Understanding Leather Degradation at Roman Vindolanda

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School of **Science, Engineering & Design**

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Vindolanda

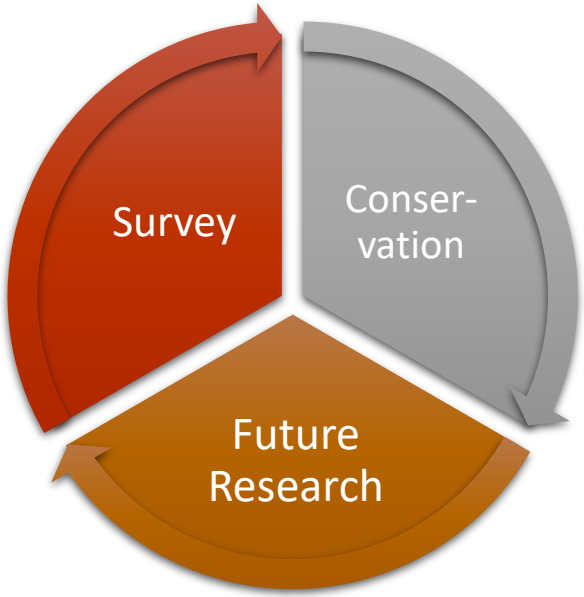
www.twitter.com/vindolandatrust
www.vindolanda.com

Preservation of artefacts at Vindolanda

Images: twitter.com/vindolandatrust

Introduction: Why leather?

- Abundance of material
  - Especially scraps
- Future research possibilities:
  - Roman Economy
  - Romano-British interactions
  - Transport and trade
- Complex matrix is expensive and difficult to conserve:
  - Archaeological leather = Vertebrate hides with a stabilising compound + soil inclusions (+ iron fittings)

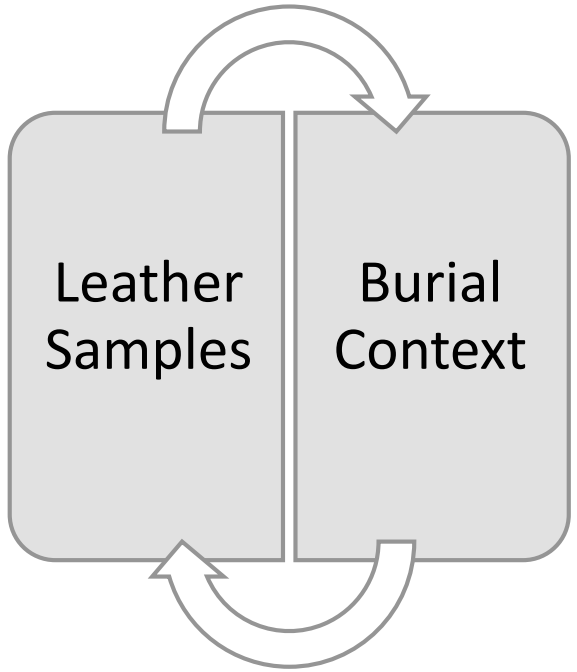


Research Questions

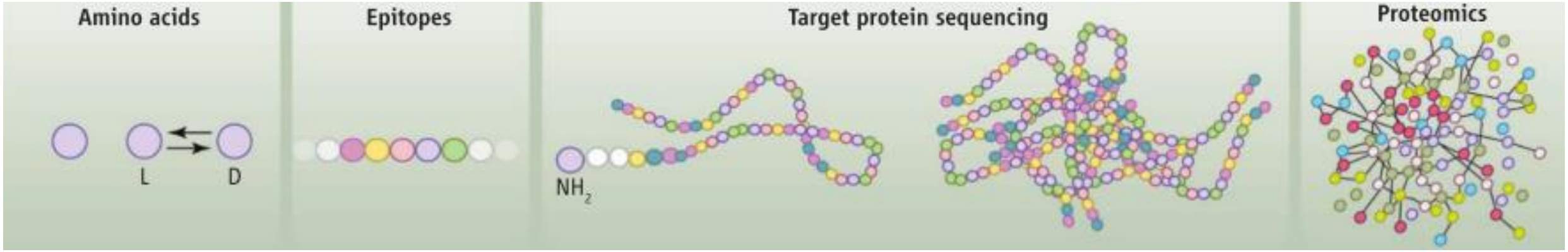
1. What is the relationship between protein preservation in leather and associated soil chemistry?

