Mapping active fault-induced changes in soil and vegetation. Roer Graben (Belgium).

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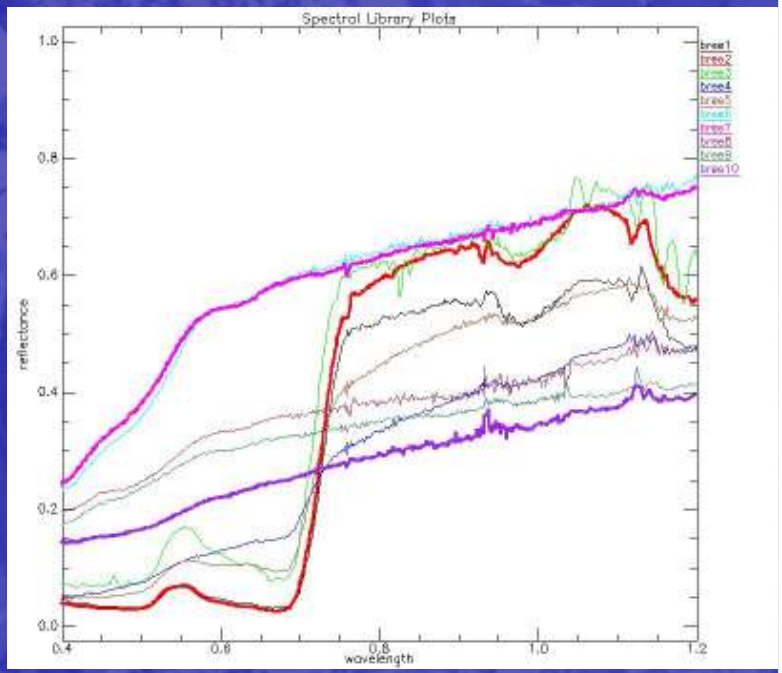

