Photoelectron Emission Microscopy Studies of Carbon Overturn in Lake Sediments from the Alaskan Coastal Plain

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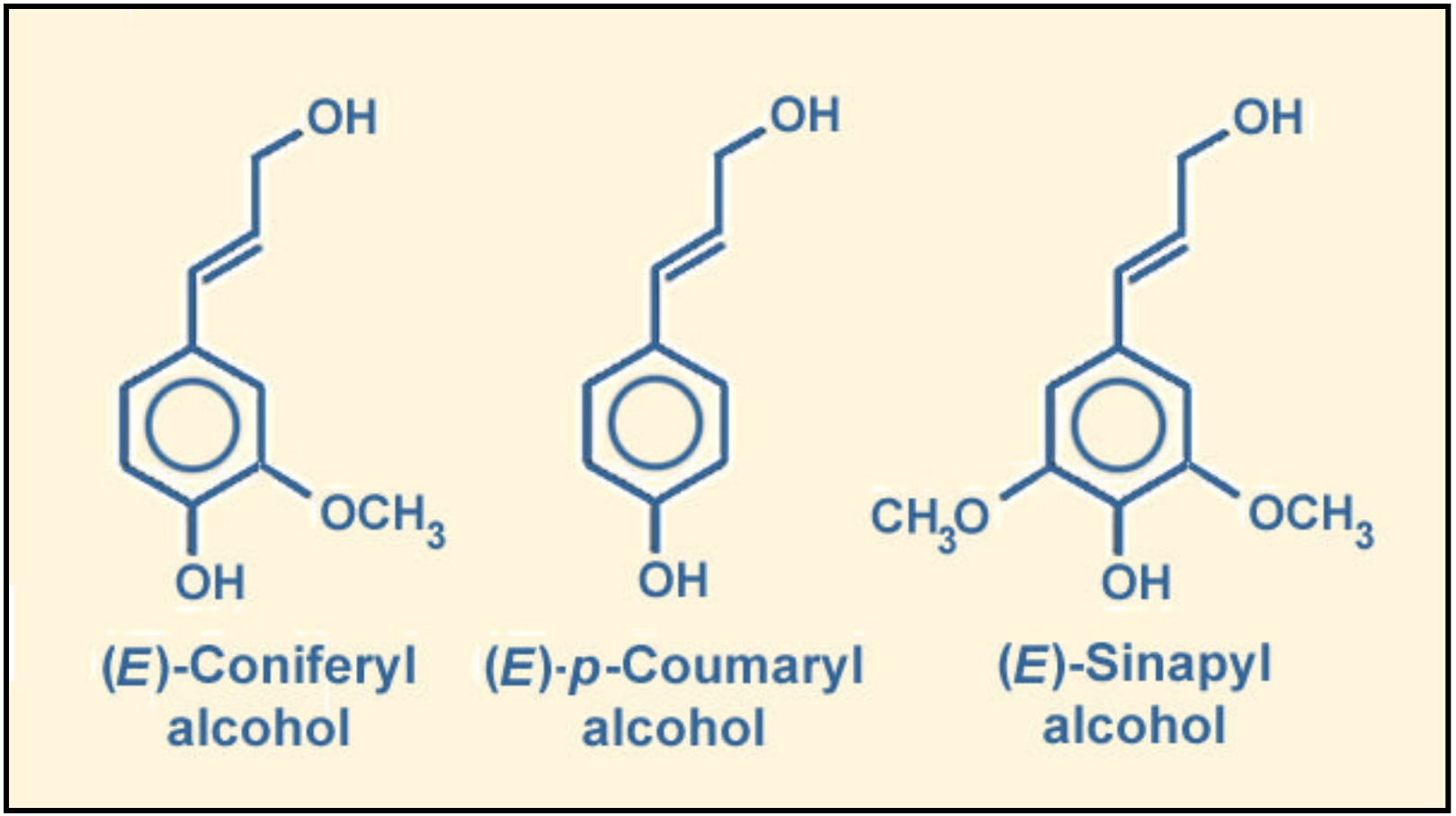
Introduction

- **Why study carbon cycling in the arctic tundra?**
- **What are some strategies for quantifying carbon turnover rates?**
- **Current progress**
- **Conclusions**

The Big Picture

- Cellulose and lignin compose cell walls in vascular plants
- Carbon turnover gradually converts original cell wall material into humified products and CO_2
- Quantifying lignin in peat may allow estimates of carbon accumulation rates during the life span of thaw lakes

