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**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

**<http://www.inl.gov>**

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# Characterization and Localization of Inorganic Species Variability in Corn Stover Fractions as Functions of Storage and Biological Heating

Patricia Kerner<sup>1,2</sup>, Chenlin Li<sup>1\*</sup>, Lisa McDougall<sup>2</sup>, Allison Ray<sup>1</sup>, Amber Hoover<sup>1</sup>

1. Energy & Environment Science & Technology, Idaho National Laboratory; 2. Dept. of Biological Sciences, Idaho State University; \*: Project PI and Mentor.

## Background

- Corn Stover:** nongrain portion of corn—stem, cob, flower, leaf, and husk fractions
  - ✓ Lignocellulosic biomass, can be converted to ethanol or burned as fuel for electricity
  - ✓ Introduced and physiological inorganic species in biomass cause severe equipment wear and impact downstream conversion yields
- Storage Methods:** 3 main storage methods that result in varying levels of exposure and moisture content, can lead to varying levels of biological heating
  - ✓ Outdoor, uncovered
  - ✓ Outdoor, plastic wrapped or tarp cover
  - ✓ Indoor, controlled environment
- Biological Heating:** plant and microbial respiration in stored corn stover leads to increased bale temperatures, degradation, and dry matter loss

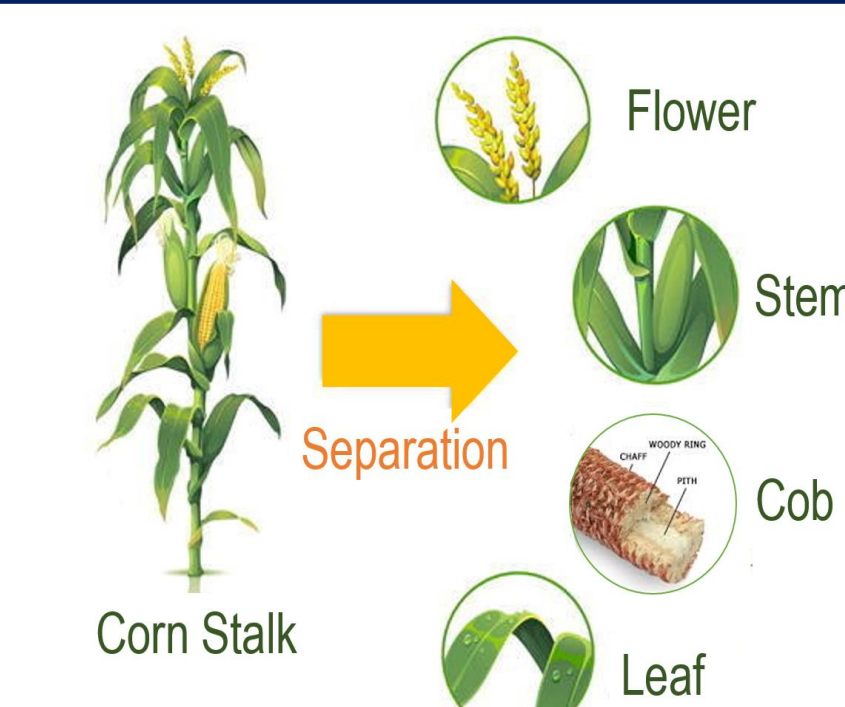


Figure 1: Corn stover fractions



Figure 2: Dissection of biological heated corn stover bales

## Objective

- Characterize structural and elemental variability, distributions, and dynamic changes in corn stover fractions that are non-biologically heated and severely biologically heated in order to establish a fundamental understanding and advise strategies for harvest and collection, wear abrasion, selective biomass preprocessing technologies, and equipment design.