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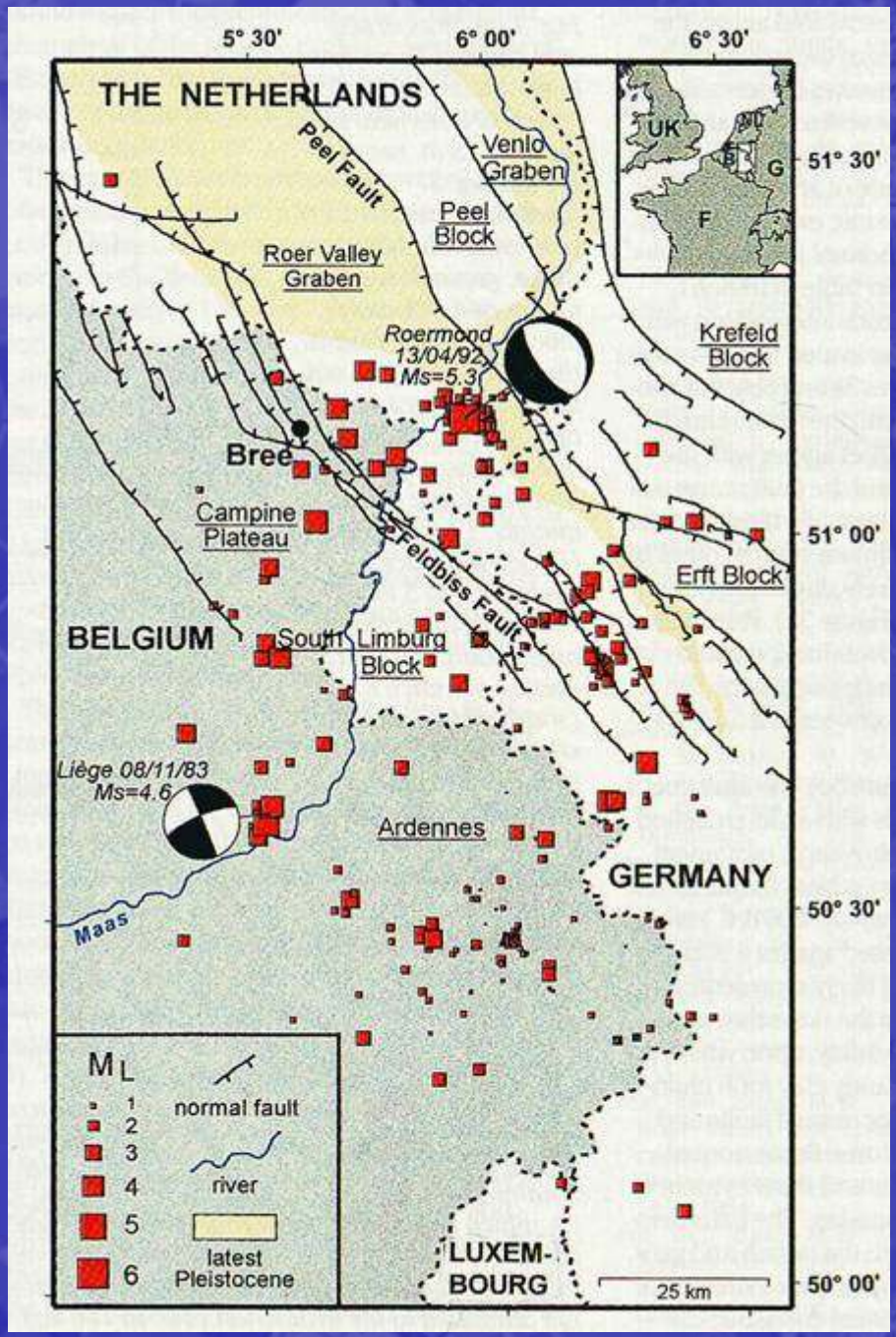
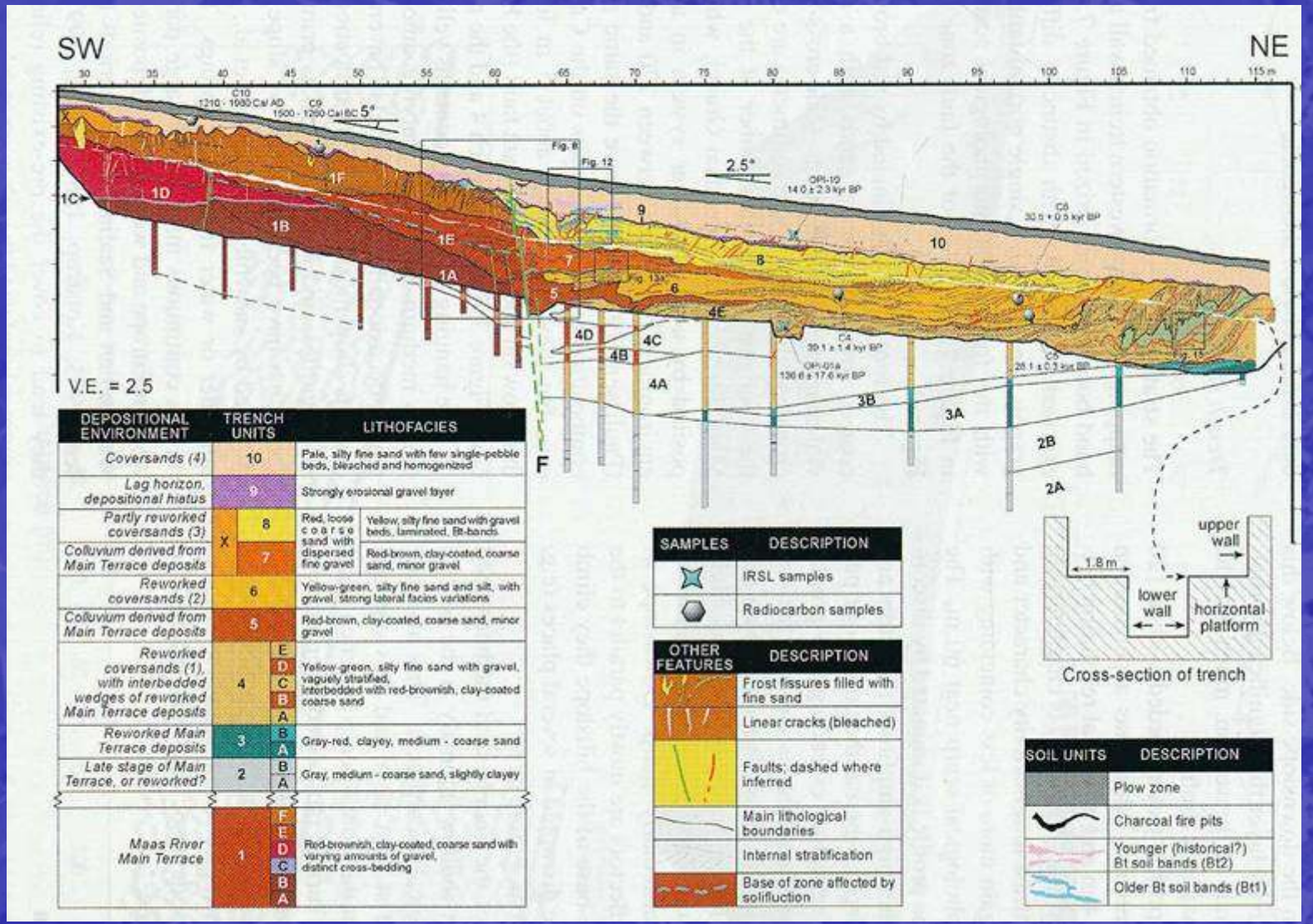