2. Is there a relationship between protein preservation in leather and past manufacturing methods?

3. What non-destructive analytical approaches are most useful to predict for protein preservation in archaeological leather?



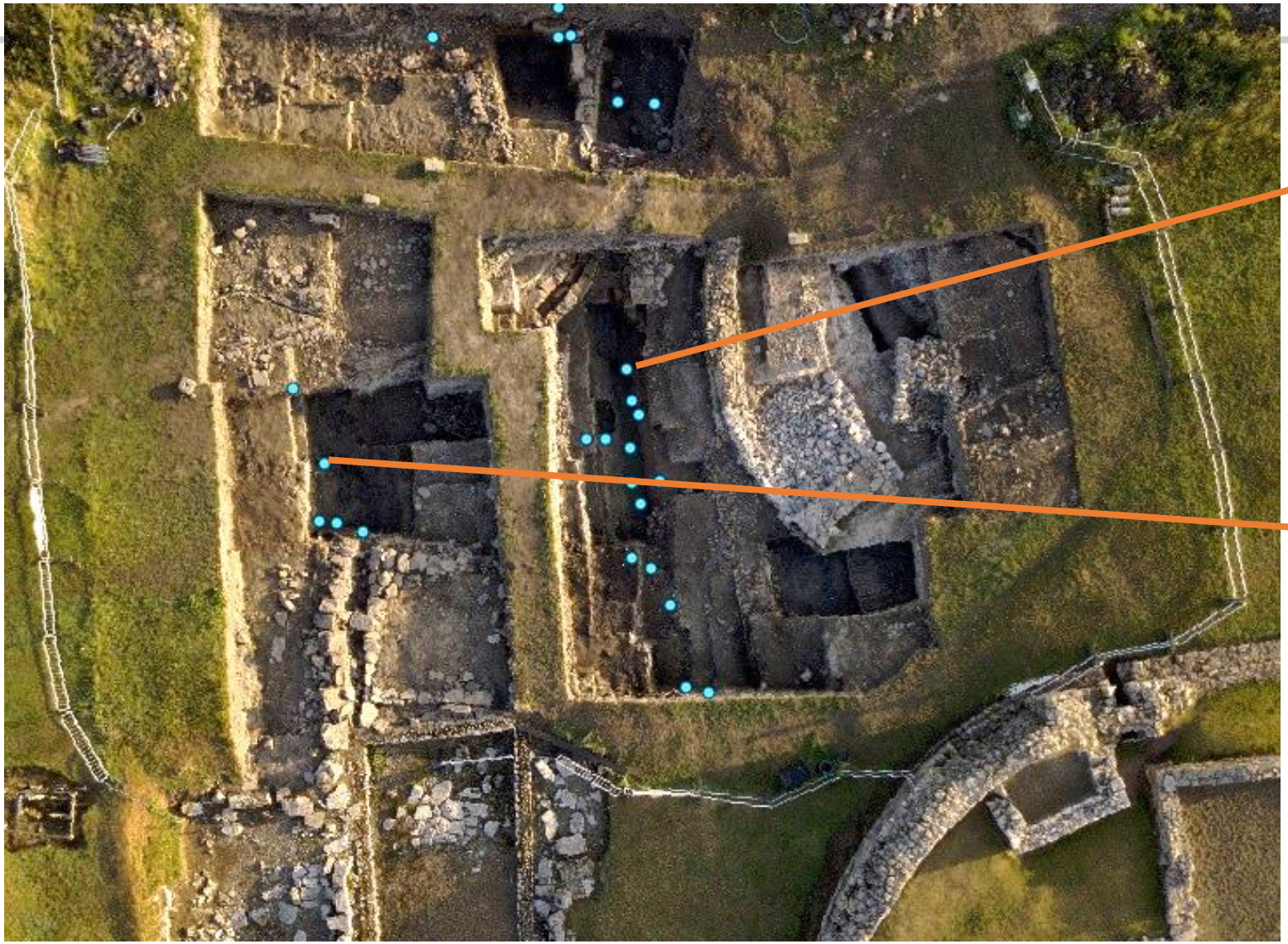
Why Proteins?



