Mapping Mine Waste within the Rheidol Valley, Mid Wales.

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Outline

- Context
- Previous Studies
- Introduction
- Study Area
- Methodology
- Results
- Conclusions

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Context

- A long history of mining in Europe has left a legacy of waste in various forms.
- Certain minerals present within this waste are harmful to people and the environment.
- Governments, Agencies and Industry need a cost effective way of mapping mine waste
- The same situations are met world wide, including in Central Africa (e.g. Shinkolobwe Uranium mining waste, RD Congo)

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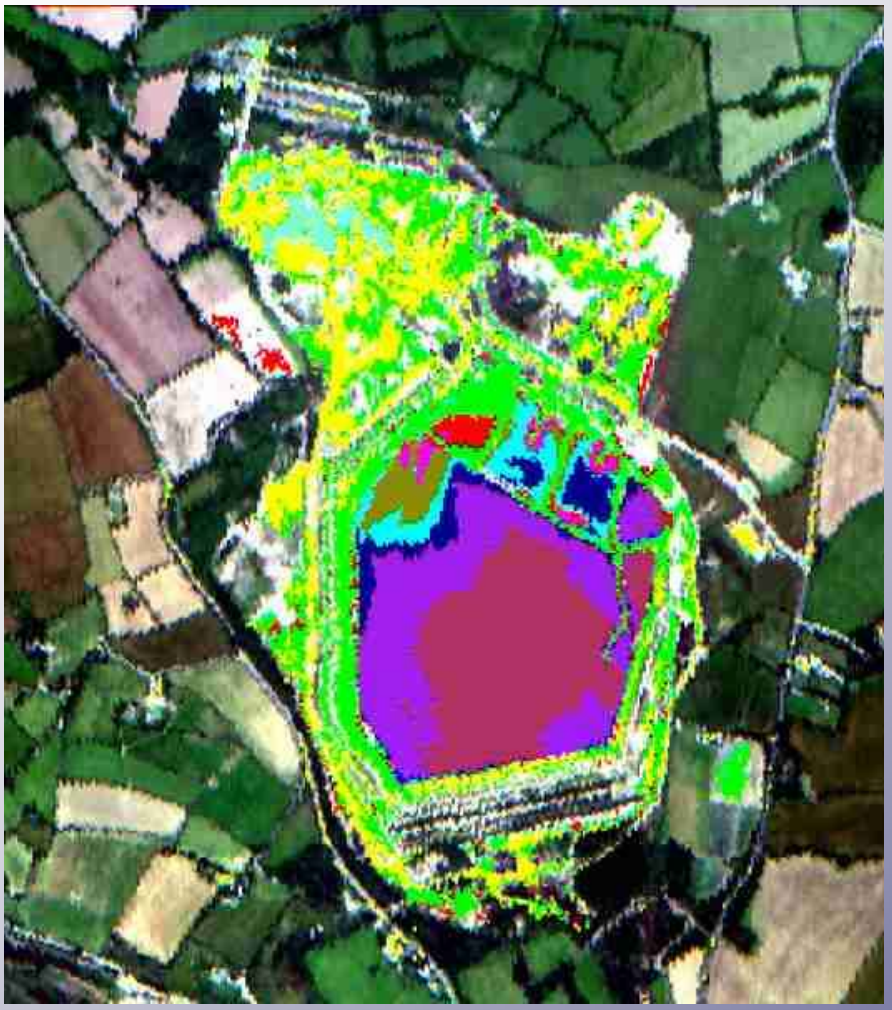
Previous Studies - MINEO



- MINEO was an EC 5th Framework R & D project
- The aim was to develop and test Hyperspectral data analysis tools in a European context
- Focusing on mine pollution rather than mineral exploration
- Work in a populous, temperate environment, rather than arid conditions

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Introduction – Rheidol Valley

- The Rheidol Valley, in Mid Wales, contains many old lead mines
- Mine waste is exposed at surface and beneath vegetation
- Leaching is occurring
- This process results in red and yellow oxides and sulphate minerals
- It is this diversity of minerals and weathering products that make this area challenging to characterize and map