The Roer Graben and its main border faults

Recent investigations of strong historical earthquakes and paleoseismic studies conducted in the Roer Graben demonstrated that large earthquakes with magnitude greater than 6.0 can occur in northwestern Europe. Thus, it is now widely recognised that this highly densely populated industrialized region contains a high risk for that type of natural events.

To evaluate the potential of the occurrence of such earthquakes, it is fundamental to first identify at the Earth surface the trace of the faults which can generate such earthquakes and then to study their activity in the geomorphology and the geologic archives.

Schematic cross section through the Bree fault.
Lithological contact



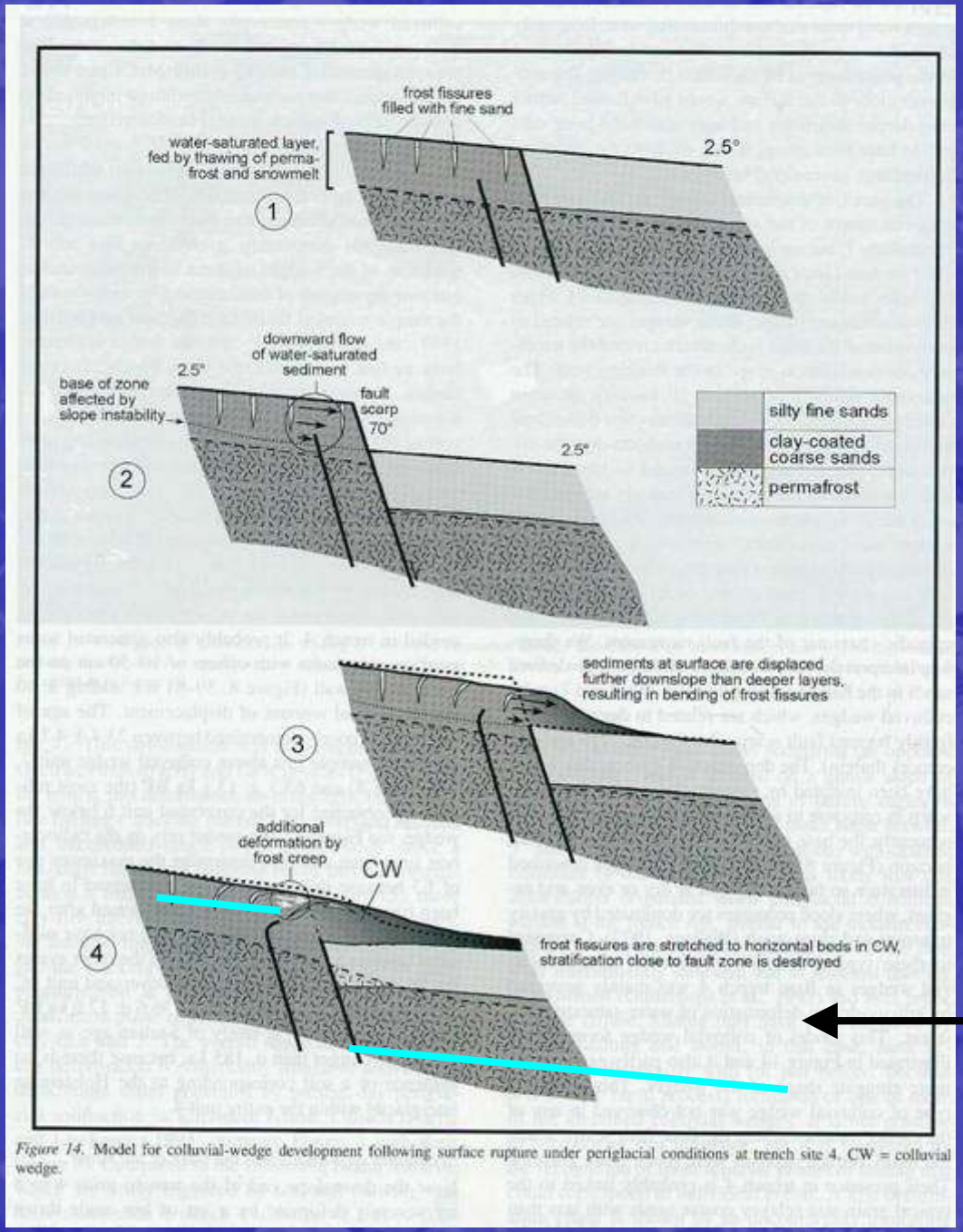


Figure 14. Model for colluvial-wedge development following surface rupture under periglacial conditions at trench site 4. CW = colluvial wedge.

