MANCHESTER 1824

The University of Manchester

Lithological control on soil chemistry, Northern Ireland

By Nicola Ashton

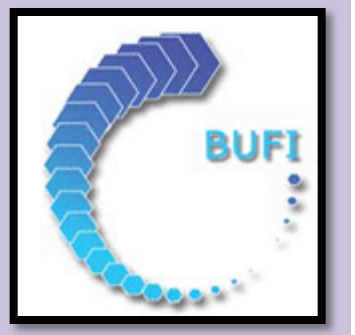
Supervisors:

Prof. R. A D. Pattrick

Prof. J. R. Lloyd

Dr B. E. van Dongen

Dr A. Tye (BGS)

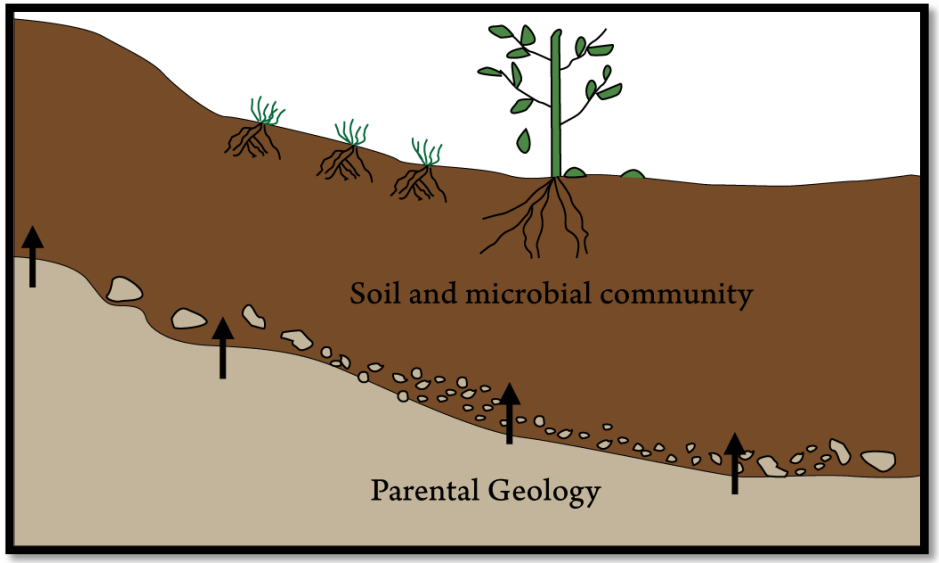


Introduction

'Soils are different around the world'

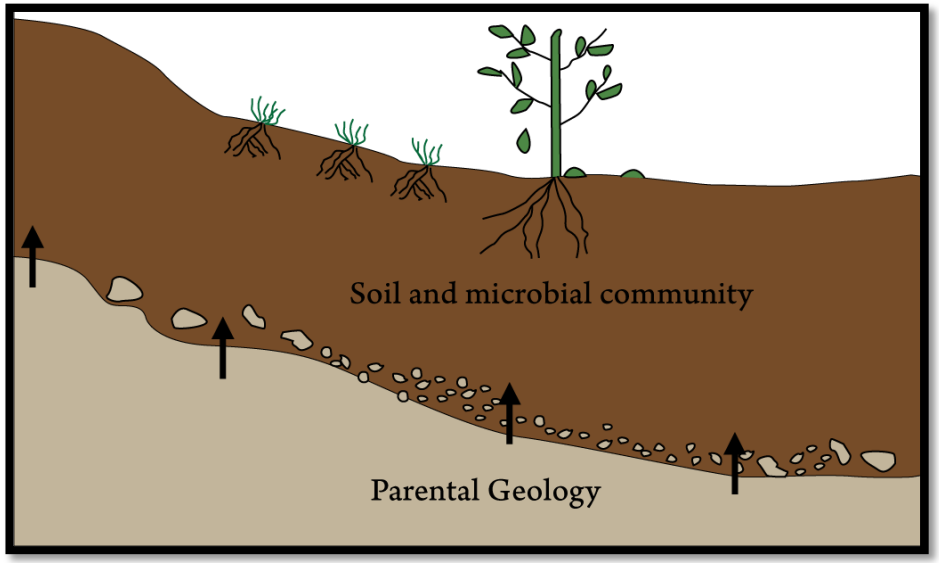
But what do we know about the relationships between source rock, soils and microorganisms?