Lignin Precursors



The Arctic Tundra: Thermal Karst Lakes

- Arctic tundra plays a crucial role in carbon sequestration
- The formation of thermal karst lakes serves as a climatic record
  - Patterned ground develops from annual freeze-thaw cycles
  - Water accumulating in depressions acts as a thermal sink thinning the underlying permafrost
  - Peat accumulates in shallow thaw lakes sequestering carbon until erosion drains the lake

Thermal Karst Lakes

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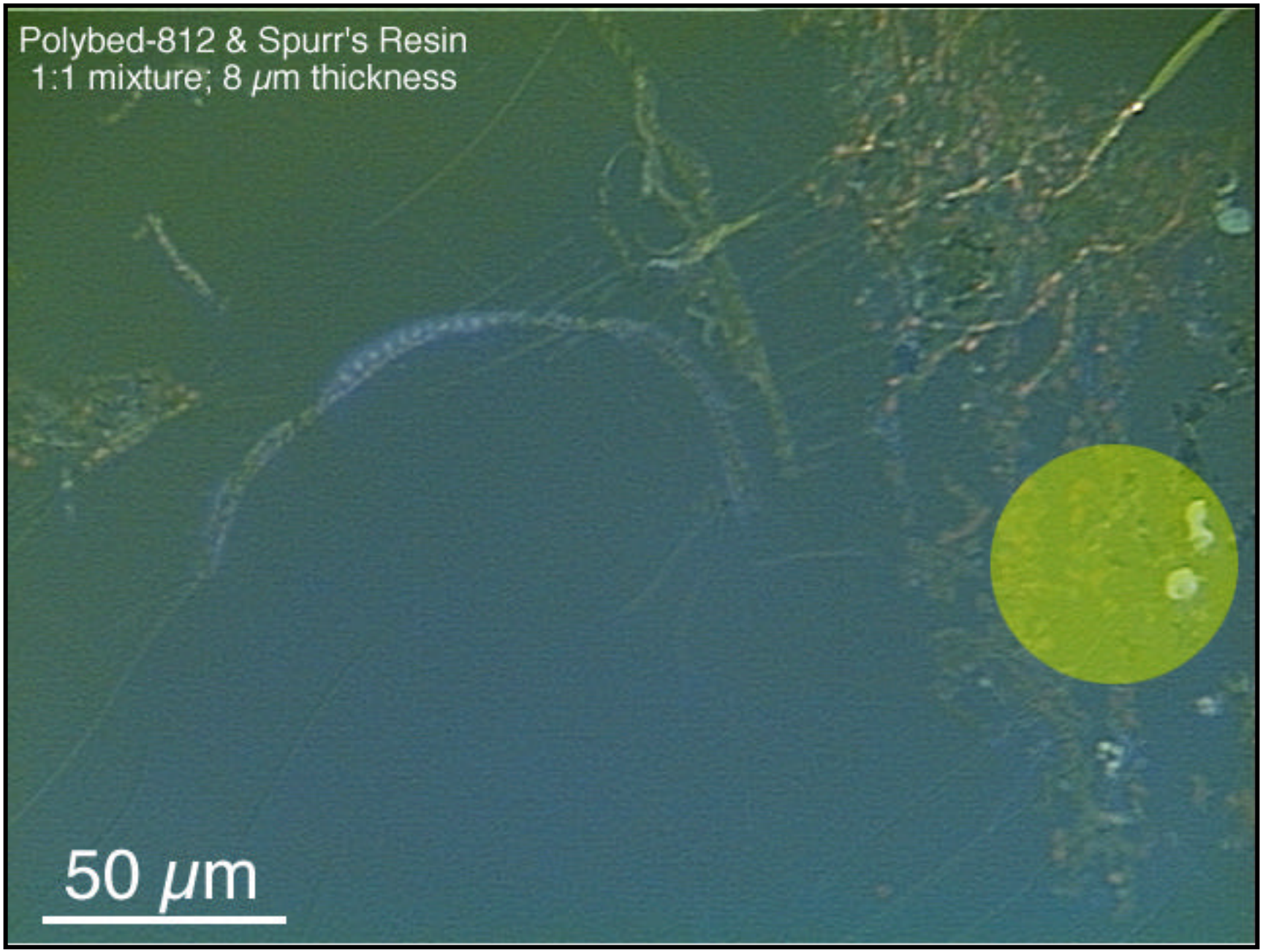
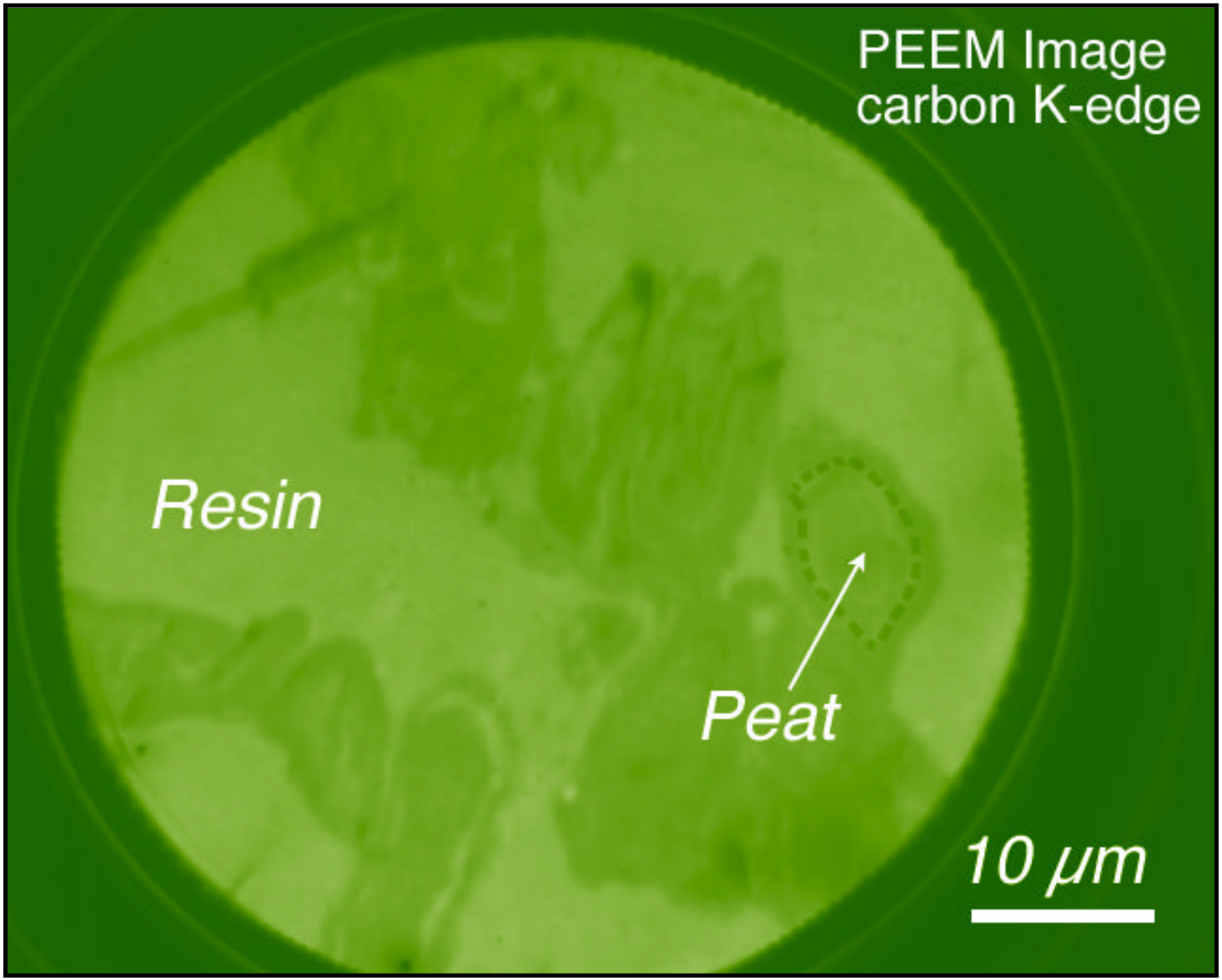
Chemical X-ray Techniques