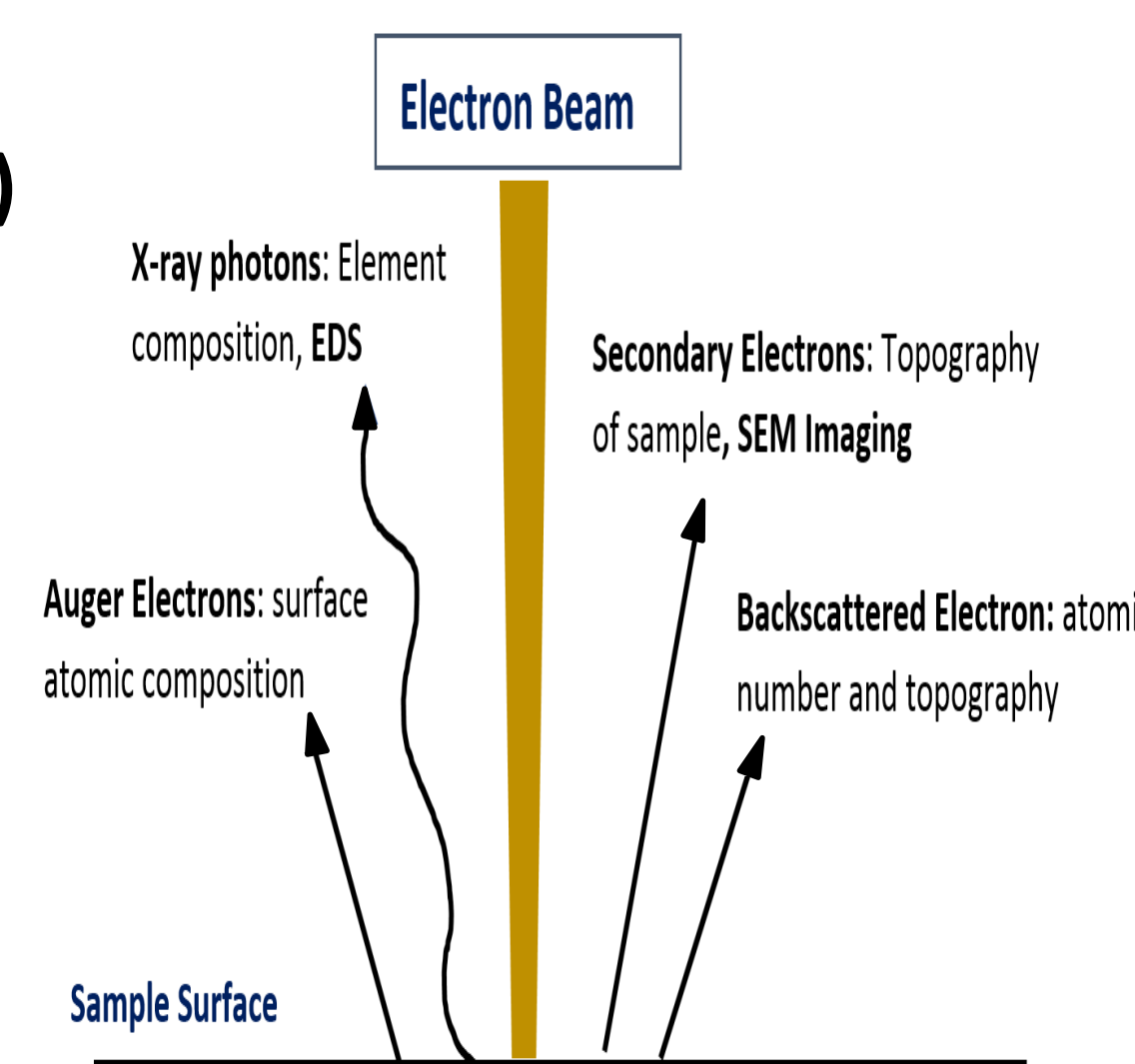
## Methods

### Scanning Electron Microscopy (SEM)

- ✓ Focused electron beam generates a variety of signals on surface of sample
- ✓ High resolution surface imaging
- ✓ Energy dispersive X-ray spectroscopy (EDS): x-ray detector used to semi-quantify elements in samples

### Confocal Microscopy

- ✓ Laser beam focused by an objective lens onto surface of sample
- ✓ Photons emitted from fluorophores in sample
- ✓ Three-dimensional images



## Results

- Structural differences in the severely biologically heated tissues were visualized with SEM imaging and confocal microscopy. A consistent pattern of compressed cell structures were observed in the severely heated tissues, specifically the pith of the cob and the vascular bundles and parenchyma cells of the stem, shown in Figures 3 and 4.
- Higher levels of potassium present in non-biologically heated tissues were detected with SEM EDS. Silicon was found to be localized in the outer layers of stover tissues and its contents got dynamically increased due to biological heating, as visualized in the stem rind using SEM-EDS mapping (Figure 5).