Introduction



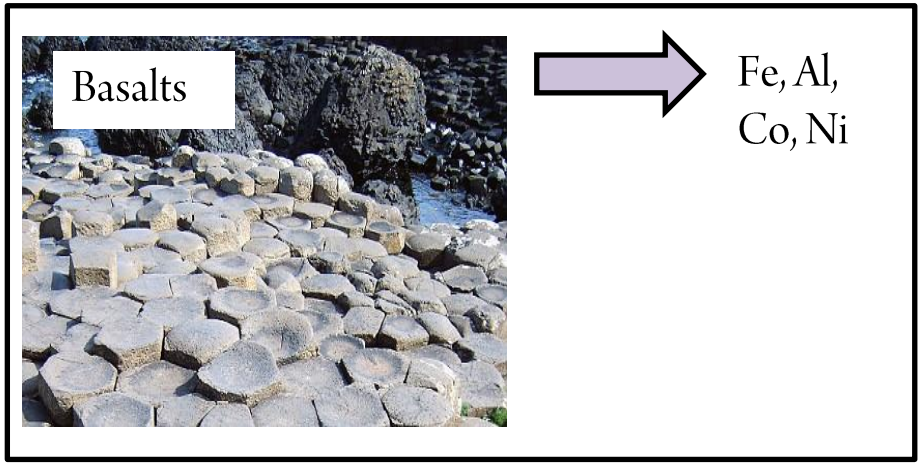
- Microbes critical for soil fertility and remediation
- Knowledge of the biogeochemical cycles is limited
- Controls on microbial communities and soil chemistry has not been systematically determined

Introduction

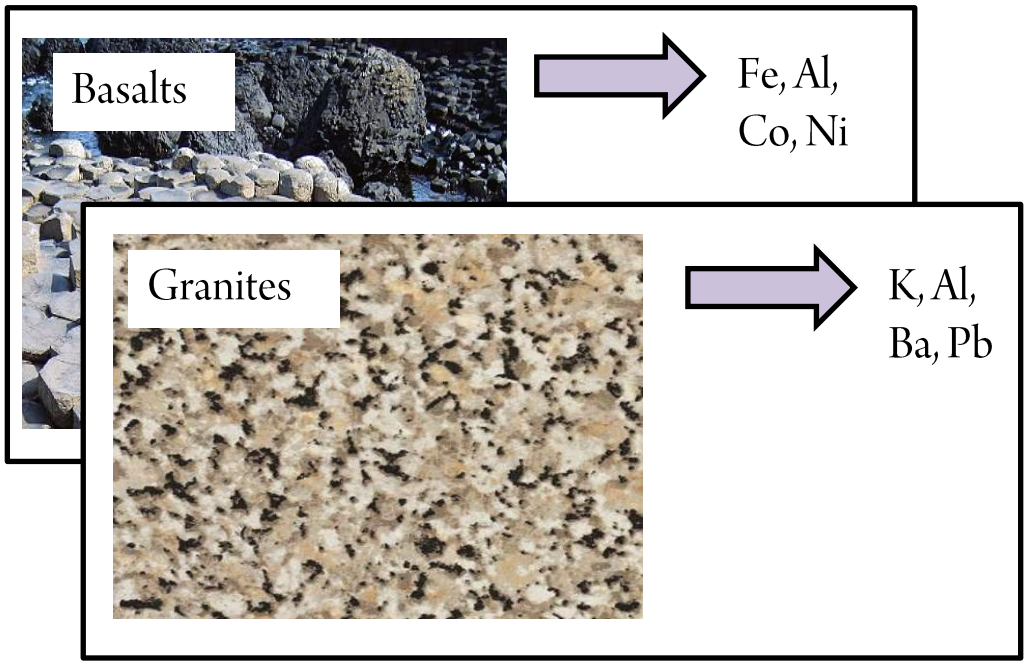


- Importance?
  - Understanding of the geochemical behaviour of soil bacteria can improve our knowledge of the release of nutrients and aid in identifying bacterial strains suitable for use
  - Bacteria can be used in variety of applications

