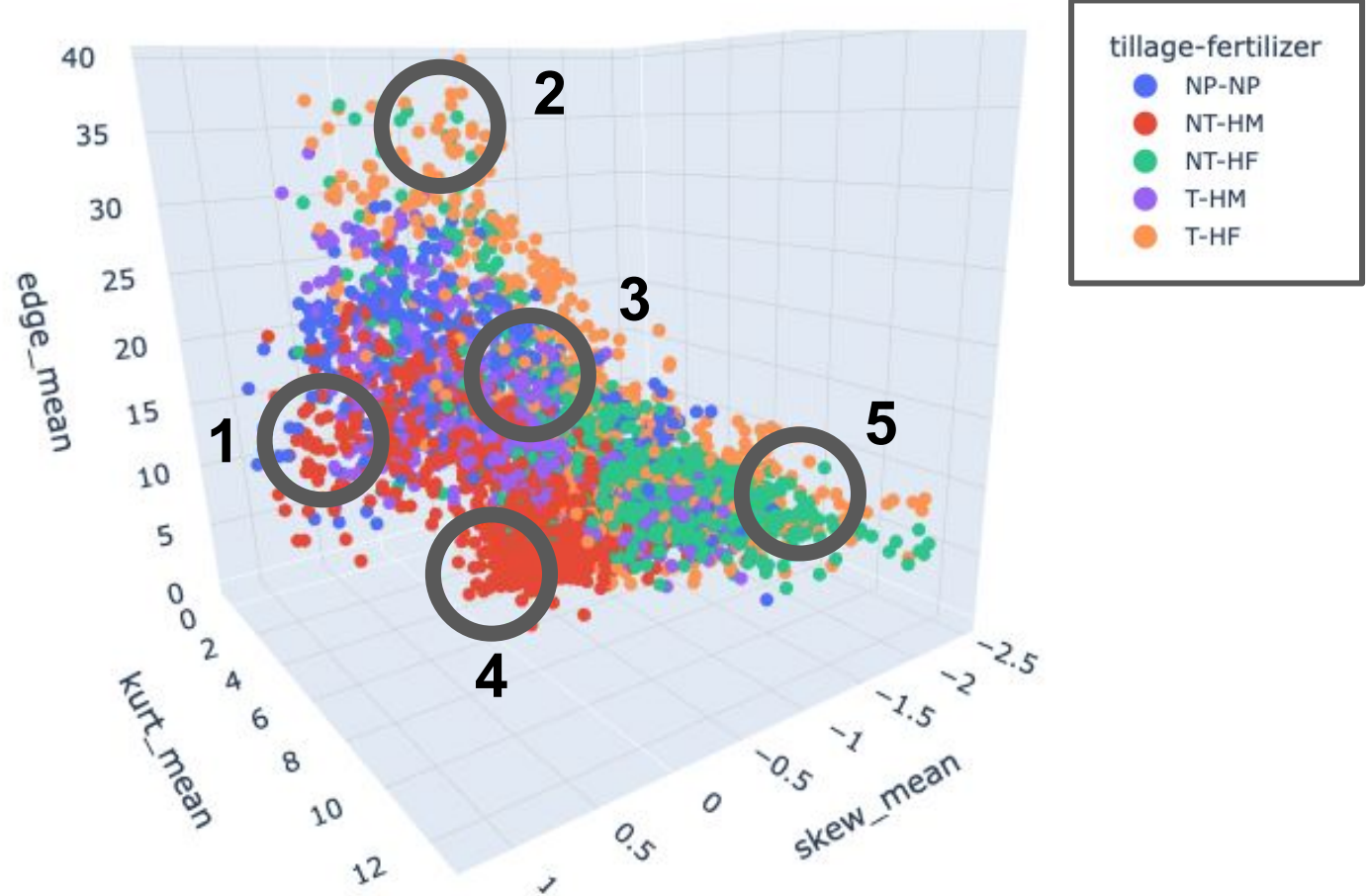
- Each point is an average value for a specific soil sample (tiff stack) in one of four depth bins, the smaller makers are more shallow depth bins.
- Depth bins:
 - 0 - 3.3 cm
 - 3.3 - 6.6 cm
 - **6.6 - 9.9 cm**
 - 9.9 - 12.9 cm