Geomorphological expression in periglacial environment: from the tectonic displacement and scarp to the colluvial wedge

The water table level is very different on the two sides of the fault, which is acting as a dam. This results in differences in soil wetness , mainly in dry periods

Techniques of field identification of faults

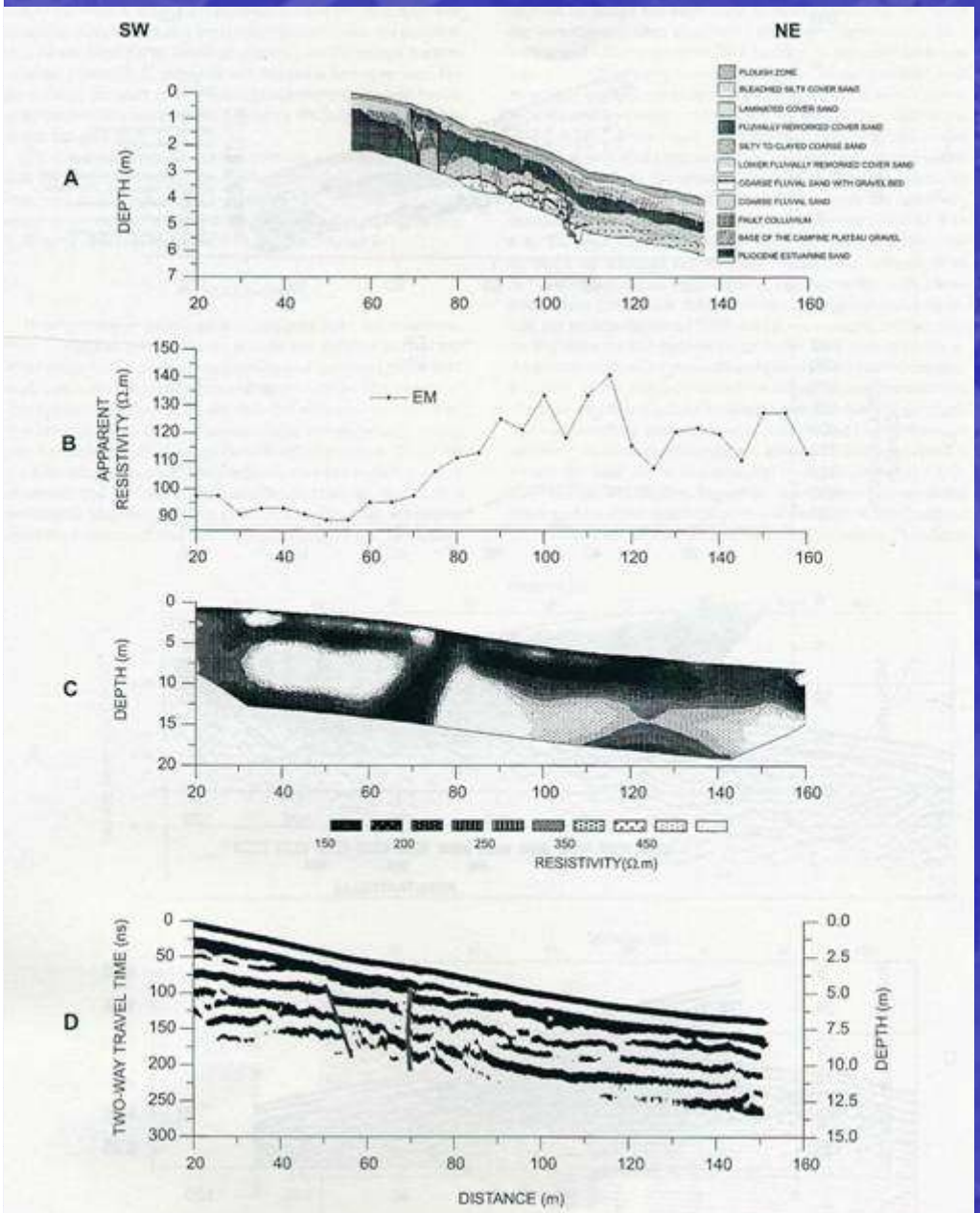


FIG. 7. Site 3. (a) Schematic trench cross-section. (b) Electromagnetic profiling (EM). (c) Electrical tomography. (d) Radar section (50 MHz).