- Main structural unit of leather.
- Palaeoproteomics: Proteins are more resistant to degradation than DNA, can preserve up to 4 million years, perhaps even longer.
- Short and altered peptide fragments tend to be recovered.
- Variability in samples between and within different sites for little known reasons.
- Important to know what is real and what is contamination.
  - Before we can say what is unique, we have to know what is normal.

Cappellini et al. (2014). Unlocking ancient protein palimpsests. Science 343, 1320-1322.

Methodological Approach 1: Case Study at Vindolanda



ArcGIS Image: Marta Alberti, Vindolanda Trust

Methodological Approach 2: Burial Experiment

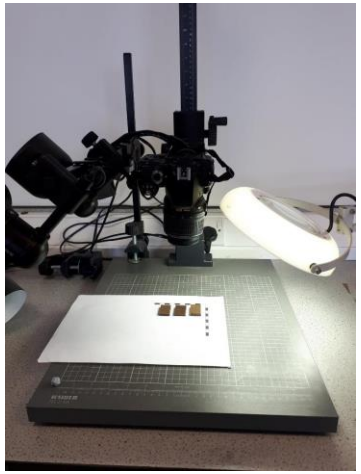
Methodological Approach 2: Burial Experiment

Pros

- Isolation of discrete variables.
- Knowledge of sample material.
- Documentation in real time.
- Samples are in soil = more representative.

Cons

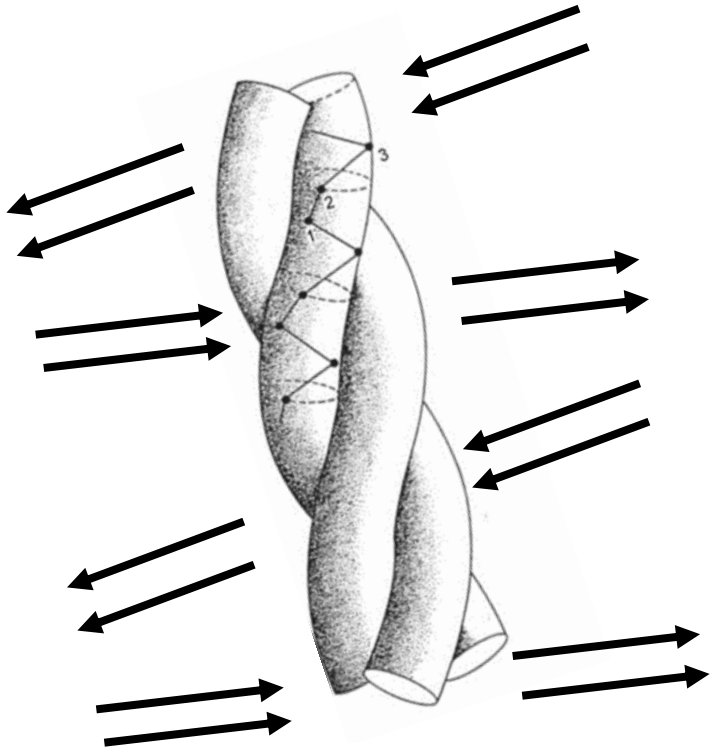
- Will never fully replicate archaeological soil environments.
- Time scale much shorter.
- Samples are in soil = incredibly complex and difficult to manage.