- Sample Preparation
  - embedding
  - plating


Polybed-812 & Spurr's Resin
1:1 mixture; 8 μm thickness
50 μm

Chemical X-ray Techniques Cont'd

- Sample Preparation
  - embedding
  - plating
- Photoelectron Emission Microscopy
  - spatial data


PEEM Image
carbon K-edge
Resin
Peat
10 μm

Chemical X-ray Techniques Cont'd

- Sample Preparation

  - embedding

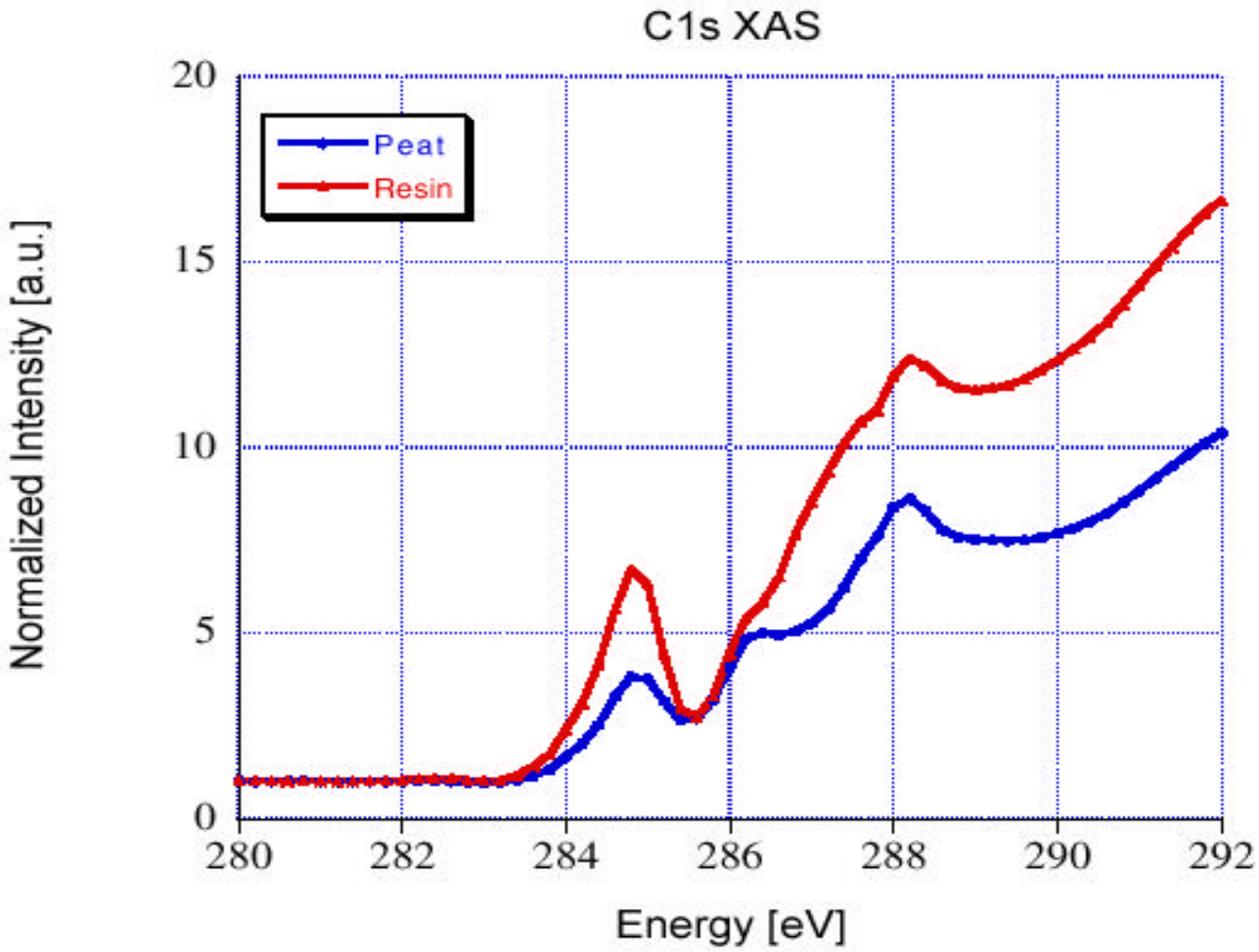
  - plating

- Photoelectron Emission Microscopy (PEEM)