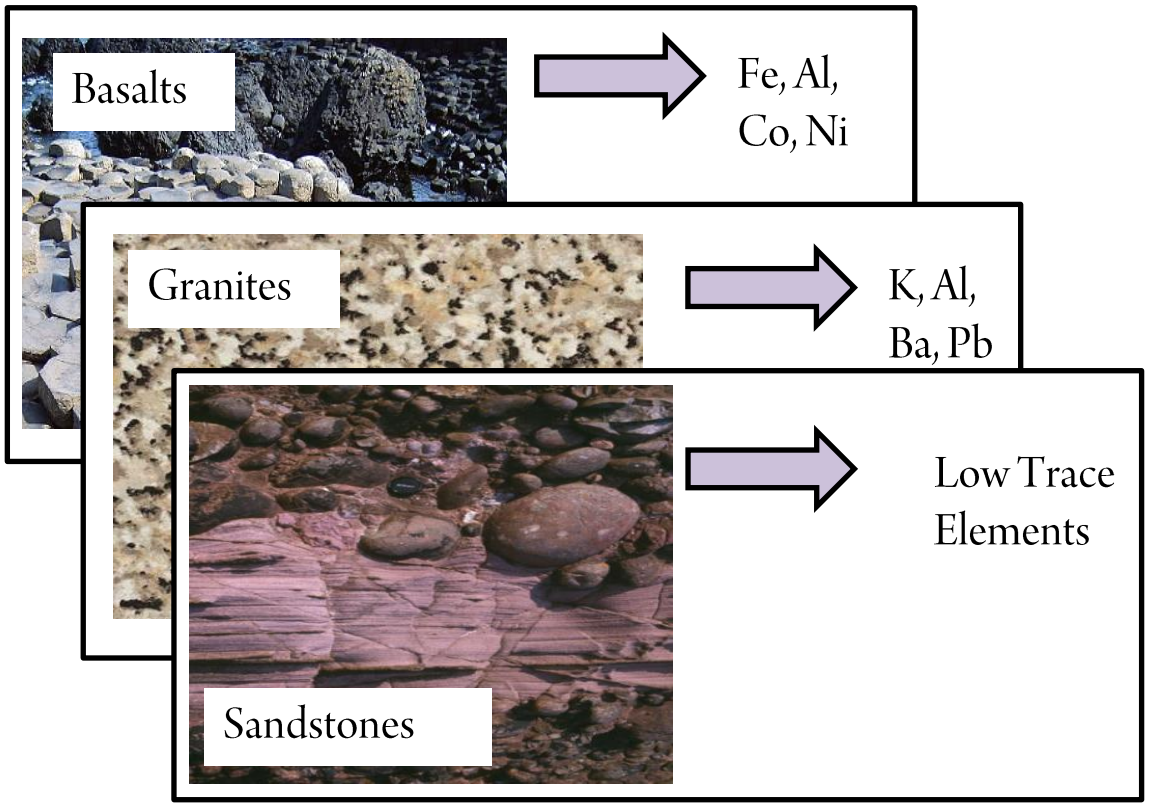
Factors – Source Rock



Factors – Source Rock



Factors – Source Rock



Aims and considerations

To better understand the relationships between the source rock, soil and microorganisms, aims include;

- Choosing suitable sites

- Analysing the collected samples to understand current conditions

- Use selected soil samples in microcosm experiments under varying conditions and monitor changes

Aims and considerations

Choosing sites of interest

Other considerations need to be taken into account:

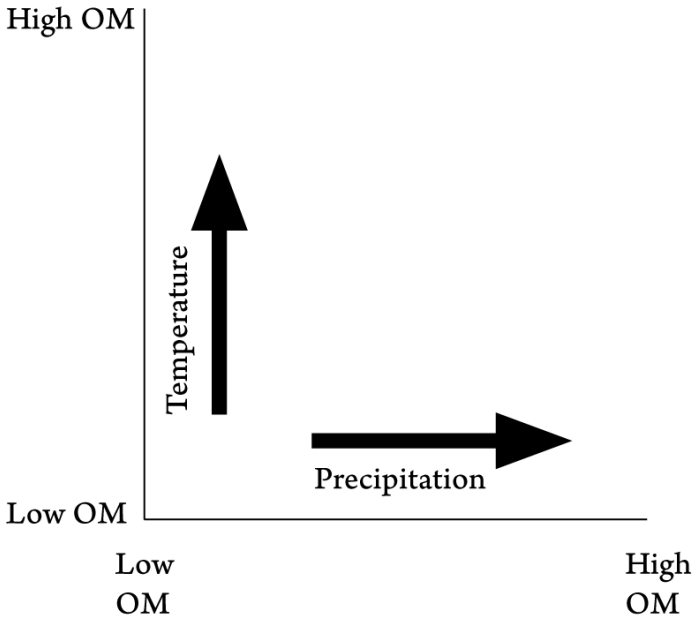
- Climate
- Age
- Topography
- Biota

Factors - Climate

Climatic input varies with respect to location;

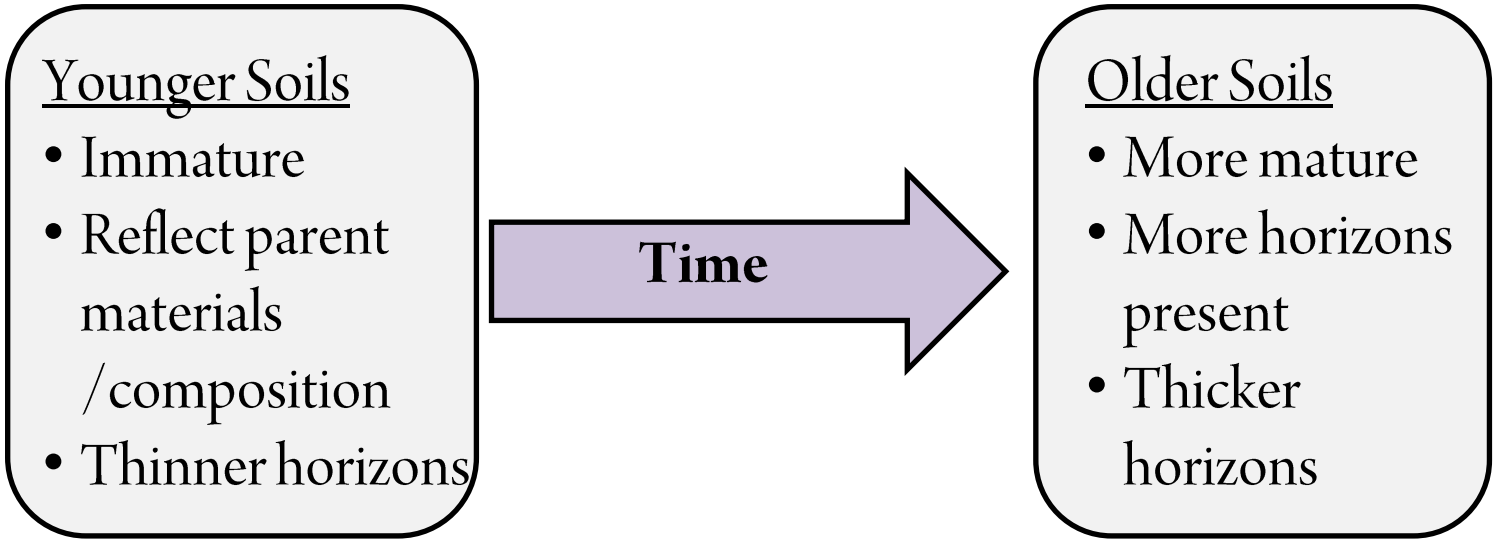
- Chemical and physical weathering
  - Temperature
  - Precipitation