Analytical Approach (Leather)

Non-destructive Screening Methods:

- Visual Assessment:
  - *Photography, Microscopy, Electron Microscopy*
- Collagen structure assessment:
  - *Fourier Transform Infrared Spectroscopy (FTIR)*
- Soil leaching:
  - *Portable X-Ray Spectroscopy (pXRF)*

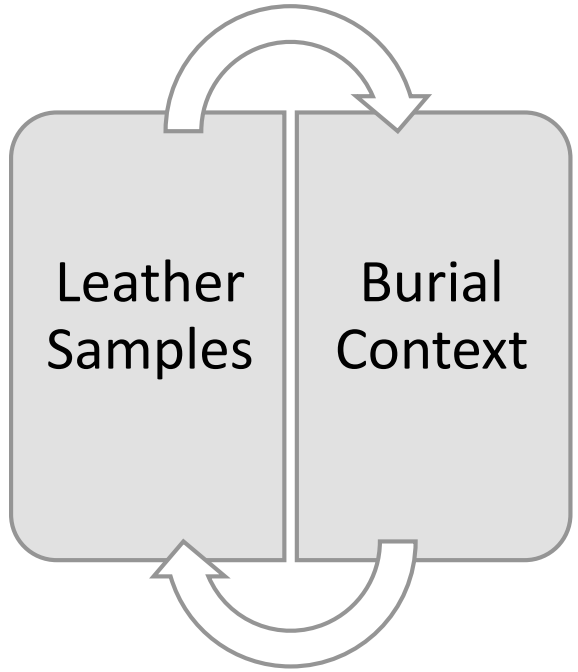


Quantitative destructive Methods:

- Amino Acid Racemization (AAR) and Chromatography (UPLC):
  - *Total % collagen per mg sample*
  - *Identification of specific amino acid degradation pathways*
- Palaeoproteomics and Tandem Mass Spectrometry (UPLC-Q-TOF):
  - *Closer look at specific degradation pathways*

Analytical Approach (Soil)

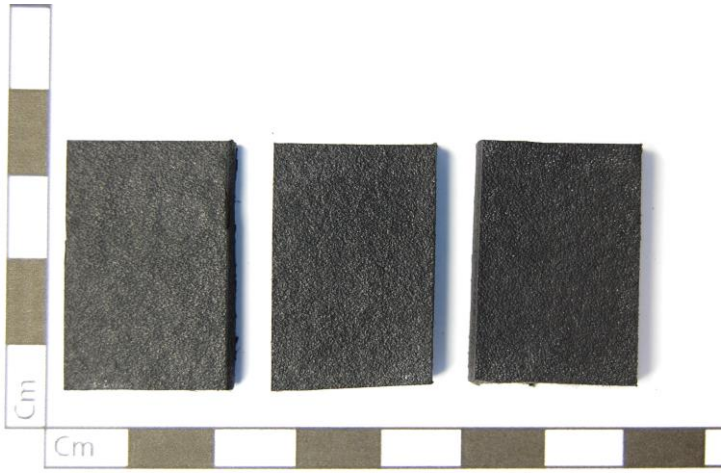
- Soil Physical Chemistry:
  - *Temperature, acidity (pH), redox potential (Eh)*
- Soil Inorganic Content:
  - *Portable X-Ray Spectroscopy (pXRF)*
- Soil Organic Content:
  - *Loss On Ignition (LOI)*
- Soil Composition:
  - *Particle size analysis.*
  - *Water permeability and moisture content*