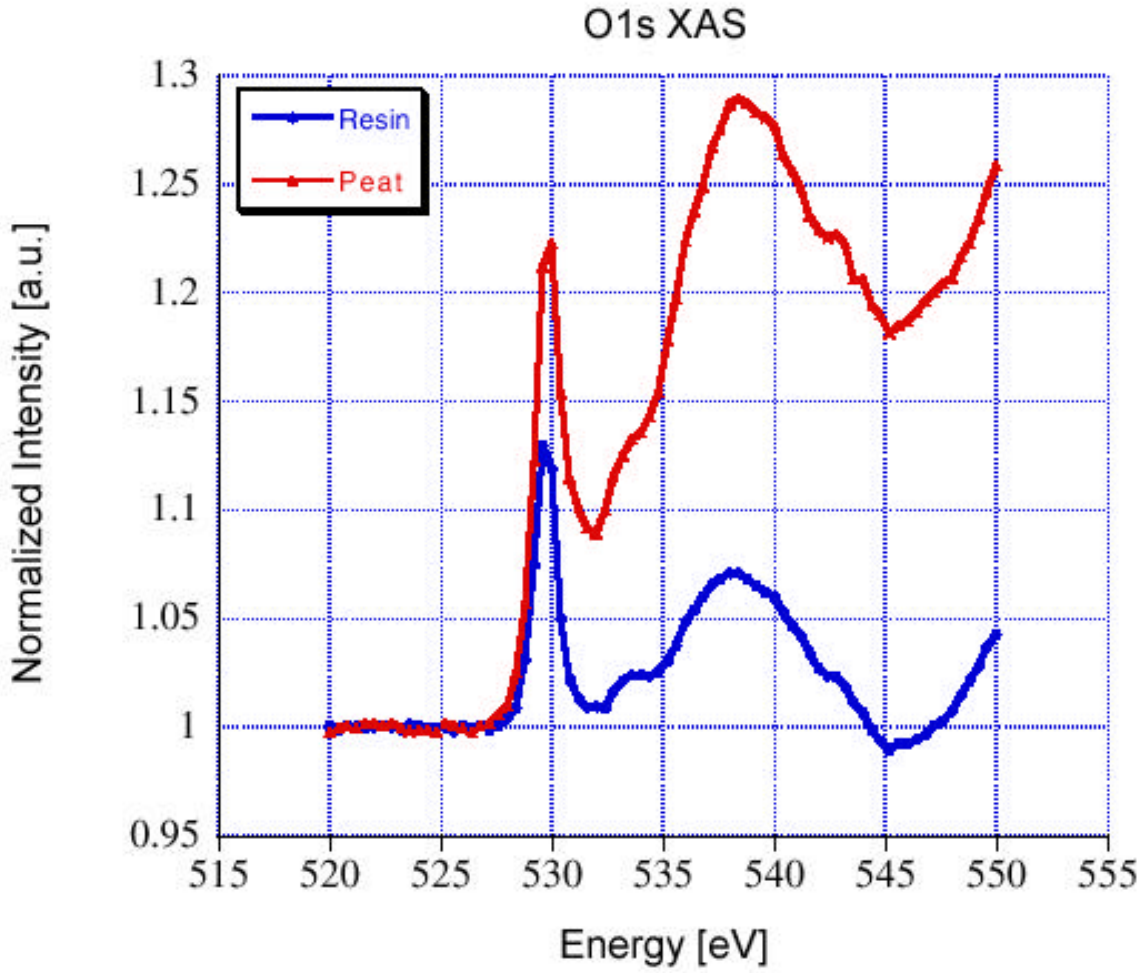
  - spatial data

- X-ray Absorption Near Edge Spectroscopy (XANES)