Skewness vs Kurtosis vs Sobel Edge Metric

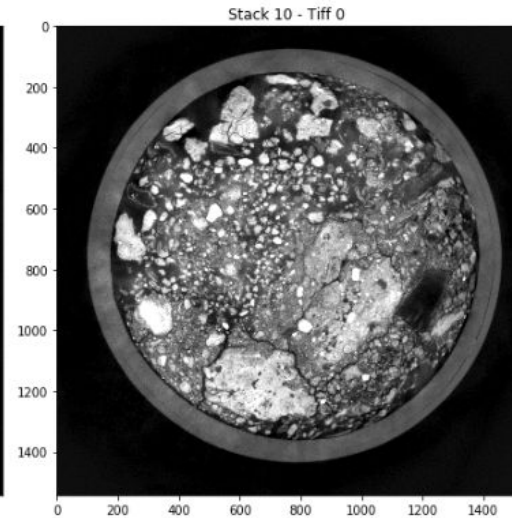
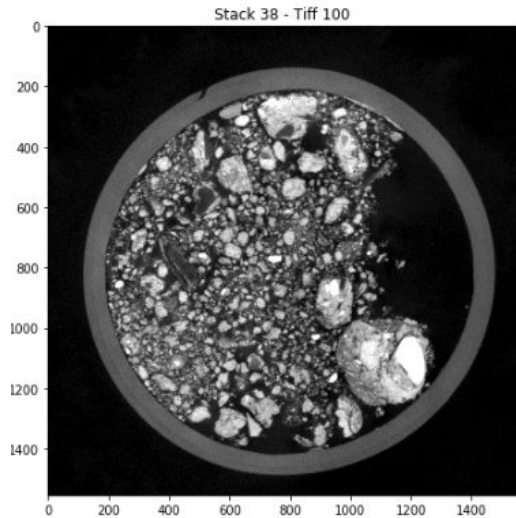
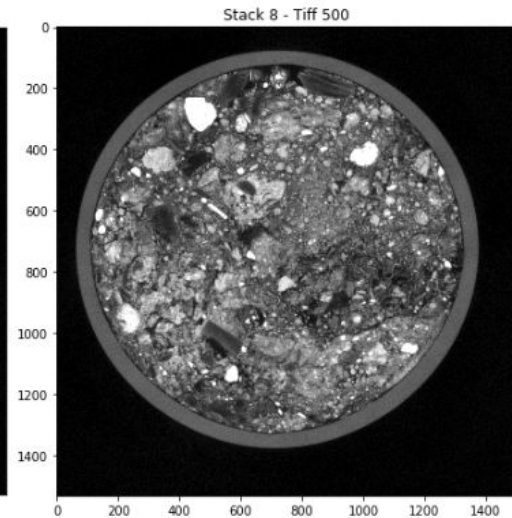
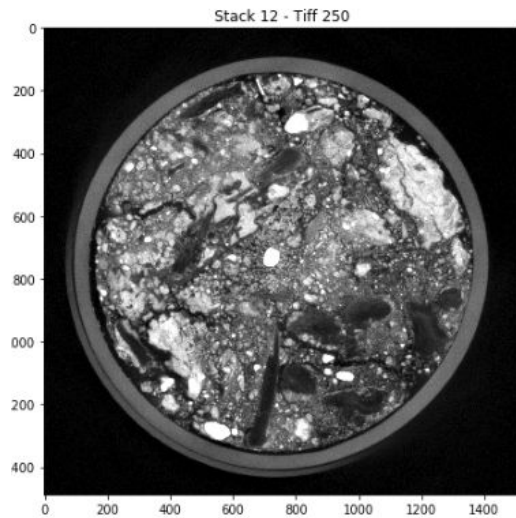


- Each point is an average value for a specific soil sample (tiff stack) in one of four depth bins, the smaller makers are more shallow depth bins.
- Depth bins:
 - 0 - 3.3 cm
 - 3.3 - 6.6 cm
 - 6.6 - 9.9 cm
 - **9.9 - 12.9 cm**