Unburied Leather

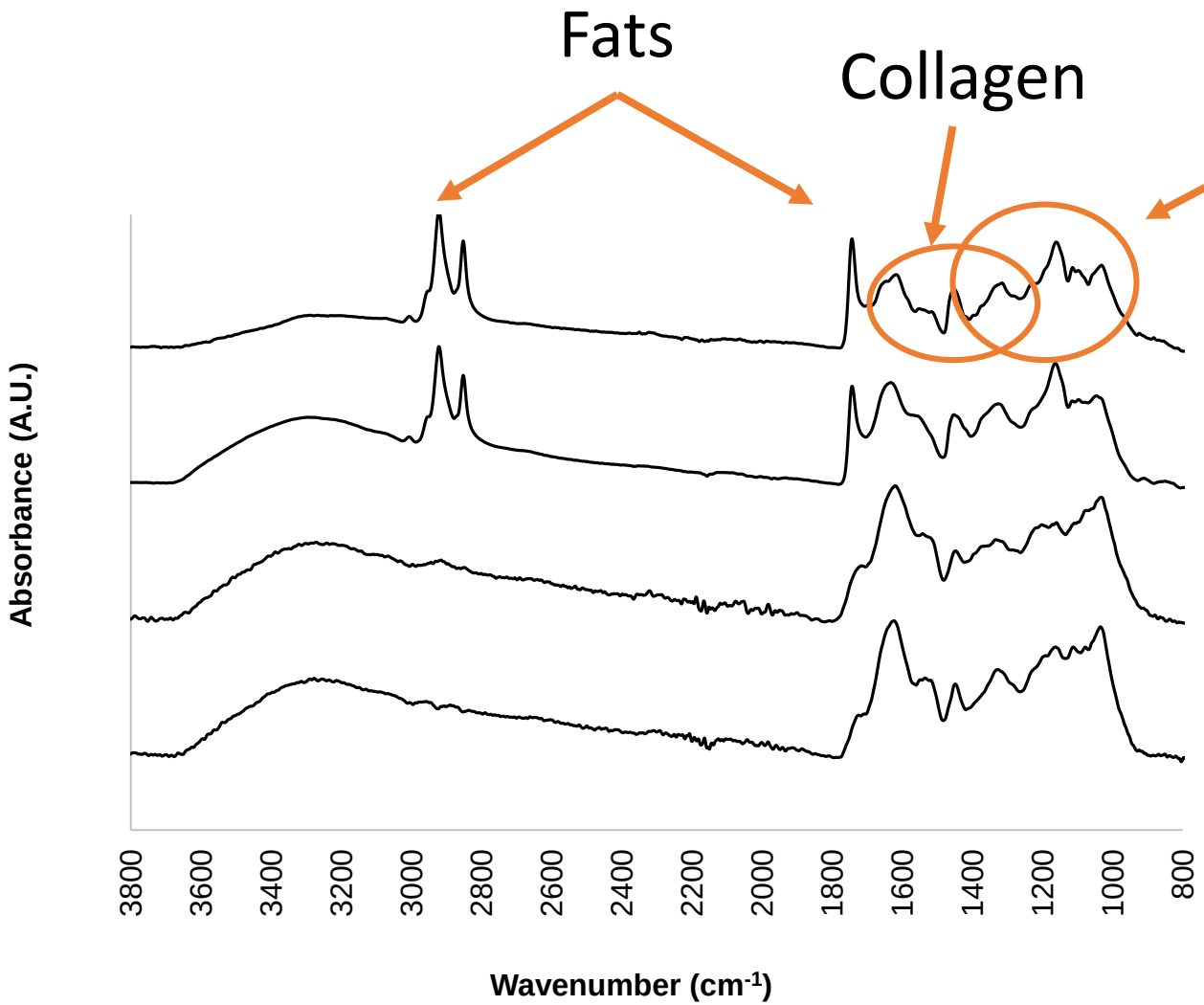
Leather in Low Oxygen Soil

Leather in Top Soil



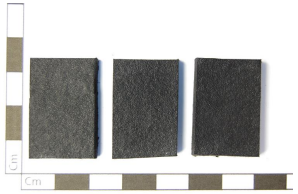
Leather in Waterlogged Conditions

Preliminary Results – Fourier Transform Infrared Spectroscopy



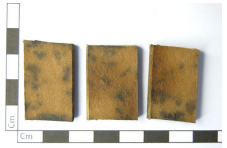
Unburied Leather

Leather in Waterlogged Soil

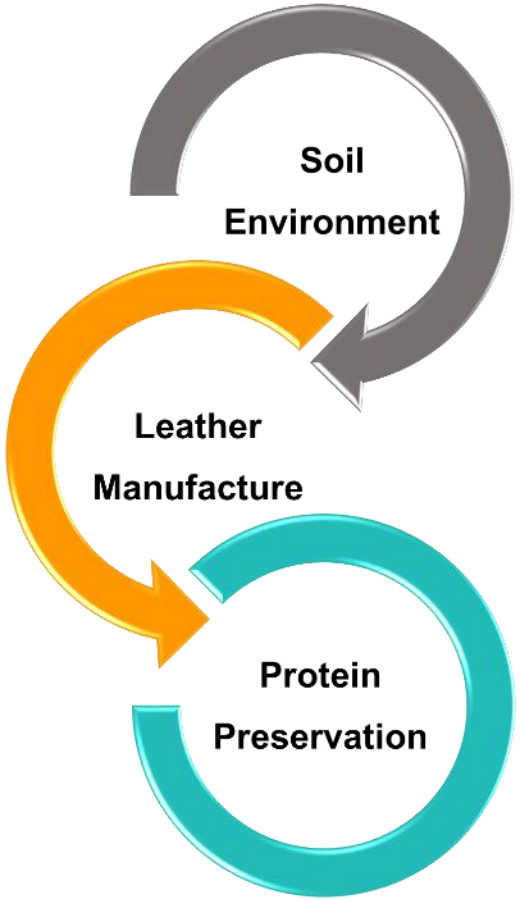