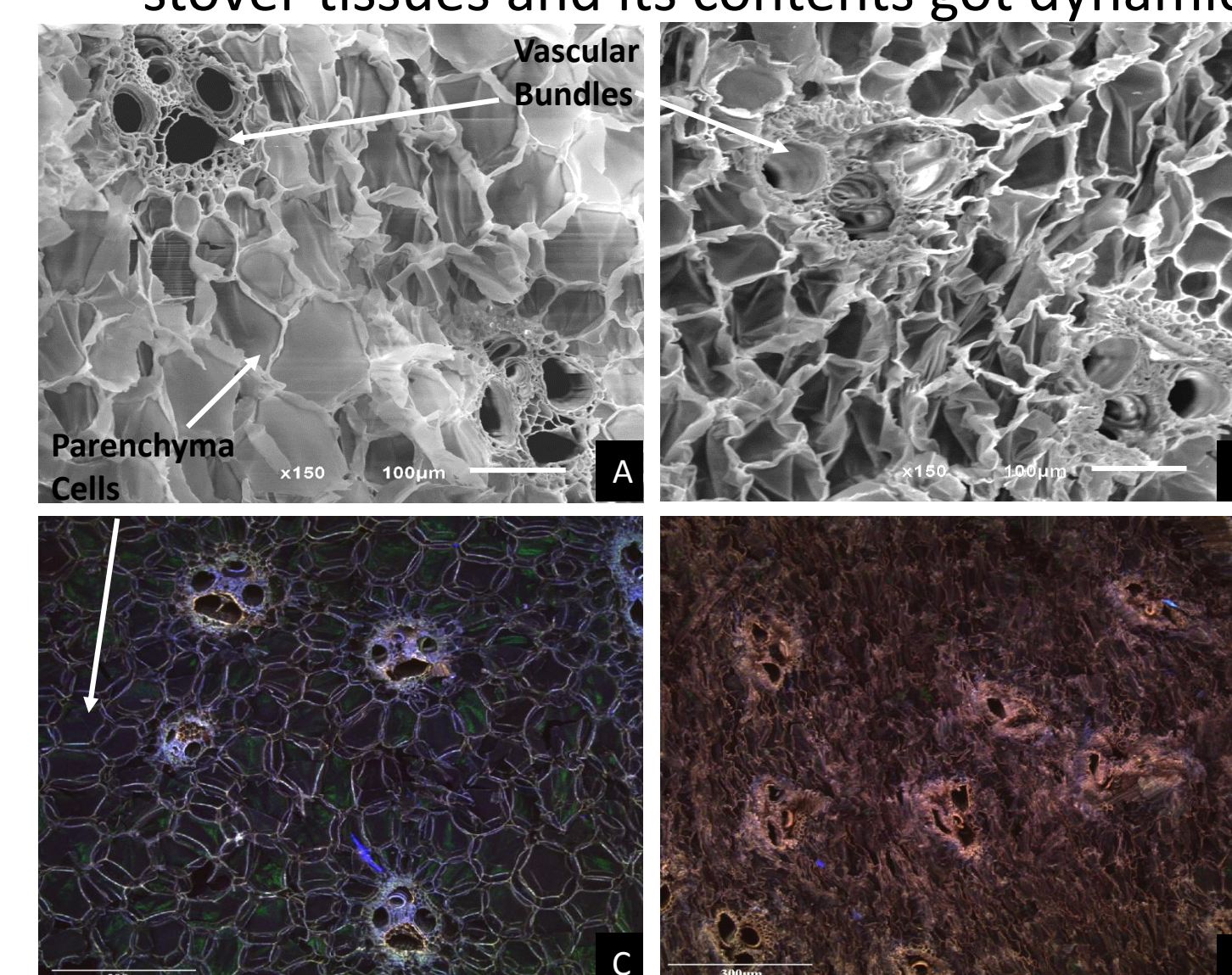


Figure 3: Stem horizontal cross sections (A) no biological heat, SEM Image, 150x (B) severely heated, SEM Image, 150x (C) no biological heat autofluorescence, confocal microscopy, 10x (D) severely heated autofluorescence, confocal microscopy, 10x