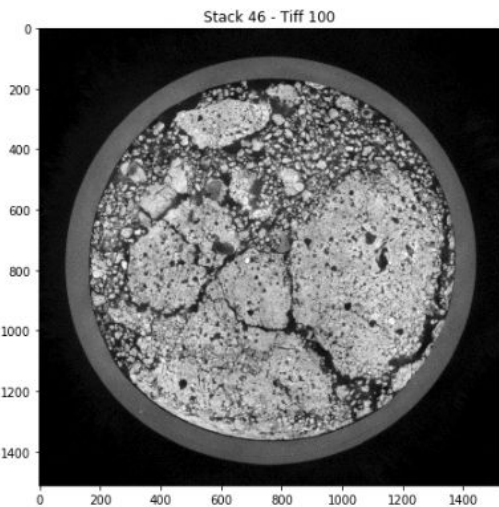
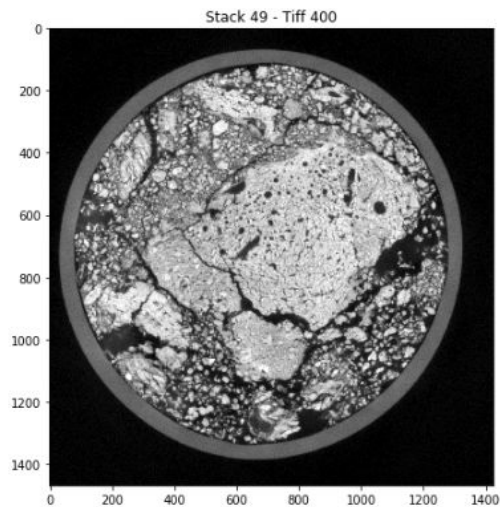
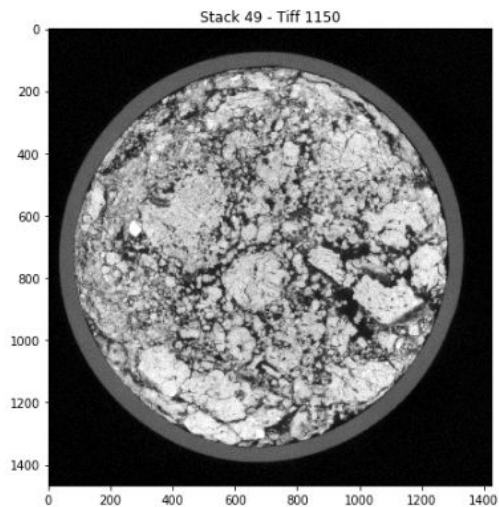
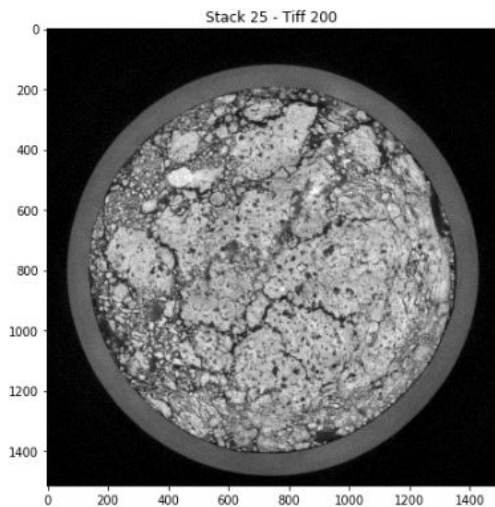
What do different regions look like?