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Study Site

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Geology

- Mineralisation within the Rheidol Valley occurs within lower Palaeozoic host rocks
- Mineralisation consists of the sulphides: pyrite (FeS_2), chalcopyrite ($CuFeS_2$), galena (PbS) and sphalerite (ZnS)
- East North East - trending lodes worked primarily for lead and zinc

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Mining History – Rheidol Valley

- Production was constant from 1750-1917
- Sphalerite principal mineral
- Associated with abundant marcasite and pyrite and smaller amounts of galena
- All mines now abandoned

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Drainage – Rheidol Mine

- Drainage waters flow from two adits
- They collect into a main stream and are channelled through a filter bed before discharging into the Rheidol River
- Despite the remediation work, the mine has a major impact on the upper Rheidol catchment

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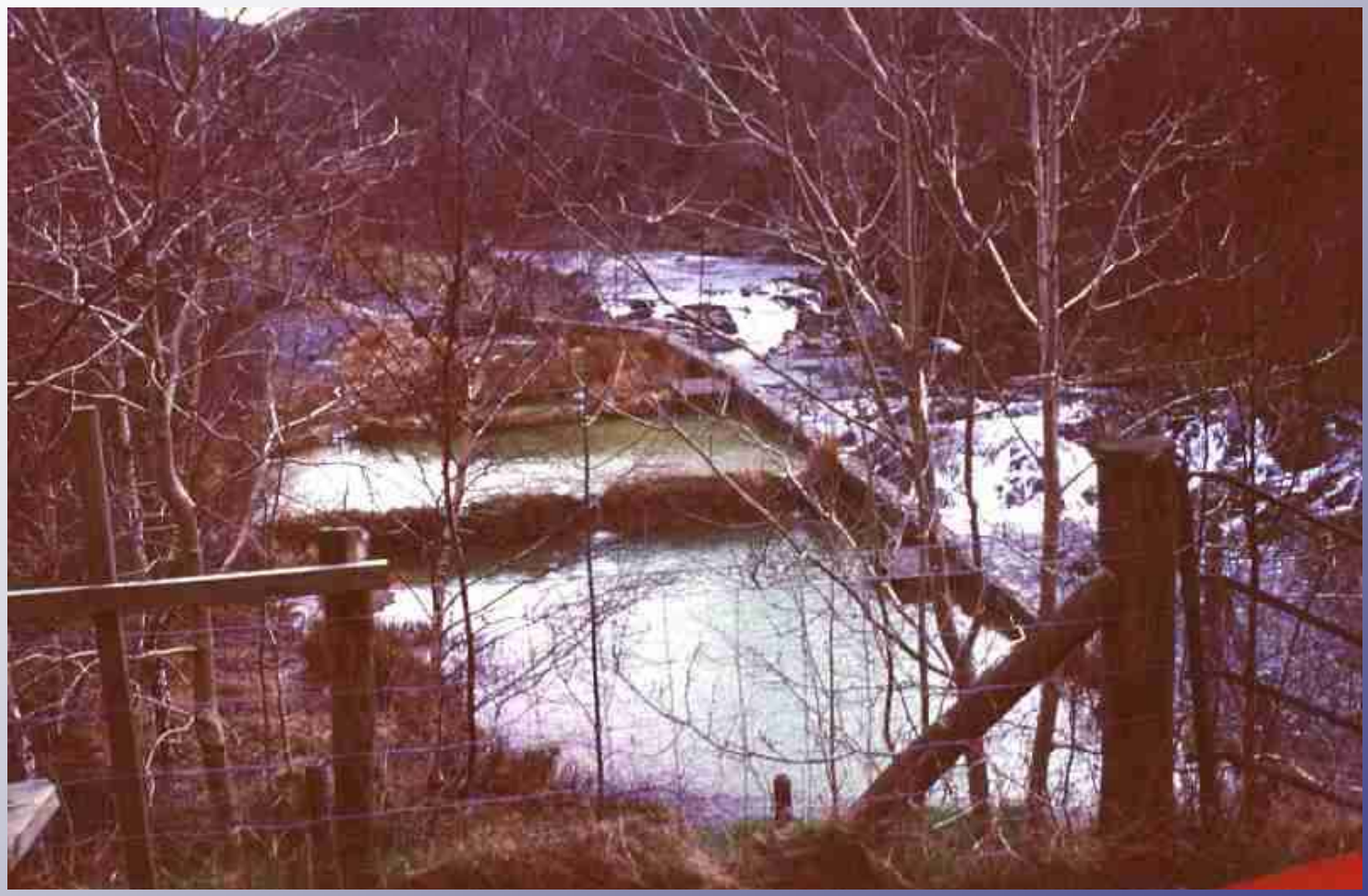
Intervention example: reed bed filter