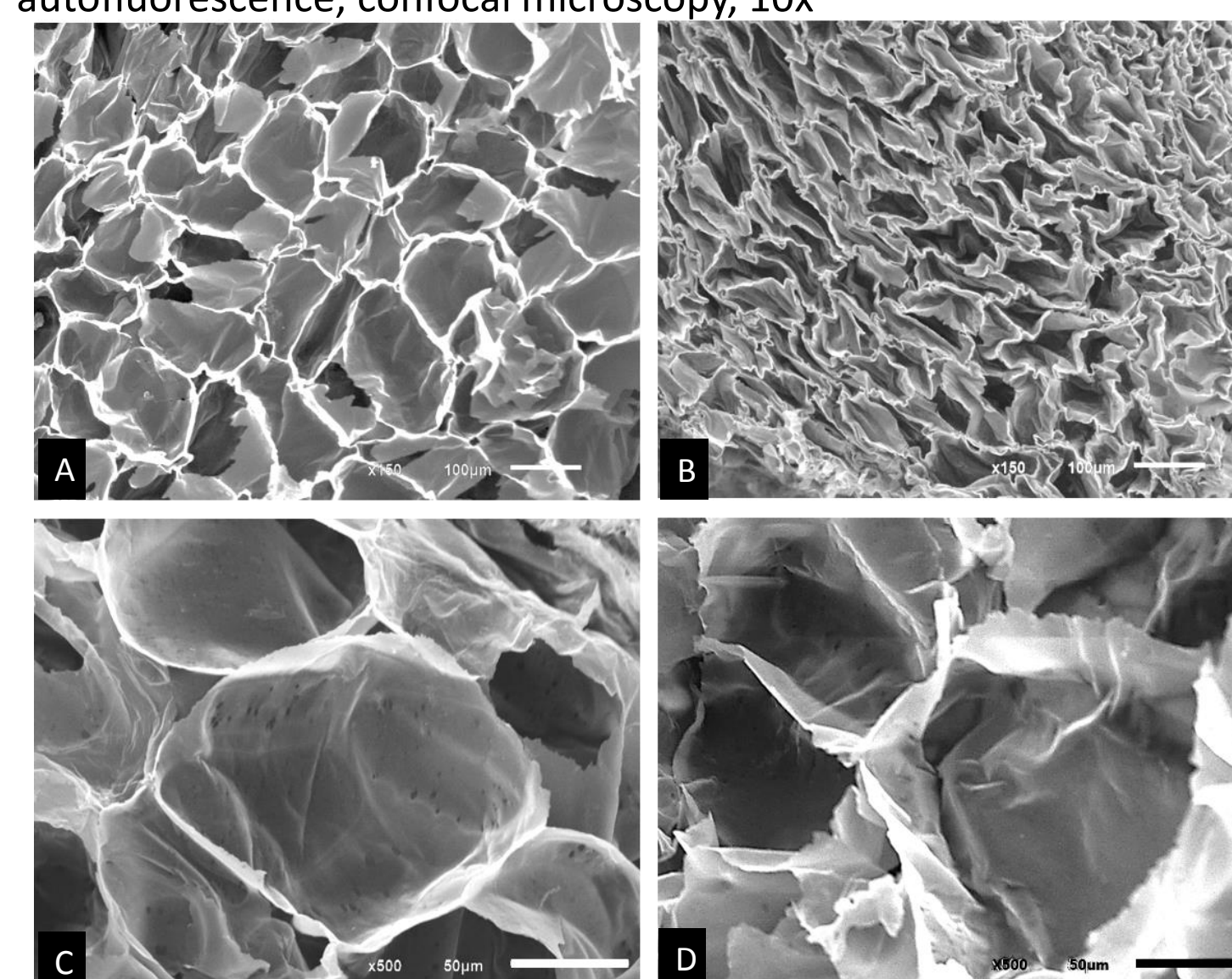


Figure 4: SEM Images of Cob pith horizontal cross section fractions (A) no biological, 150x (B) severely heated, 150x (C) no biological heat, 500x (D) severely heated, 500x

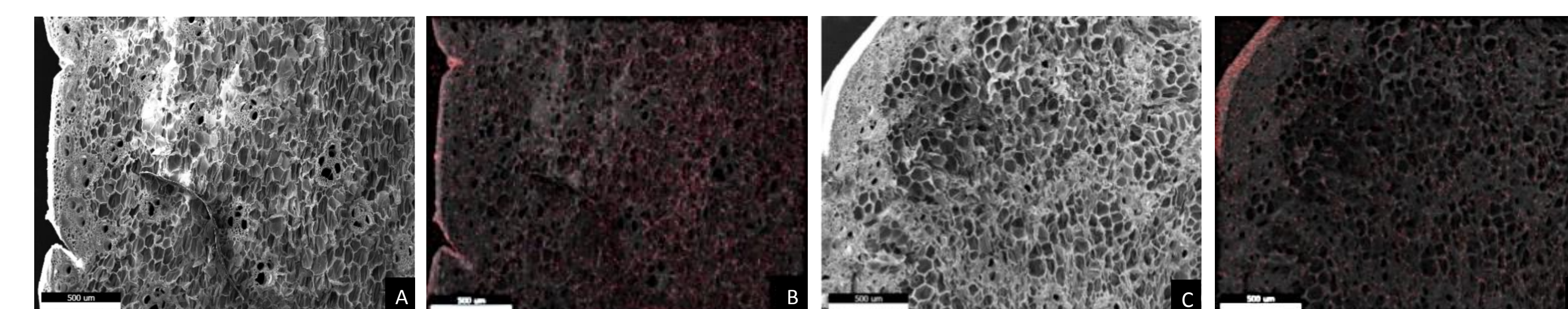
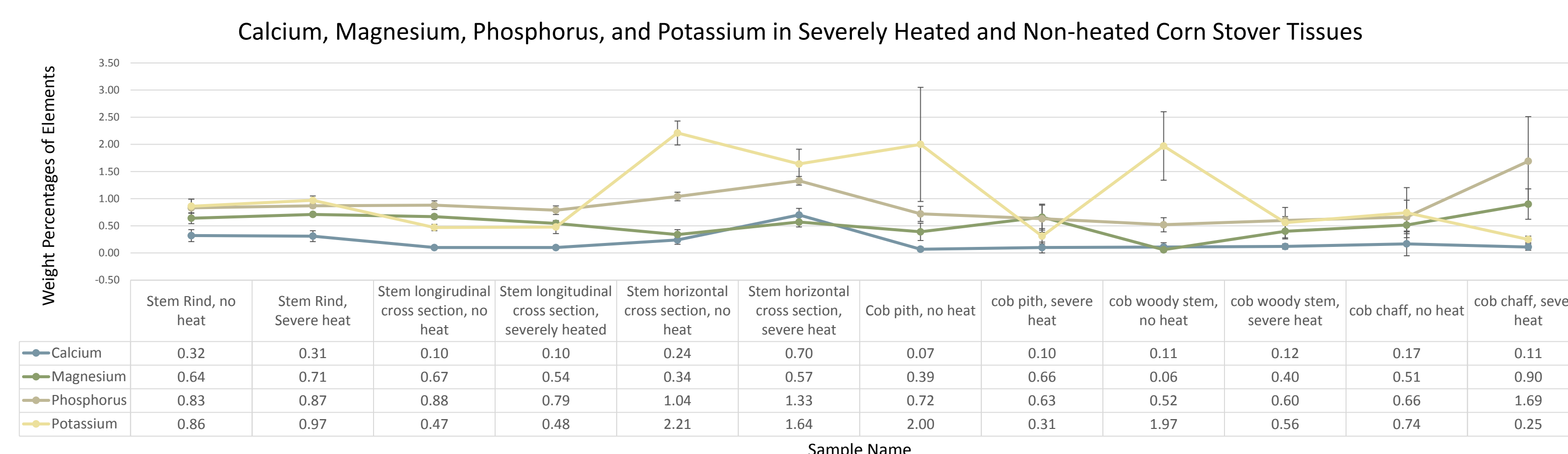
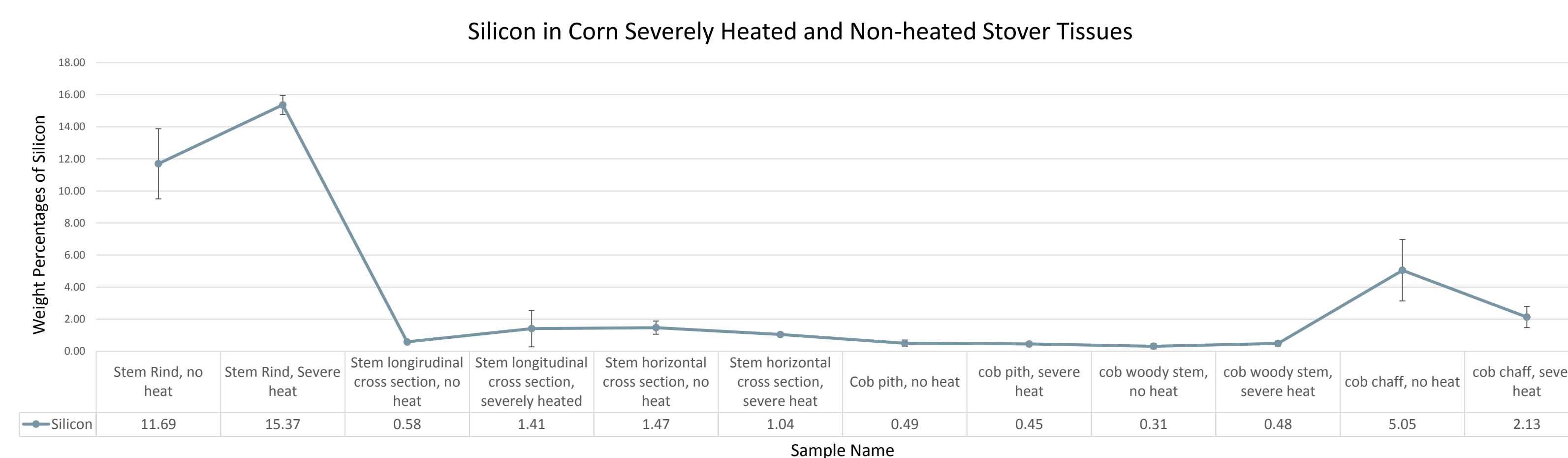


Figure 5: Stem horizontal cross section fractions. (A) no biological heat, SEM Image, 150x. (B) no biological heat, EDS element mapping, Silicon. (C) Severe biological heating, SEM Image, 150x. (D) Severe biological heating, EDS element mapping, Silicon



## Conclusion

Overall, dynamic structural and elemental variability, changes, and distributions were observed in corn stover fractions as functions of storage and biological heating. This is preliminary research and supplementary confocal microscopy experiments are being conducted to further visualize tissue variability by staining specific cell wall components. Also, further wet chemistry analysis is necessary to fully characterize the inorganic species in the fractions. This research is necessary to expand our understanding of the source of variability, i.e., storage, on the quality of corn stover and its impact on the equipment wear and downstream biomass conversion efficiency.

## References

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