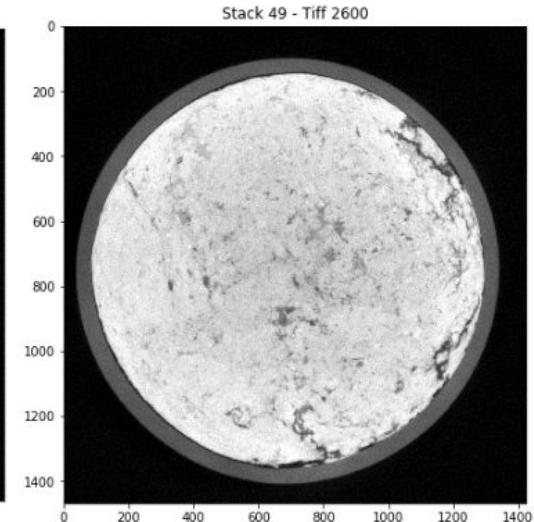
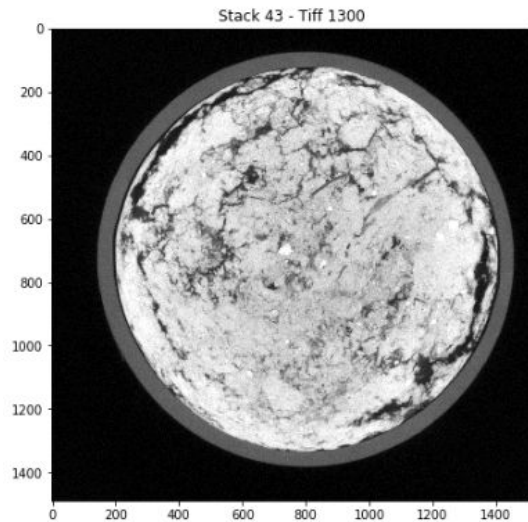
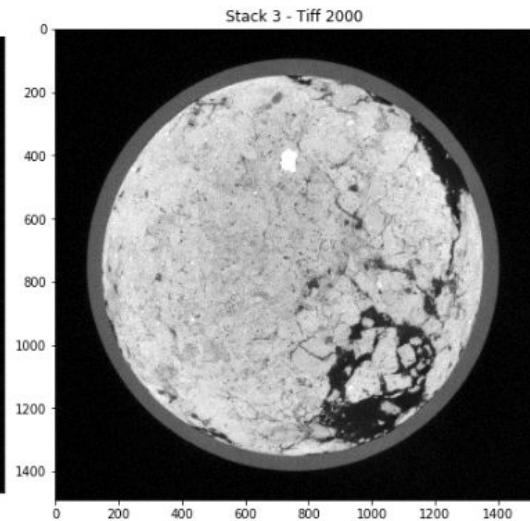
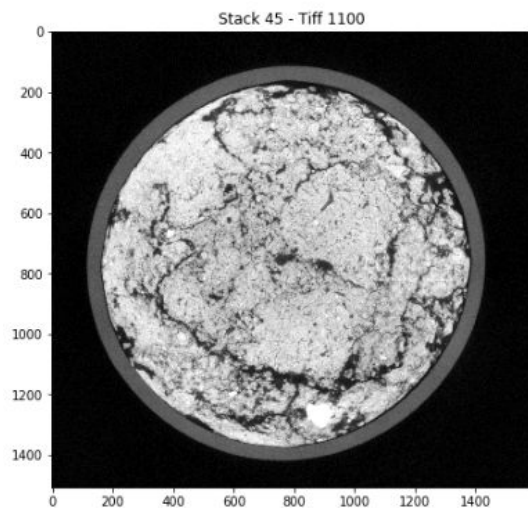
Region 1