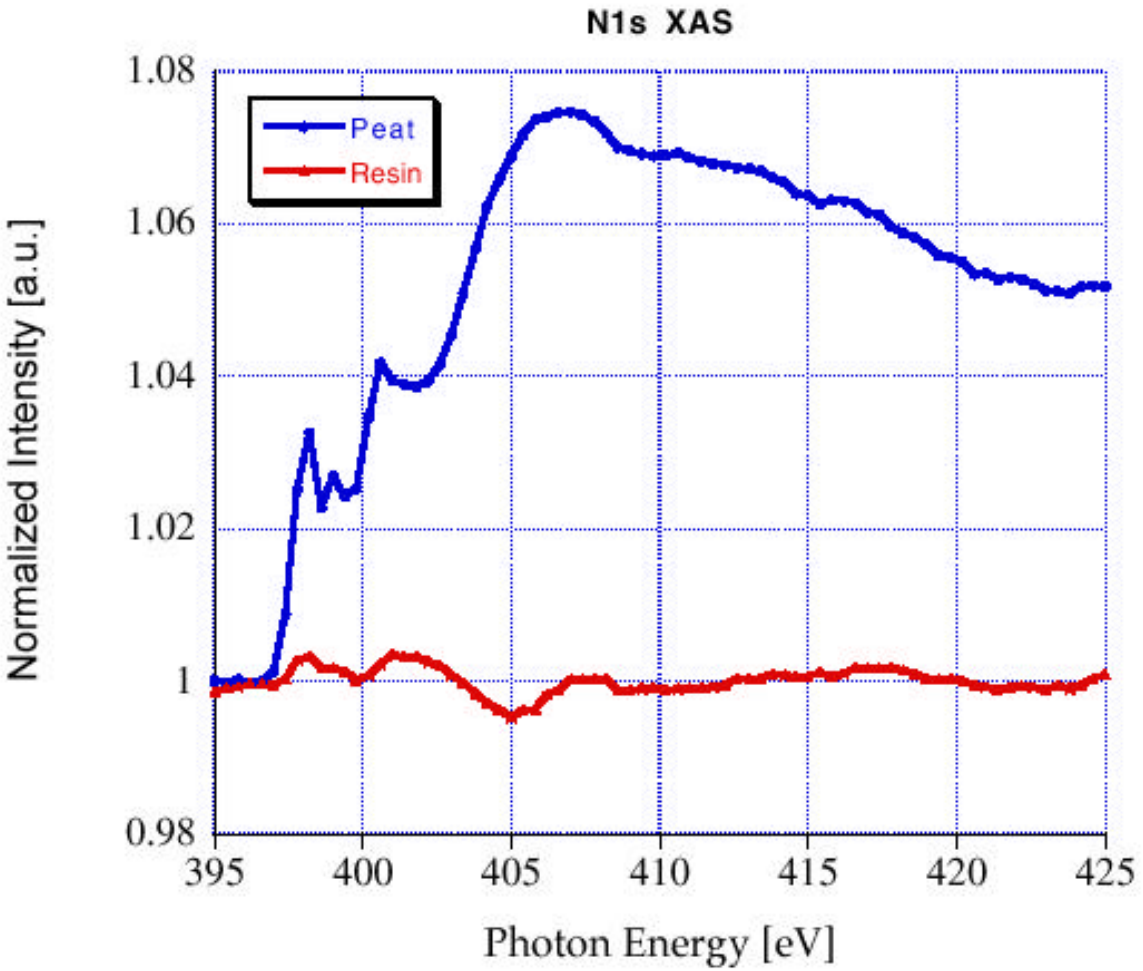
Carbon K-edge Spectrum



Oxygen K-edge Spectrum



Nitrogen K-edge Spectrum



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Outlook

- Developed a normalization procedure to provide better quality data (quantitative x-ray data requires improved methods for reliable measurement)
- Combine data with Nuclear Magnetic Resonance (NMR) spectra
- Discriminating original cell wall materials from humified products appears feasible

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Future Directions

- Establish a link between chemical analysis and microbiology via lipid/enzyme analysis
- Eventually combine data with pollen analysis (climate -> carbon storage -> responsible microbial populations)