Leather in Top Soil

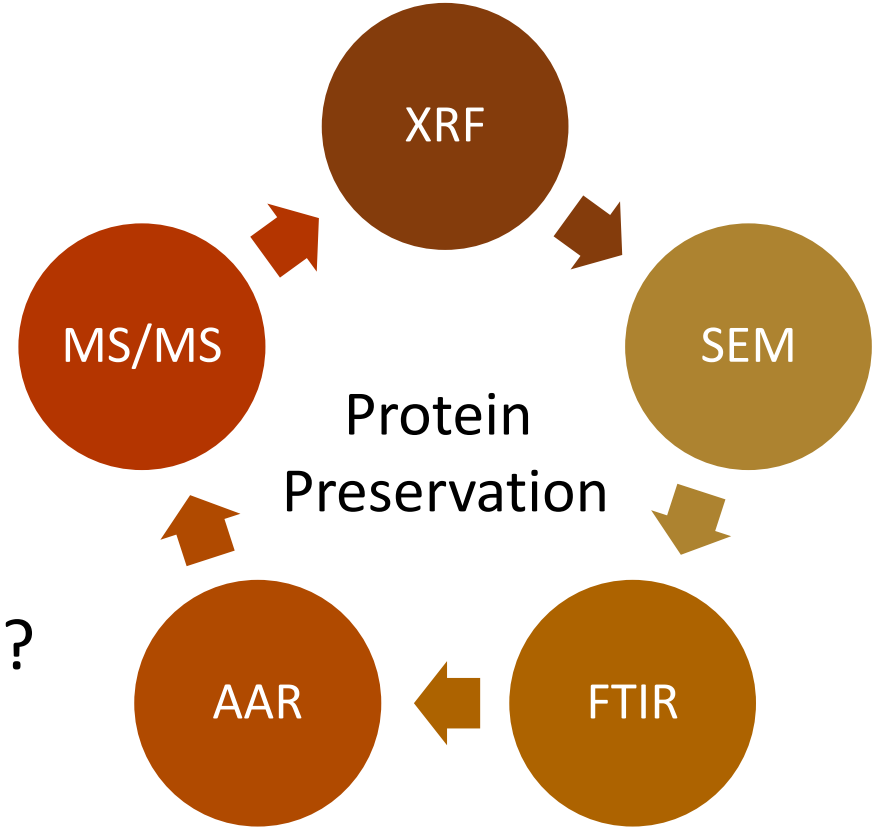
Leather in Low Oxygen Soil



Next Steps



- Are there differences between leathers of different manufacture?
- What is the role of the soil chemistry?
- Does FTIR accurately reflect collagen preservation in leather?
- Comparison to Vindolanda samples.
- What is the role of bacteria?