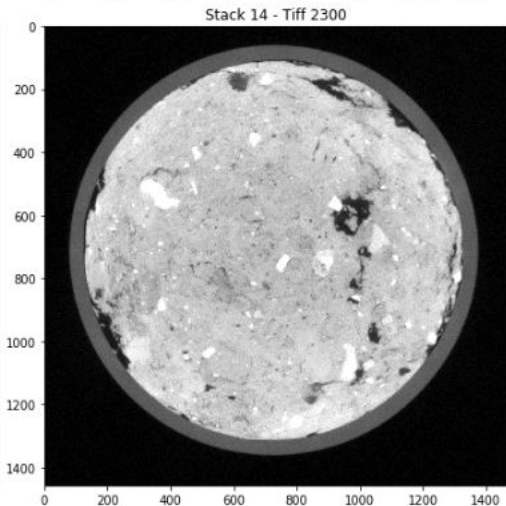
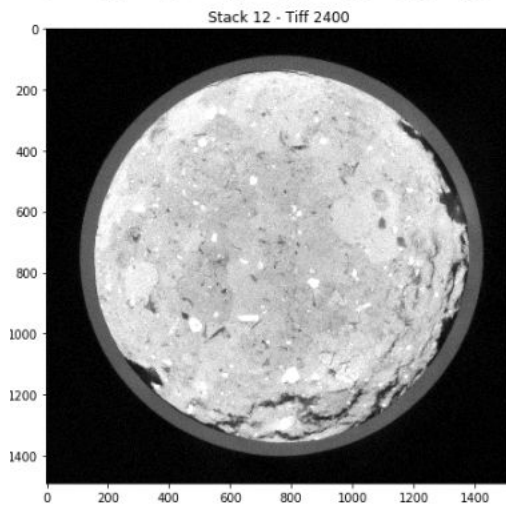
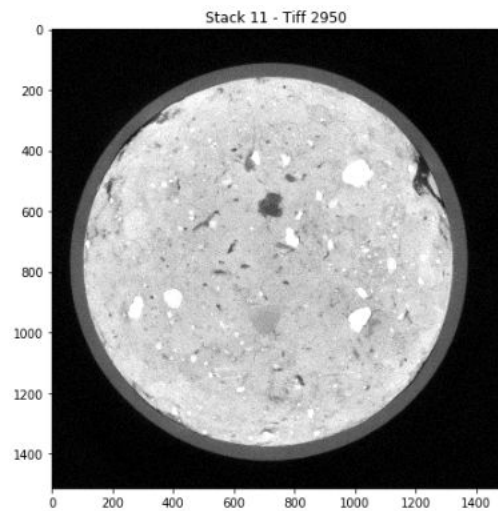
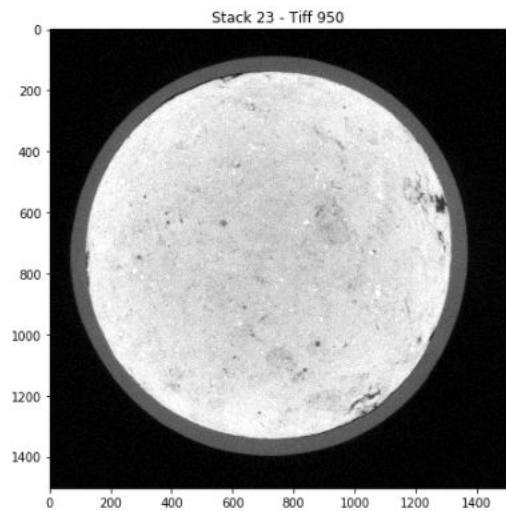
Region 2