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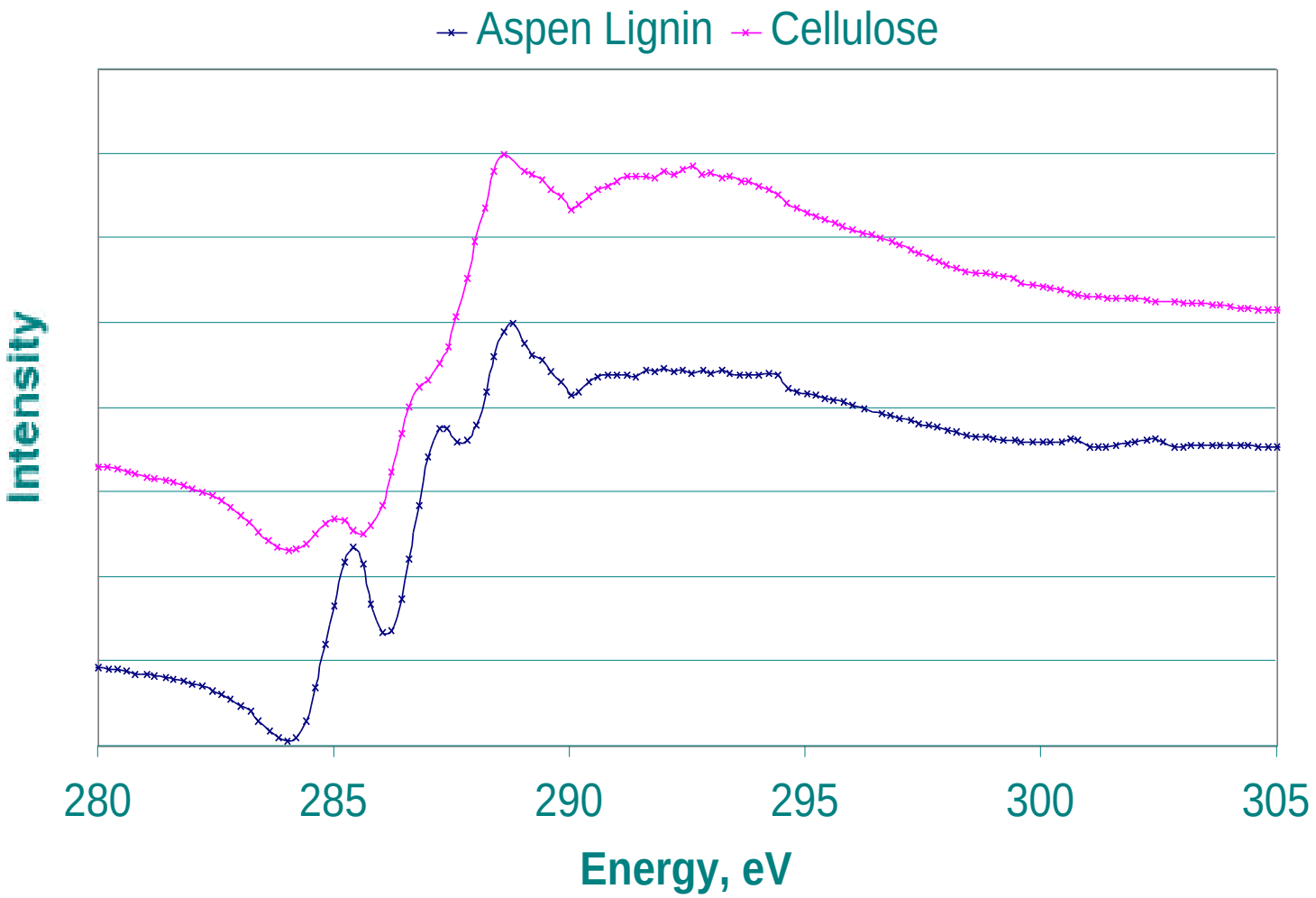
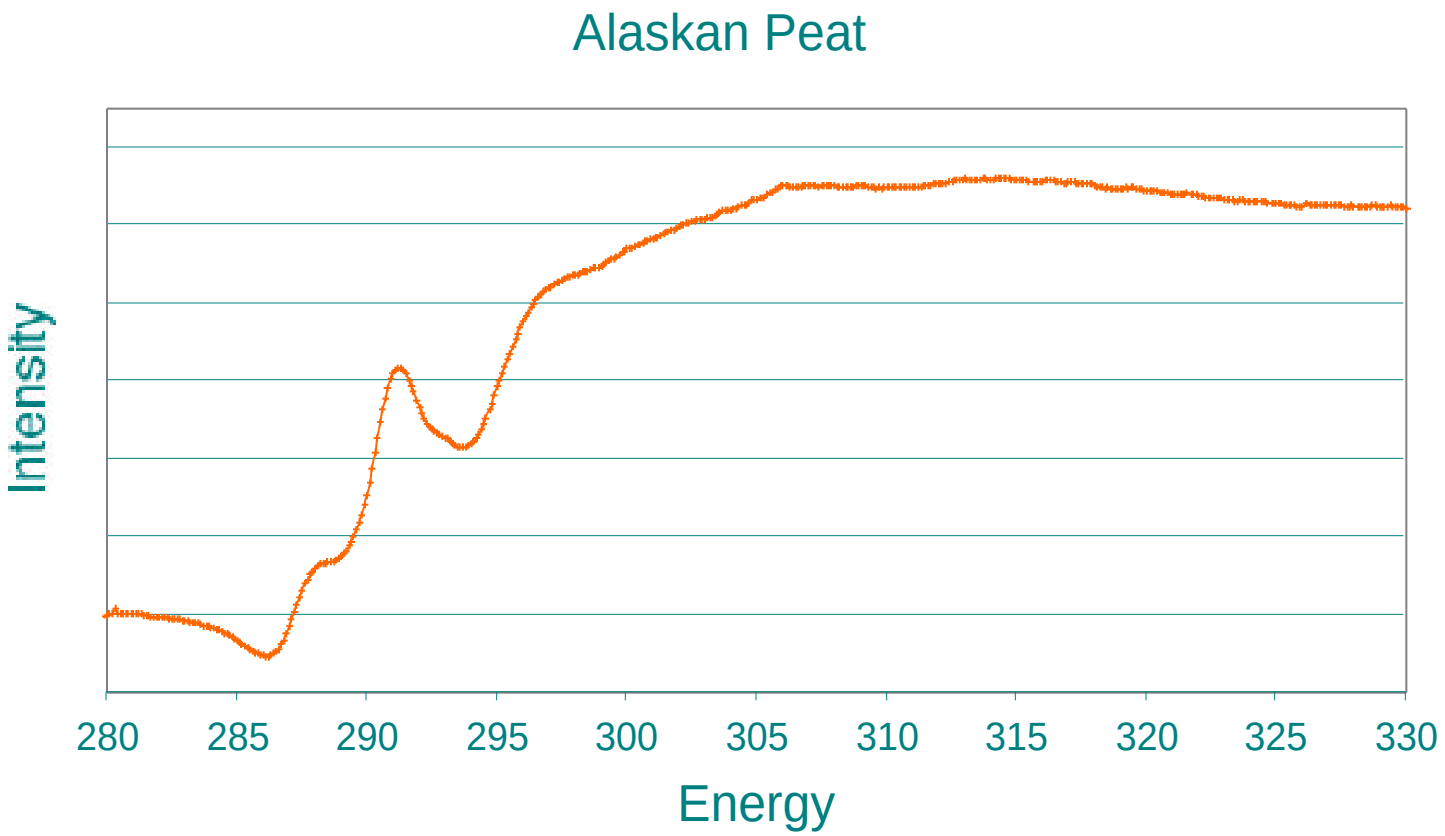