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Geochemical Analysis

- Water sampled before and after the reed bed filter shows only a limited increase in pH from 3.42 to 4.02 and reduction in heavy metal amounts (Pb from 724 to 357 mg/l, Zn from 12.9 to 9.8 mg/l)
- The influence of the mine on the River Rheidol is evident in the concentration of zinc increasing downstream of the mine site
- This concentration is greatly over the recommended EQS limit for Zn in waters such as Cwm Rheidol

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HyMap Data

Sensor used is HyMap

- Hyperspectral Airborne Scanner
- 126 Bands
- Wavelength region 0.45 - 2.5 μm
- Bandwidth between 15 and 20 nm
- Pixel size between 3 and 10 m

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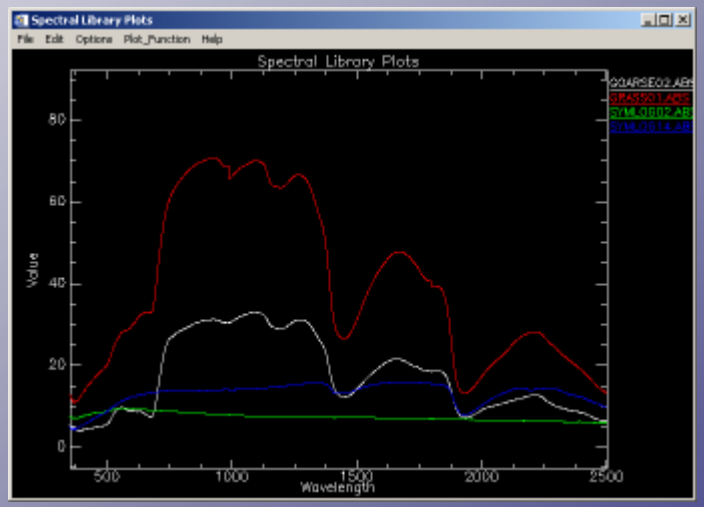
Rheidol Valley
HyMap and field spectra