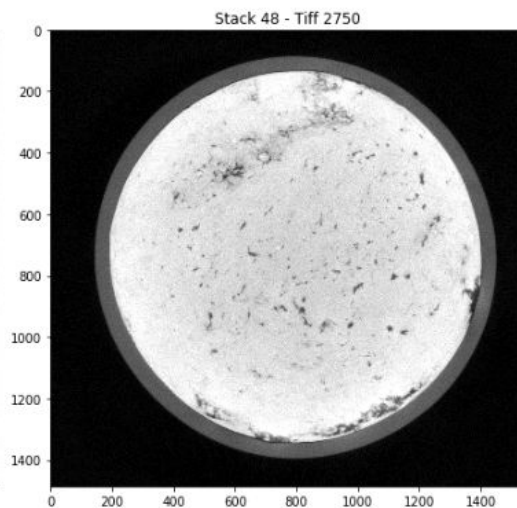
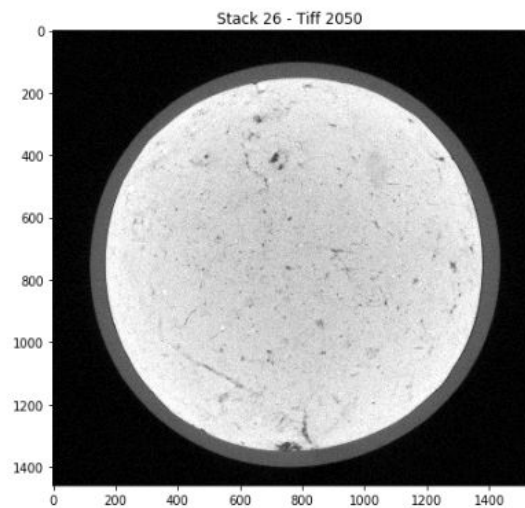
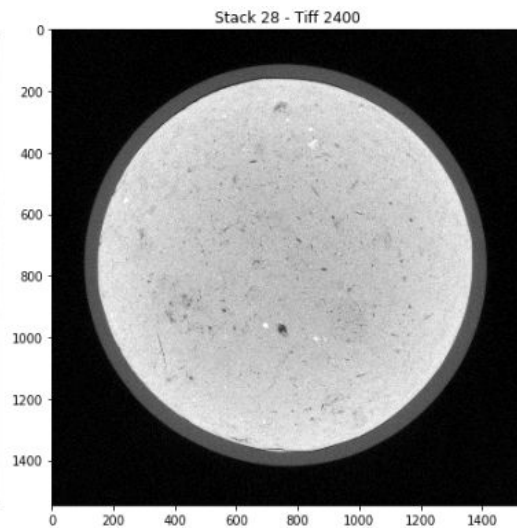
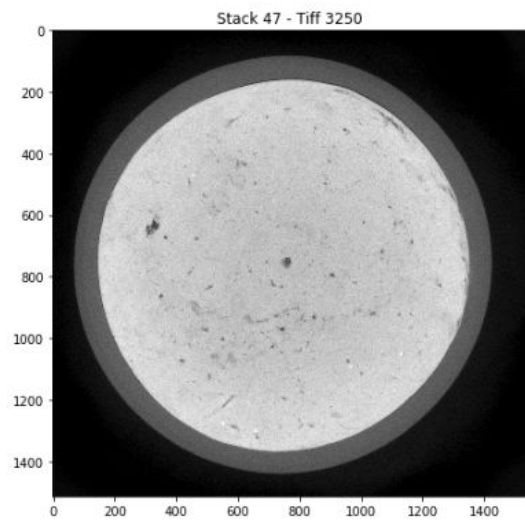
Region 3