- Glacial, fluvial and aeolian movement



Need to study soils which are in close proximity

Factors - Age



Need to study samples of similar age

Factors – Biota

Interactions of plants, soil organisms and anthropogenic activity

- Plants – influence amount of organic matter build up
- Soil organisms – soil mixing, element mobility
- Anthropogenic influence – industrial waste, fires

Need samples with comparable vegetation and limited human impact

Factors - Topography

Slope affects ;

- Rate of water infiltration and surface runoff
- Soil erosion
- Hillside shading

Need samples from comparable relief and limited human impact

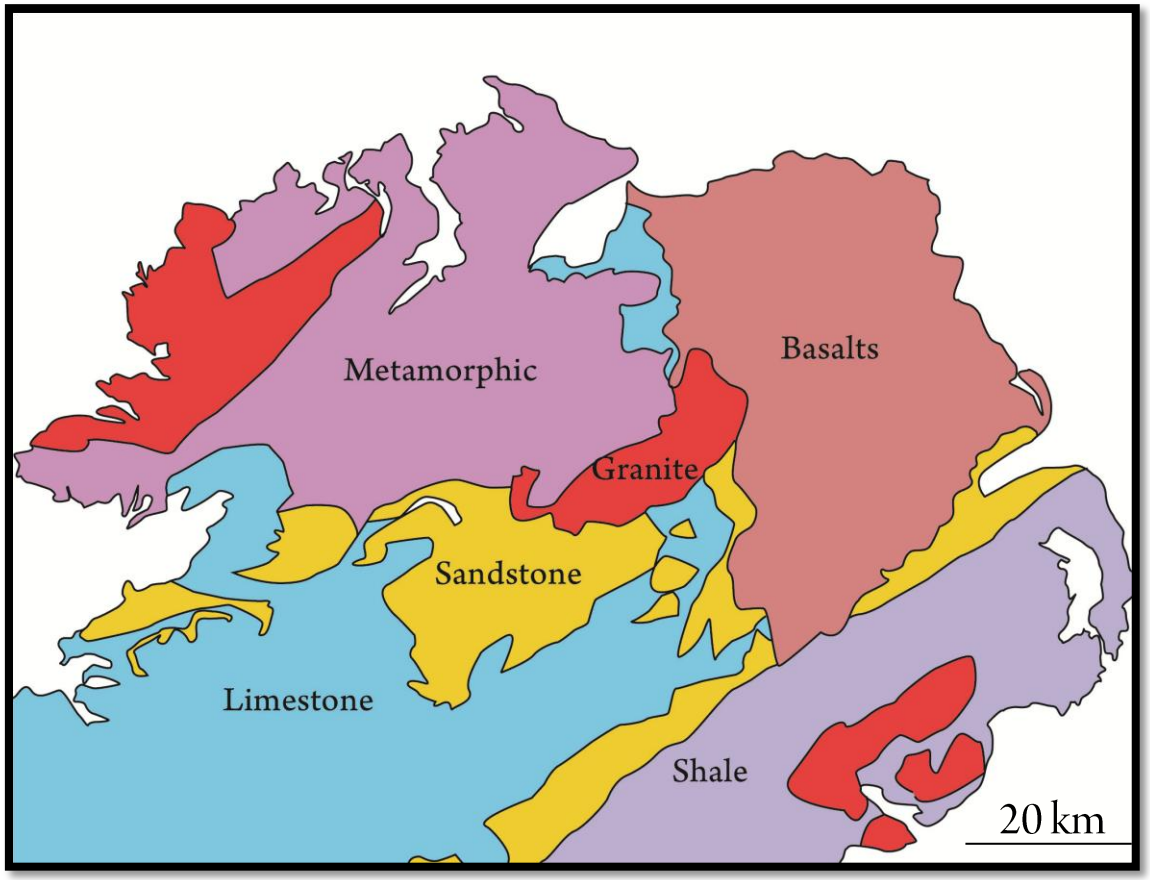
Considerations ?