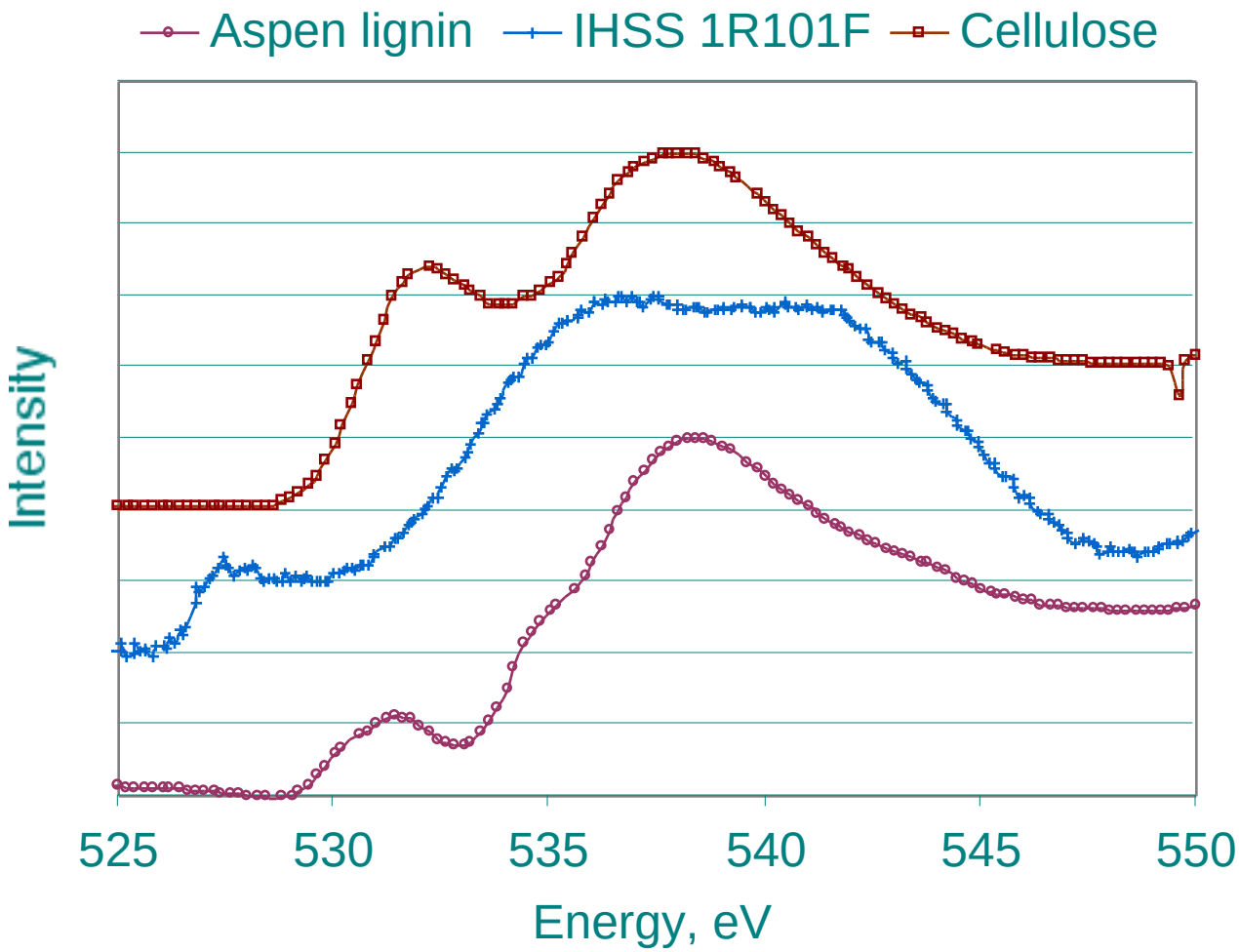
Carbon K-edge



Carbon K-edge



Oxygen K-edge



Nitrogen K-edge