Region 4



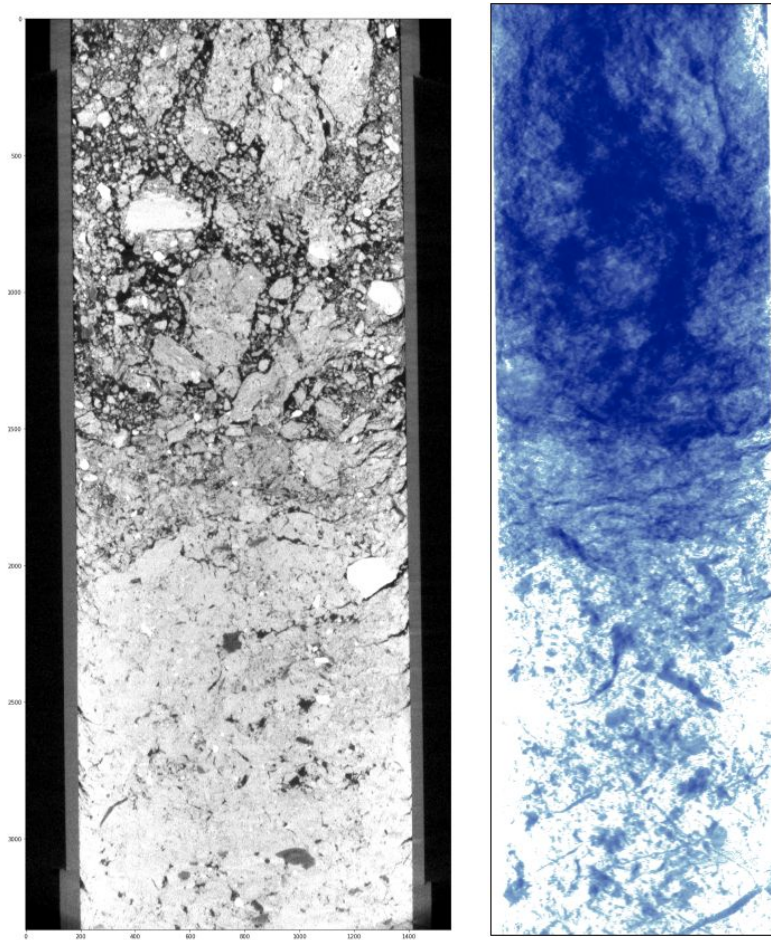
Region 5



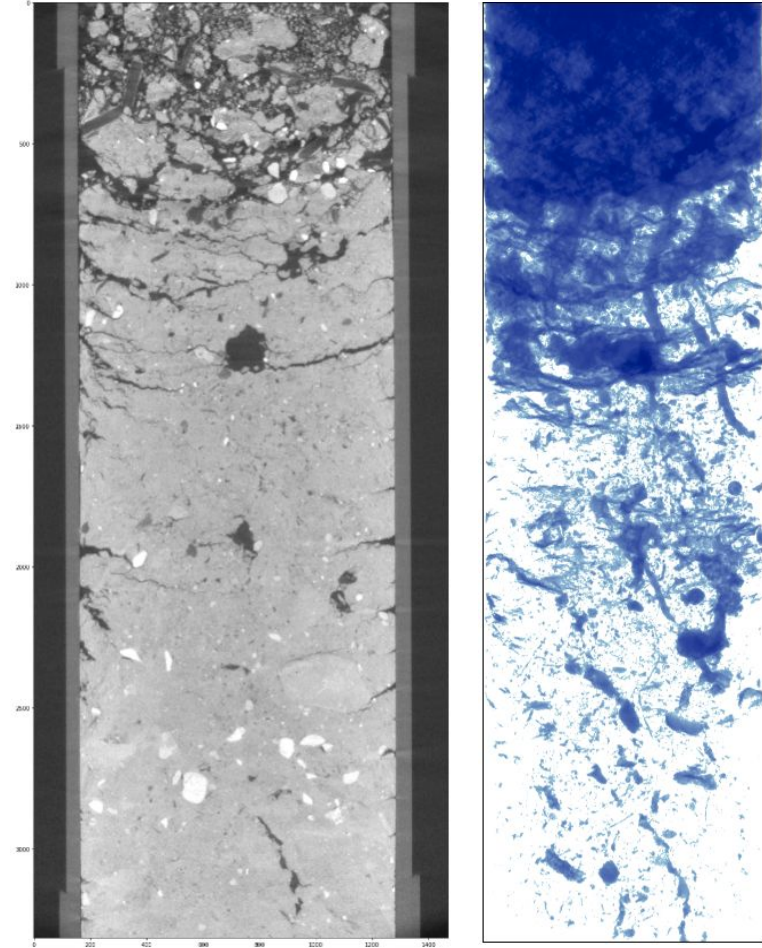
Current Takeaways

- Visually, based on the regions, current metrics might be indicating:
 - Amount of aggregates, characteristics of their variability
 - Void characteristics - such as pore size and shape
- Possibilities to investigate further
 - For voids, see how the current metrics relate to pore space calculations derived through segmentation (see next slides for sample segmentations, potentially good qualitative view for intuition of pore spaces)
 - Segment, calculate average porosity, number of pores, size and shape analysis (void convexity, circularity, elongation, etc.)
 - Determine how correlated they are with statistical metrics
 - Identify distinct regions in skew/kurt/edge space (through kmeans, other cluster techniques, or manually define based on qualitative characteristics), develop a quantitative signature for each treatment.
 - Use mutual information, other techniques to identify other potential correlative statistical measures.