Acknowledgements

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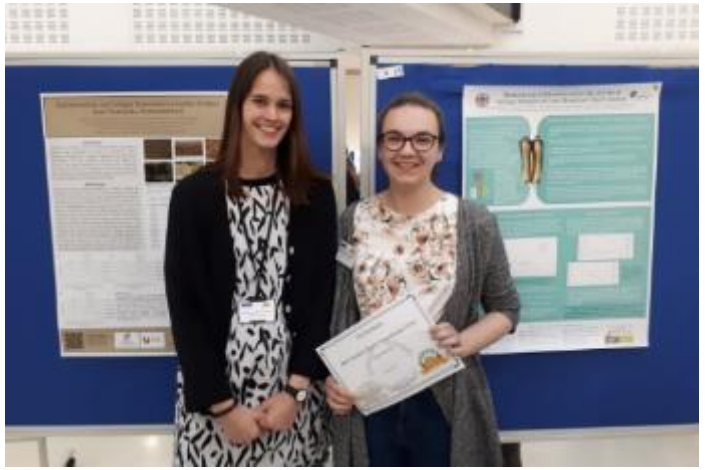

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Questions?

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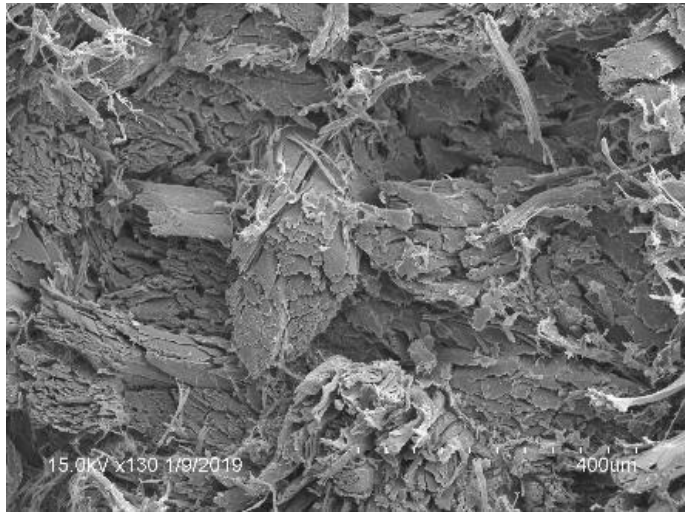