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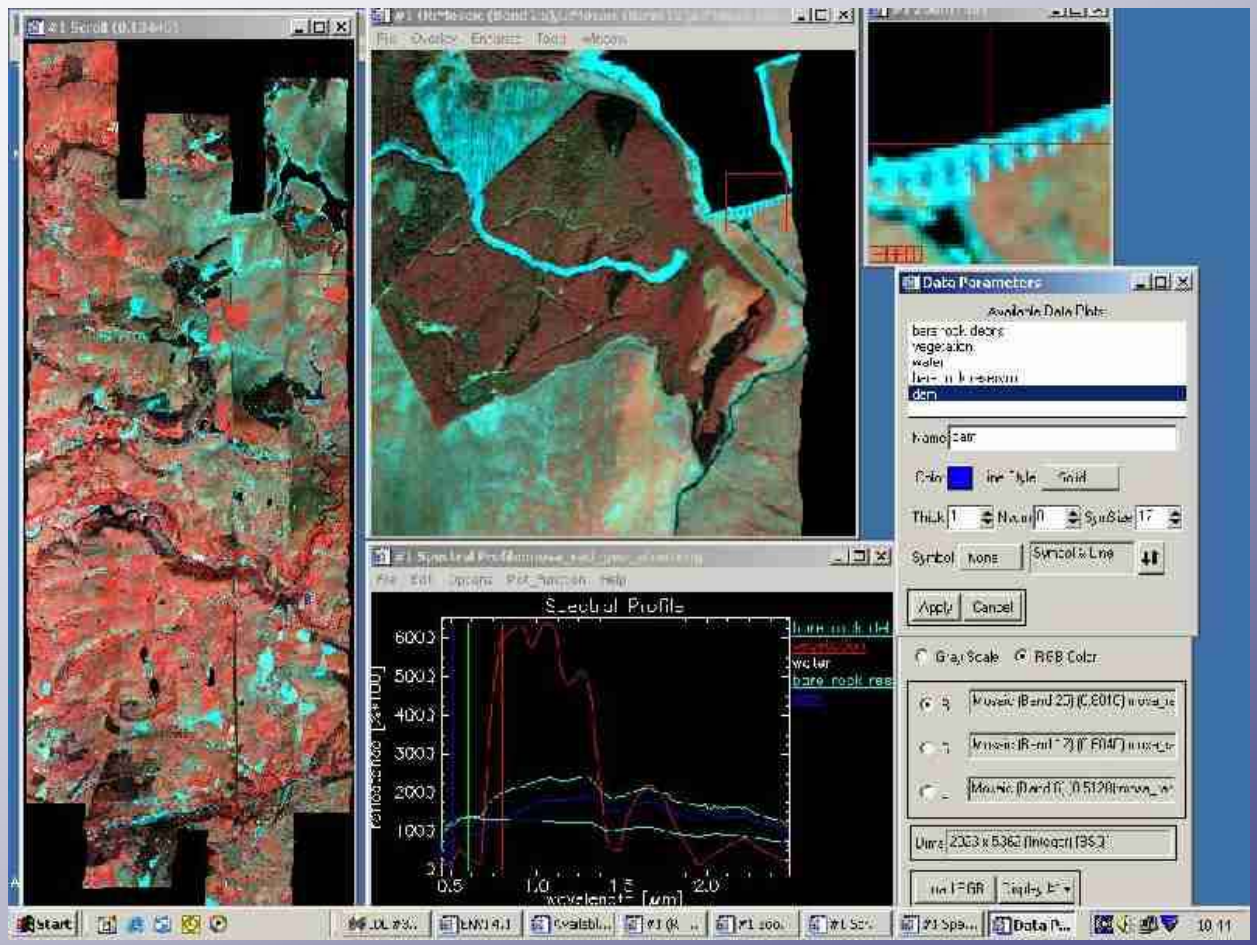
HyMap mosaic



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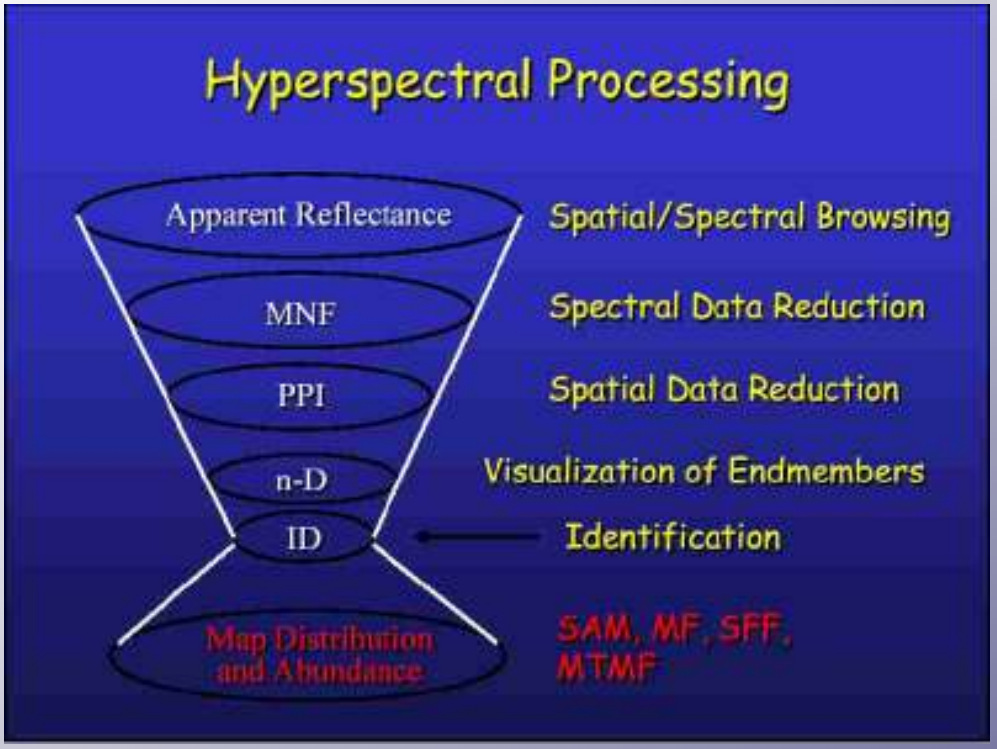
Methodology