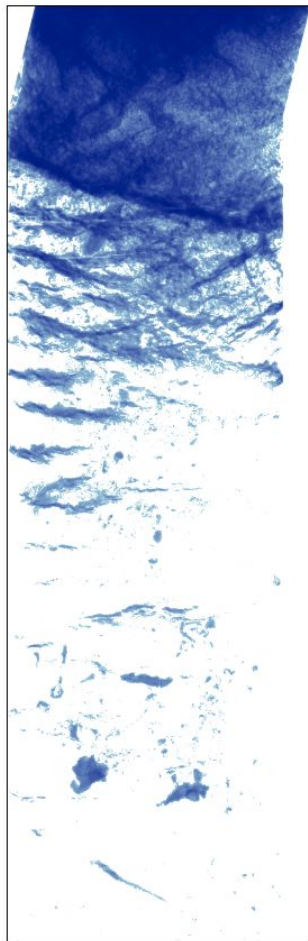
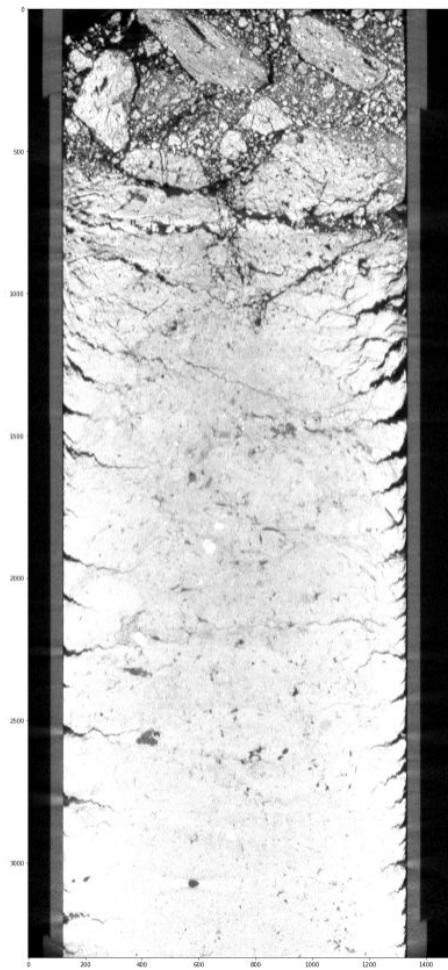
Till, High Manure



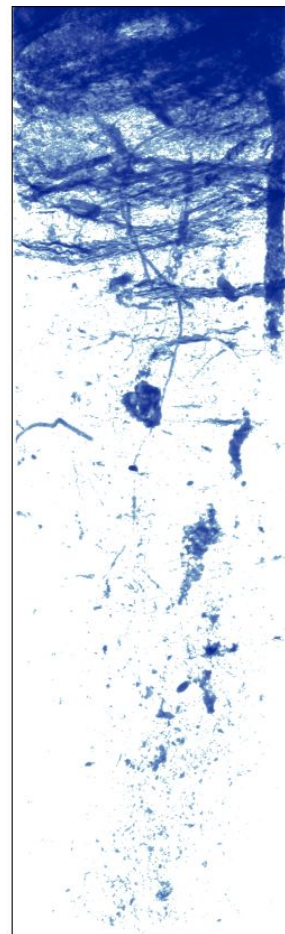
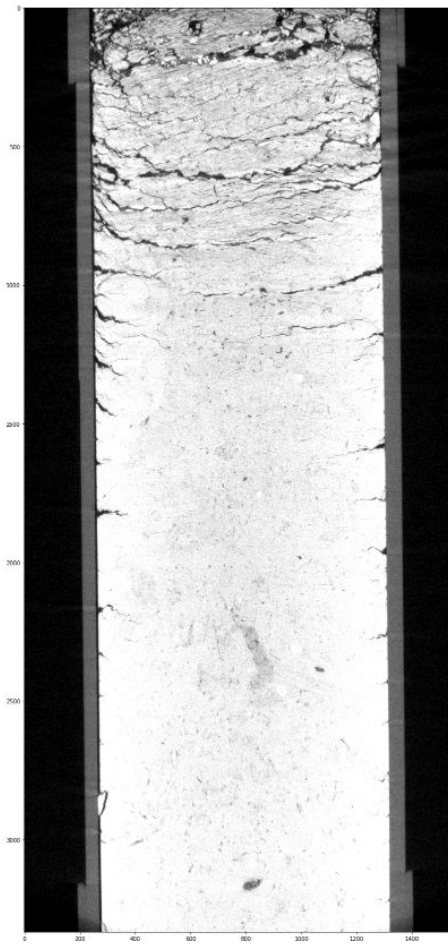
No Till, High Manure



Till, High Fertilizer



No Till, High Fertilizer



Native Prairie