Samples need:

- to originate from a variety of different parent rocks
- to be in close proximity to each other
- to be of similar age
- to be of comparable vegetation and topography

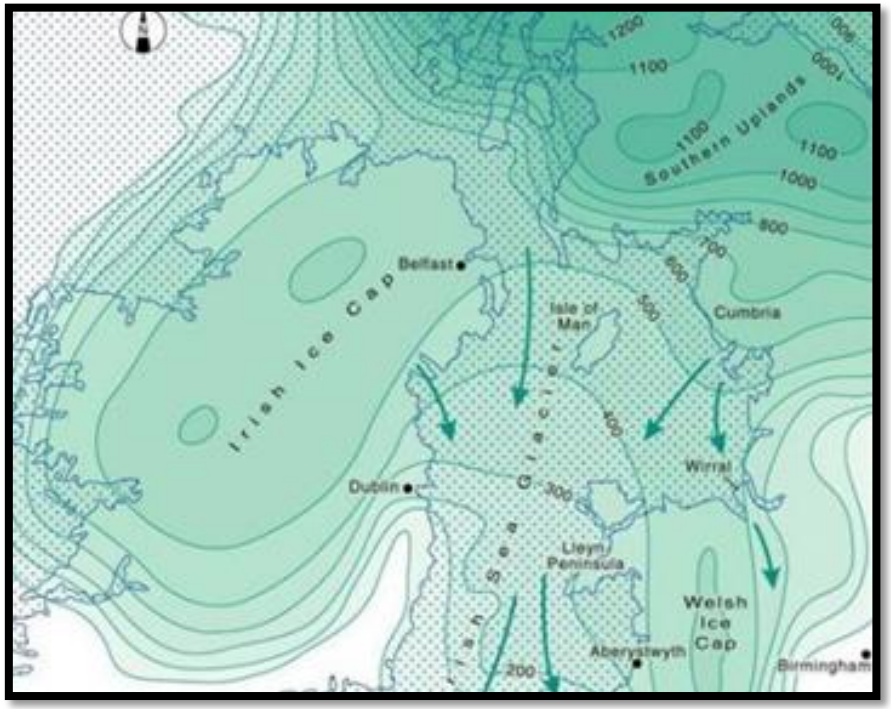
Where ?

Northern Ireland!



- **Large variety of geology**
- **Small land area – 13,550 km^2 (approximately the same size as Yorkshire!**

Northern Ireland!



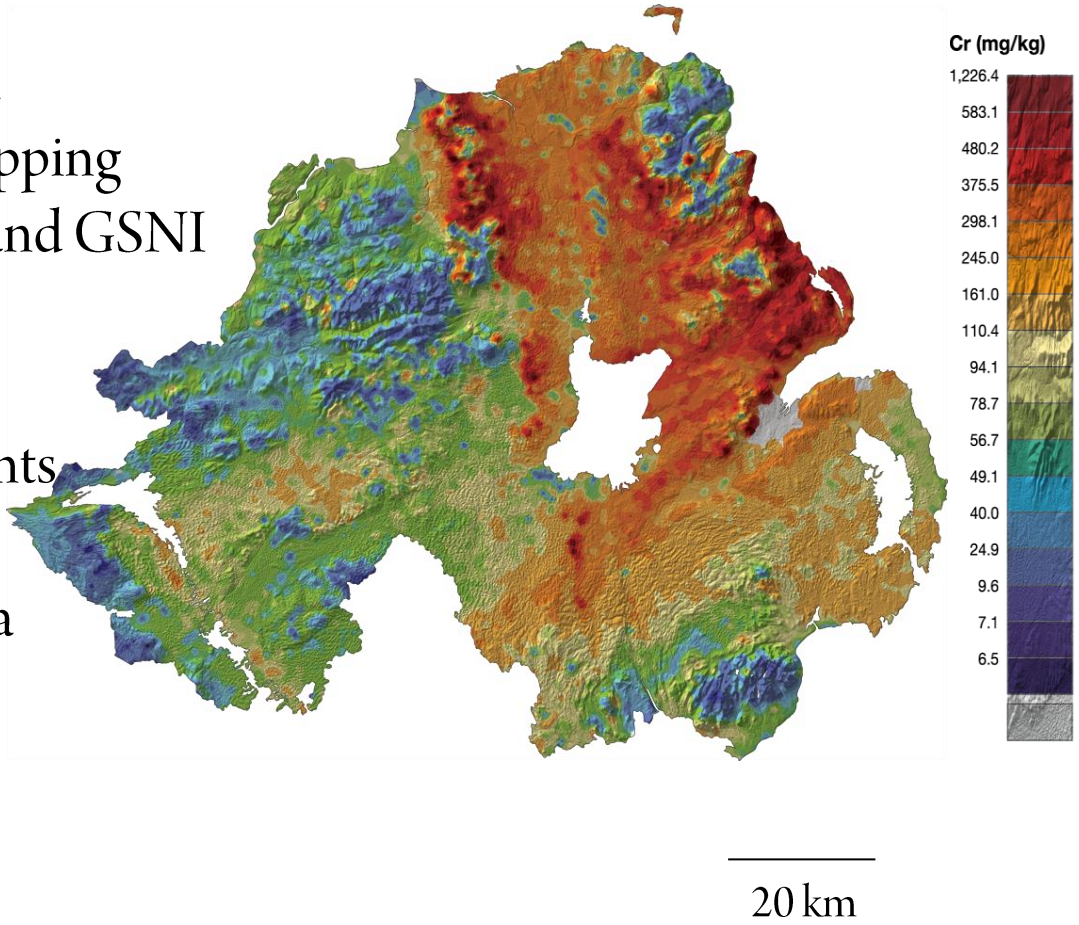
- **Soils of similar ages**
- **Soils have undergone similar climatic conditions**