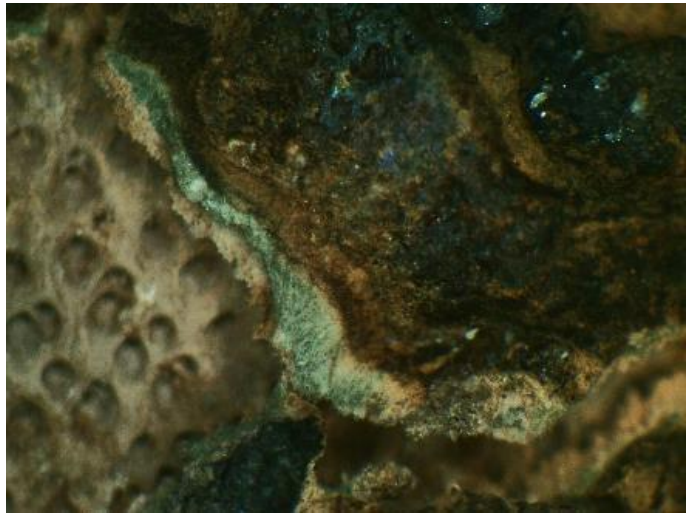

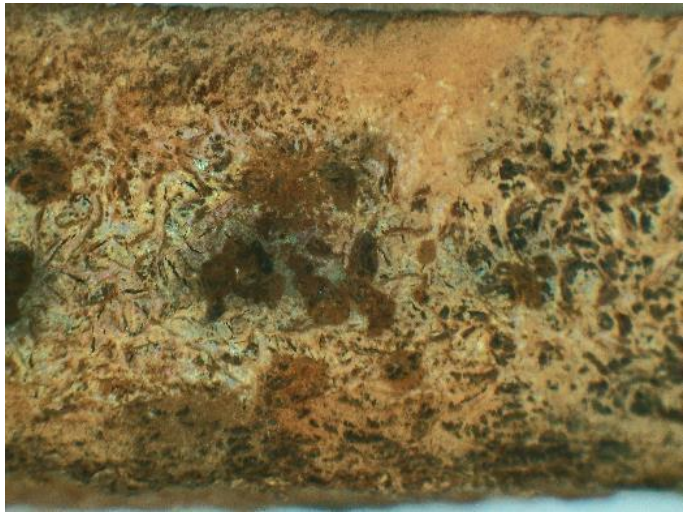

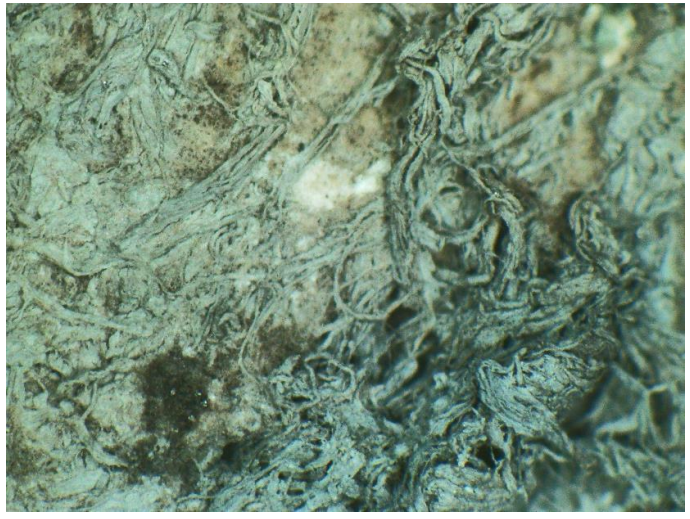

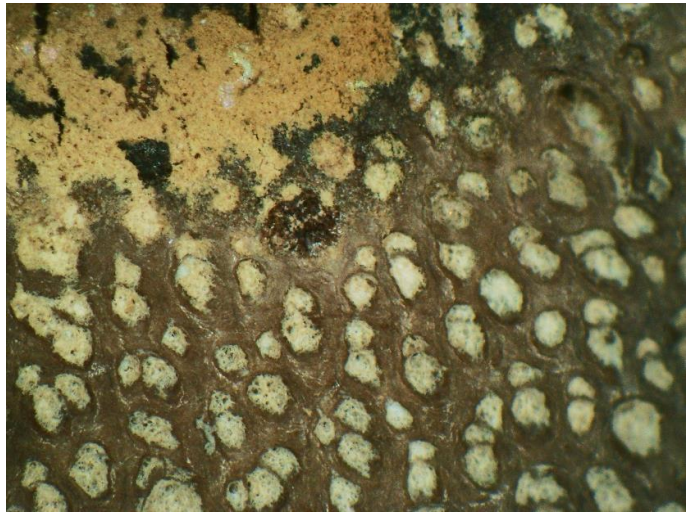

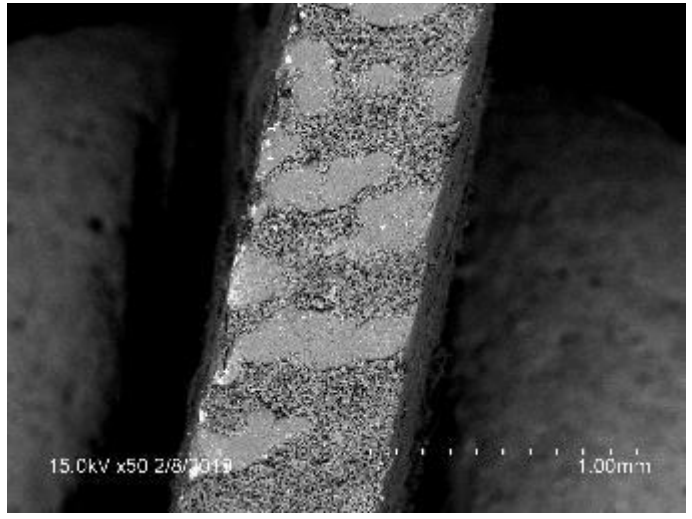

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Thank you

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