- Atmospheric correction
- Minimum Noise Fraction (MNF)
- Pixel Purity Index (PPI)
- n-D scatter plots
- End-member selection

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Methodology Cont…

- Visual Inspection of end members
- Comparison with field spectra
- SAM classification
  - ➢ Physically based spectral classification
  - ➢ Uses n-dimensional angle to match pixels
  - ➢ Algorithm calculates the angle between spectra

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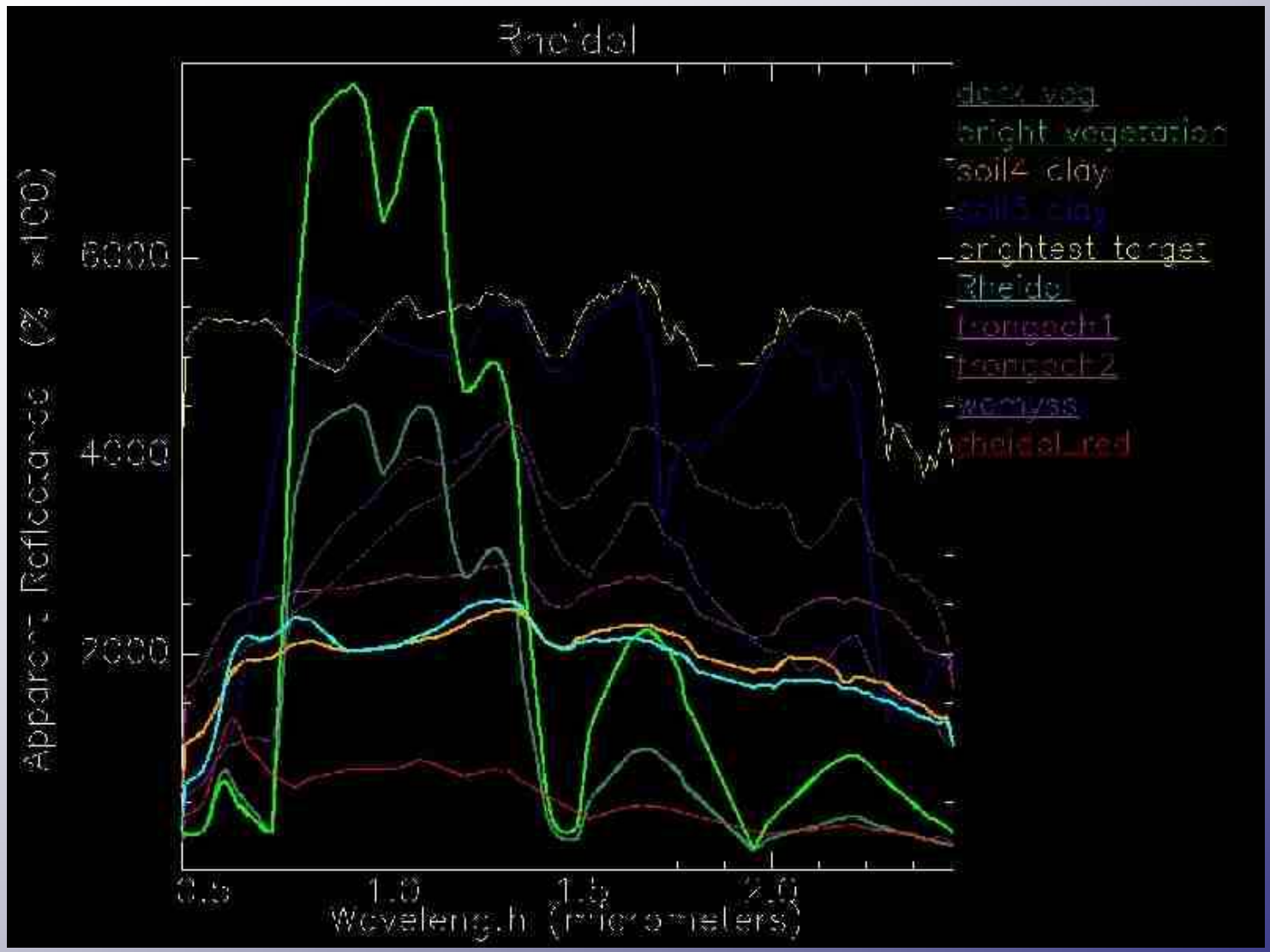
End-members: image spectra