Palaeogeographical reconstruction of the last British-Irish Ice sheet and Irish Sea glacier, Aberystwyth University

Tellus Database

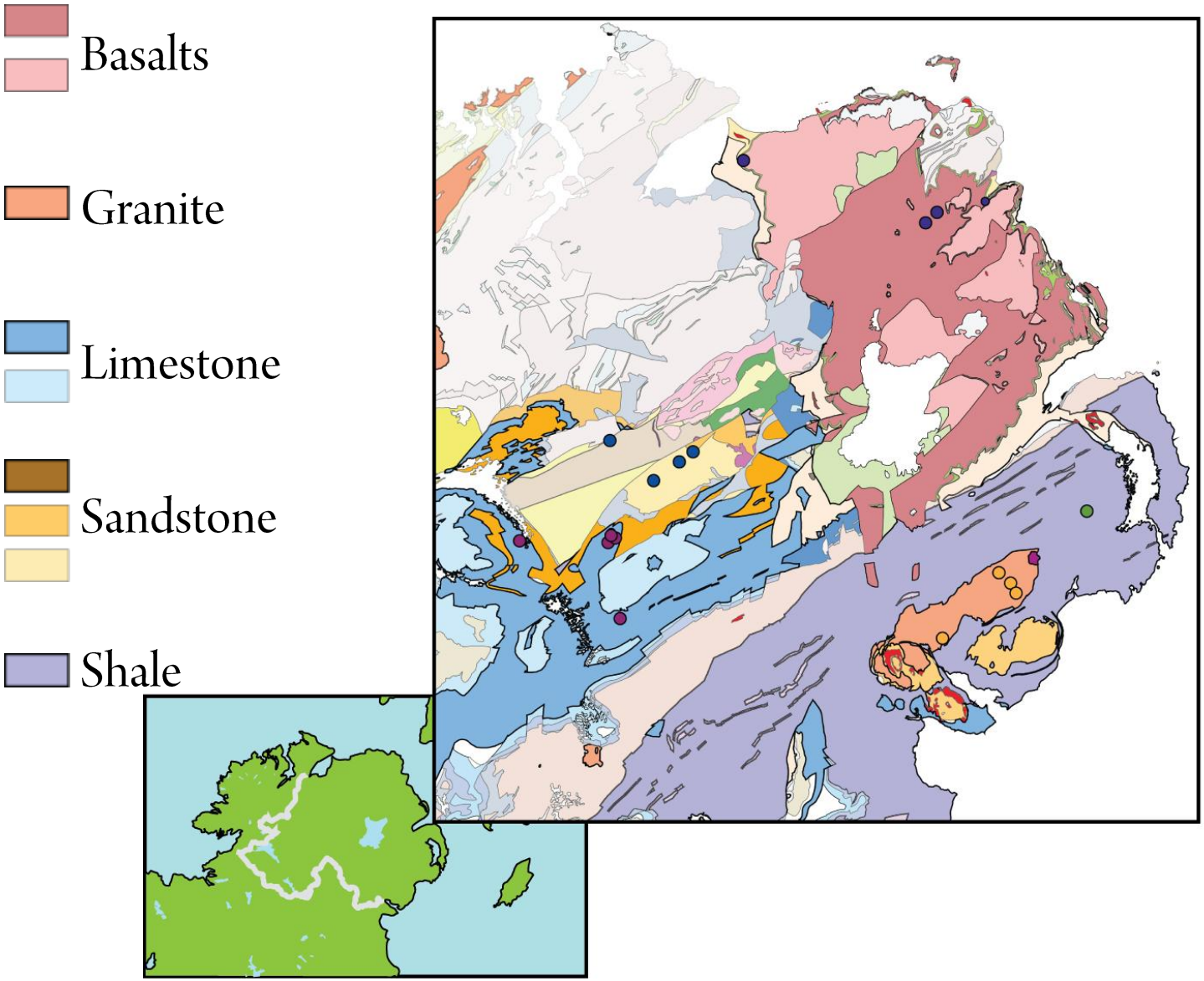
High Resolution geochemical mapping project by BGS and GSNI
- soils
- stream waters
- stream sediments

Detailed site data



Cr geochemical base line map from Tellus Survey. Provided by GSNI, crown copywrited.

Site Selection



MANCHESTER 1824

The University of Manchester

Introduction

Factors

- Source Rock
- Climate
- Age
- Biota
- Topography

Sampling

Organic Analysis

Case study

Summary

Northern Ireland is the ideal location to sample

- Varied lithology
- Soils are of same age and undergone same climatic conditions
- Easily identifiable area's of interest
- Tellus database

Already collected samples from Basalts

Future lithologies: Sandstone, Limestone, Granite and Shale

Case study

- Location: County Meath, Republic of Ireland.

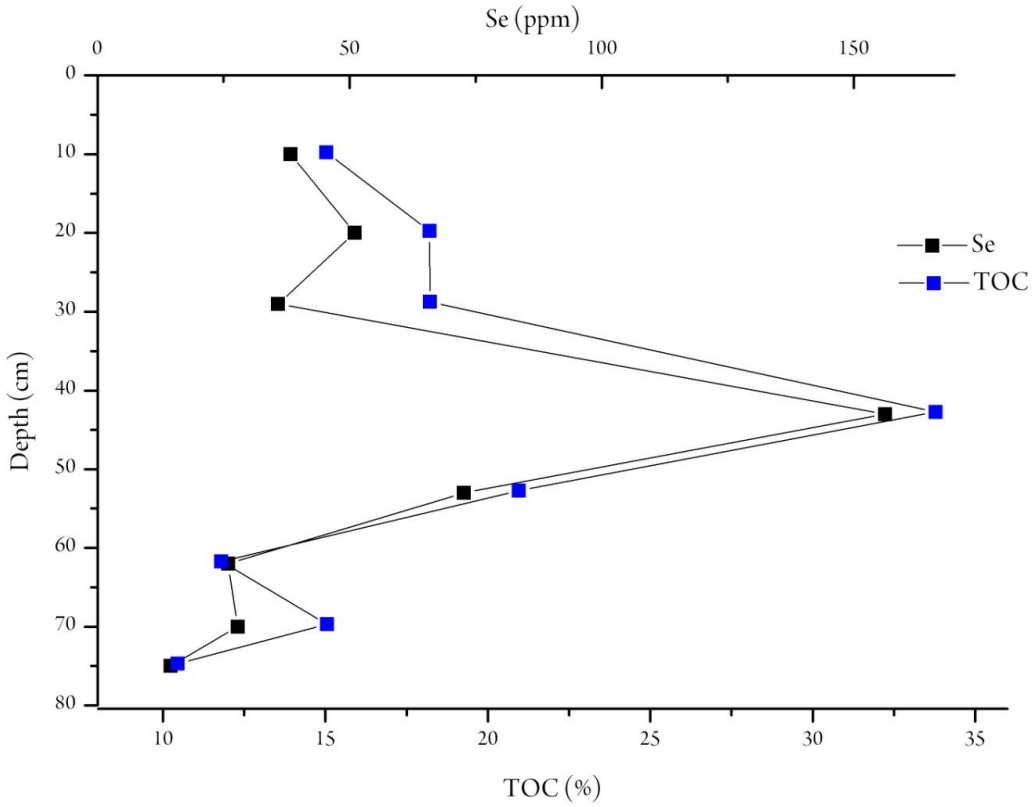
- Work of Jon Fellowes, organic analysis by Wafa al Lawati