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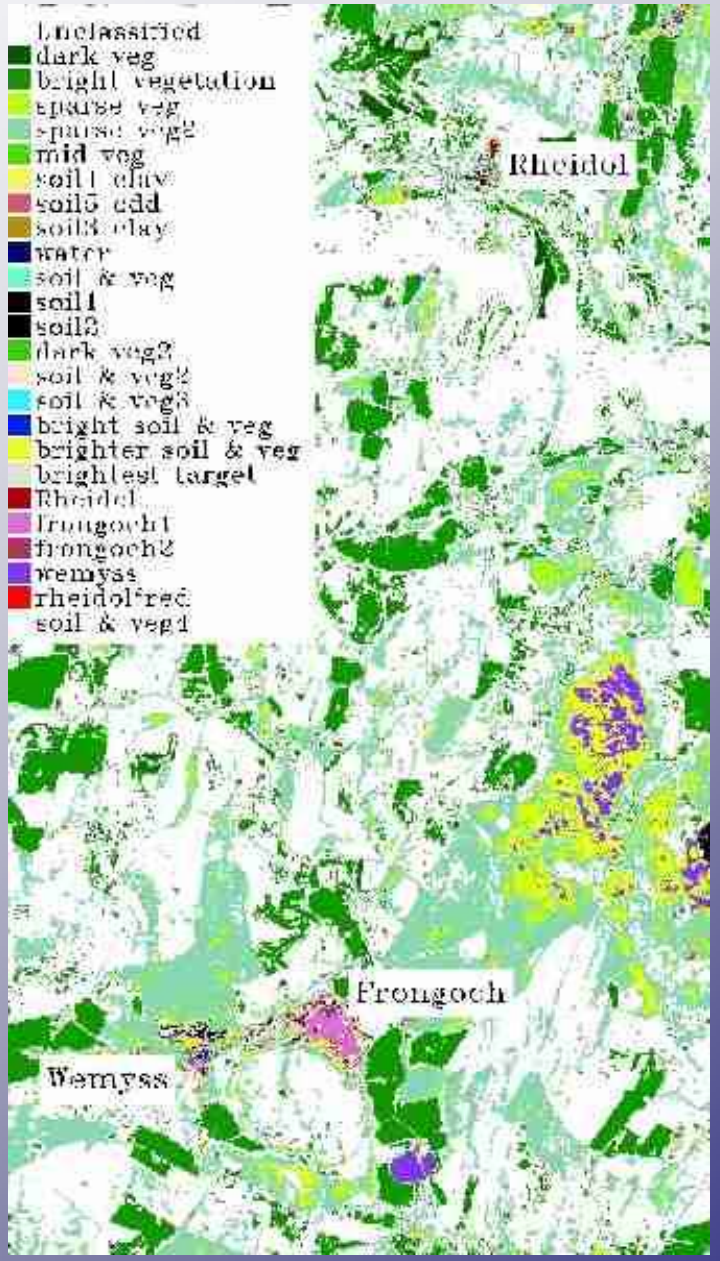
SAM classifications



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Mine Waste Classification

Mine waste of differing mineralogy discriminated using hyperspectral imagery and field spectra (geochemical analysis still needed for identification)

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Conclusions

- In this work, we used the spectral signatures of end-members extracted from the image data for discrimination
- Classifications were then based on these image reference spectra
- Field and laboratory spectra will continue to be integrated
- Further verification will then be carried out by undertaking geochemical analysis*
- A suite of “materials” of interest will be built up to produce a site-specific spectral library*

* *work still carrying on…*

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