- Focus upon understanding the chemical behaviour of Se

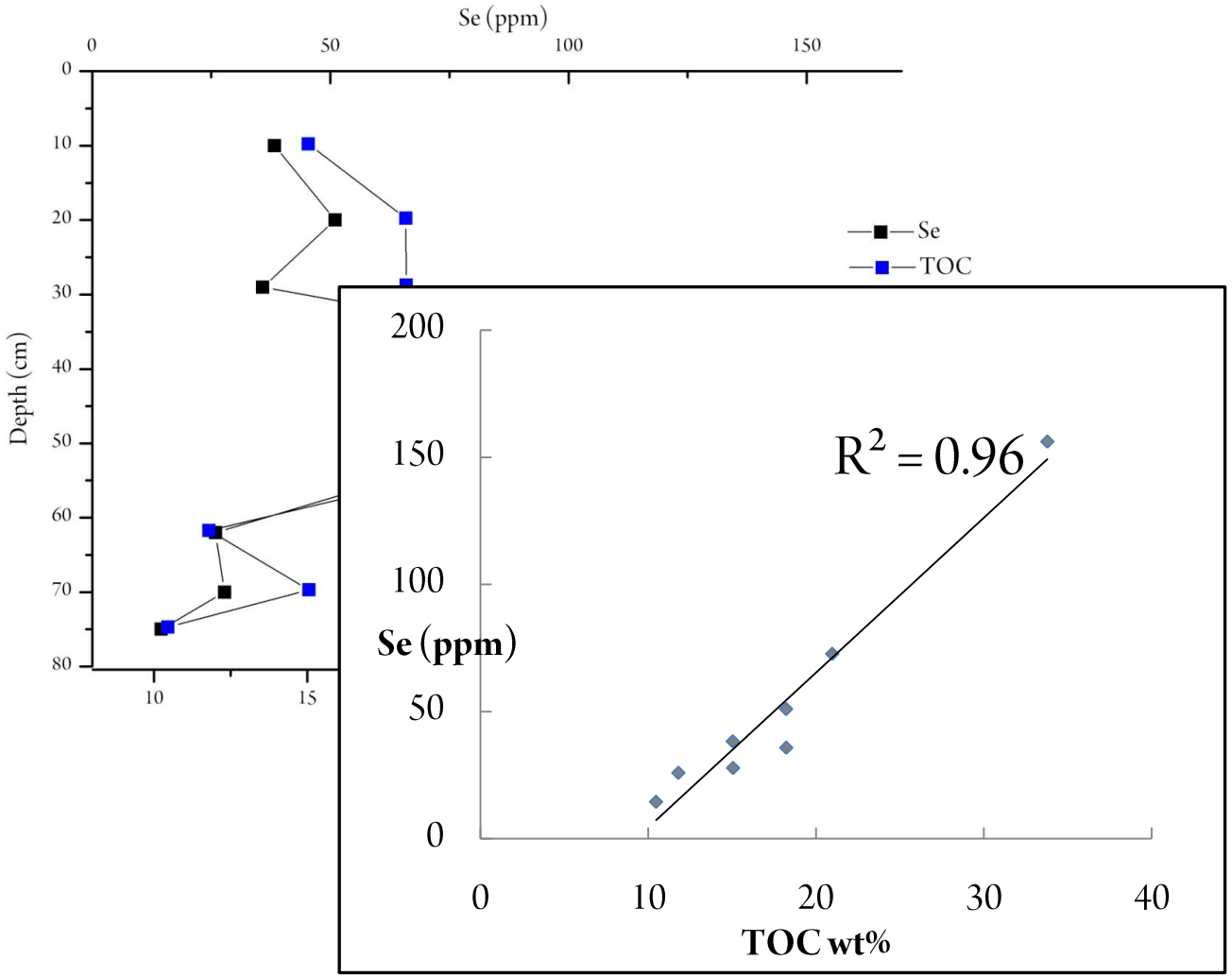
- Previous sites identified showed specific localities with very high concentrations

- Se is required for many cellular processes but is toxic at high concentrations, although this is not easily defined

Se/TOC correlation



Se/ TOC correlation



Suggests Strong correlation of Se with TOC

Se / Biomarkers?

Is Se associated with any specific biomarkers?

Se / Biomarkers?

Is Se associated with any specific biomarkers?

Correlation with Se

Biomarker Class	R^2
HMW *n*-alkanes	0.48
HMW *Alkanoic Acids*	0.77
HMW *Alkanols*	0.14
LMW *Alkanoic Acids*	0.86
LMW *Alkanols*	0.81

Se / Biomarkers?

Correlation with Se	
Biomarker Class [1]	R^2
HMW *n*-alkanes	0.48
HMW *Alkanoic Acids*	0.77
HMW *Alkanols*	0.14
LMW *Alkanoic Acids*	0.86
LMW *Alkanols*	0.81

- Of the functional groups alkanoic acids have generally the strongest correlations

Se / Biomarkers?

Correlation with Se	
Biomarker Class [1]	R^2
HMW *n*-alkanes	0.48
HMW *Alkanoic Acids*	0.77
HMW *Alkanols*	0.14
LMW *Alkanoic Acids*	0.86
LMW *Alkanols*	0.81

- Of the functional groups alkanoic acids have generally the strongest correlations
- Based upon molecular weight, LMW correlation is stronger suggesting a possible correlation with microbial biomass?
- However strongest correlation is still observed between Se and TOC

Summary

- Ireland site location
- Interesting correlation of Se with TOC, suggesting that the processes which are responsible for mobilisation of Se and TOC are the same
- Correlation with specific classes of compounds varied, generally strongest with alkanoic acids.
- Stronger correlations for LMW compounds if compared to HMW counterparts, suggesting a possible correlation with biomass.

References

- Work in progress by Jon Fellowes
- Basalts, www.irelandtourismguide.com
- Granites, www.stonecontact.com
- www.habitas.org.uk
- http://environmentalchemistry.com/yogi/periodic/Se.html#Regulatory
- GSNI
- http://www.aber.ac.uk/en/iges/research-groups/centre-glaciology/research-intro/welsh-glacial-palaeoenvironments/