Trench

Resistivity

Electric tomography

Ground penetrating radar

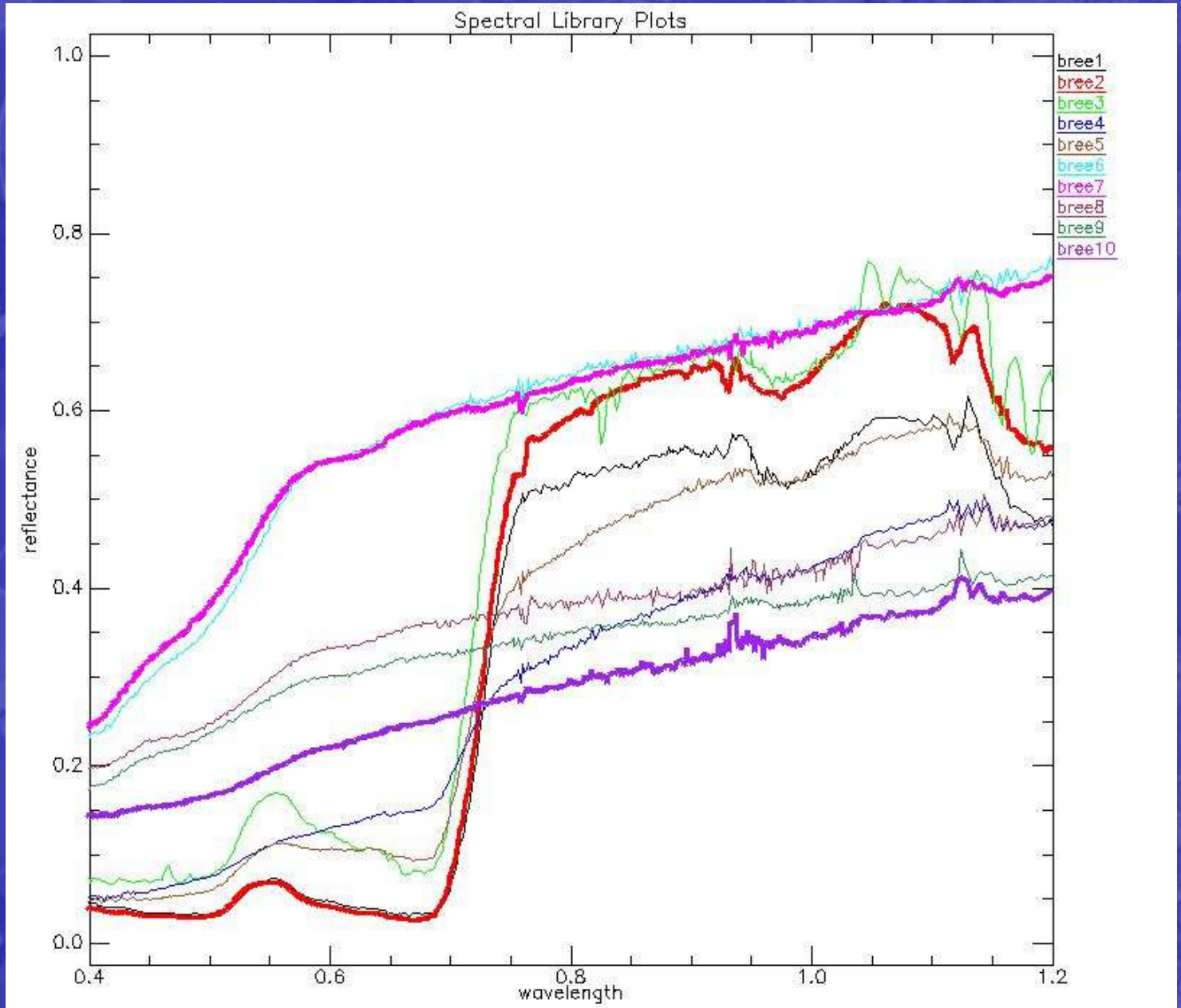
Field spectroradiometric measurements synchronous to the data acquisition, near Houben, Bree

Calibration field targets

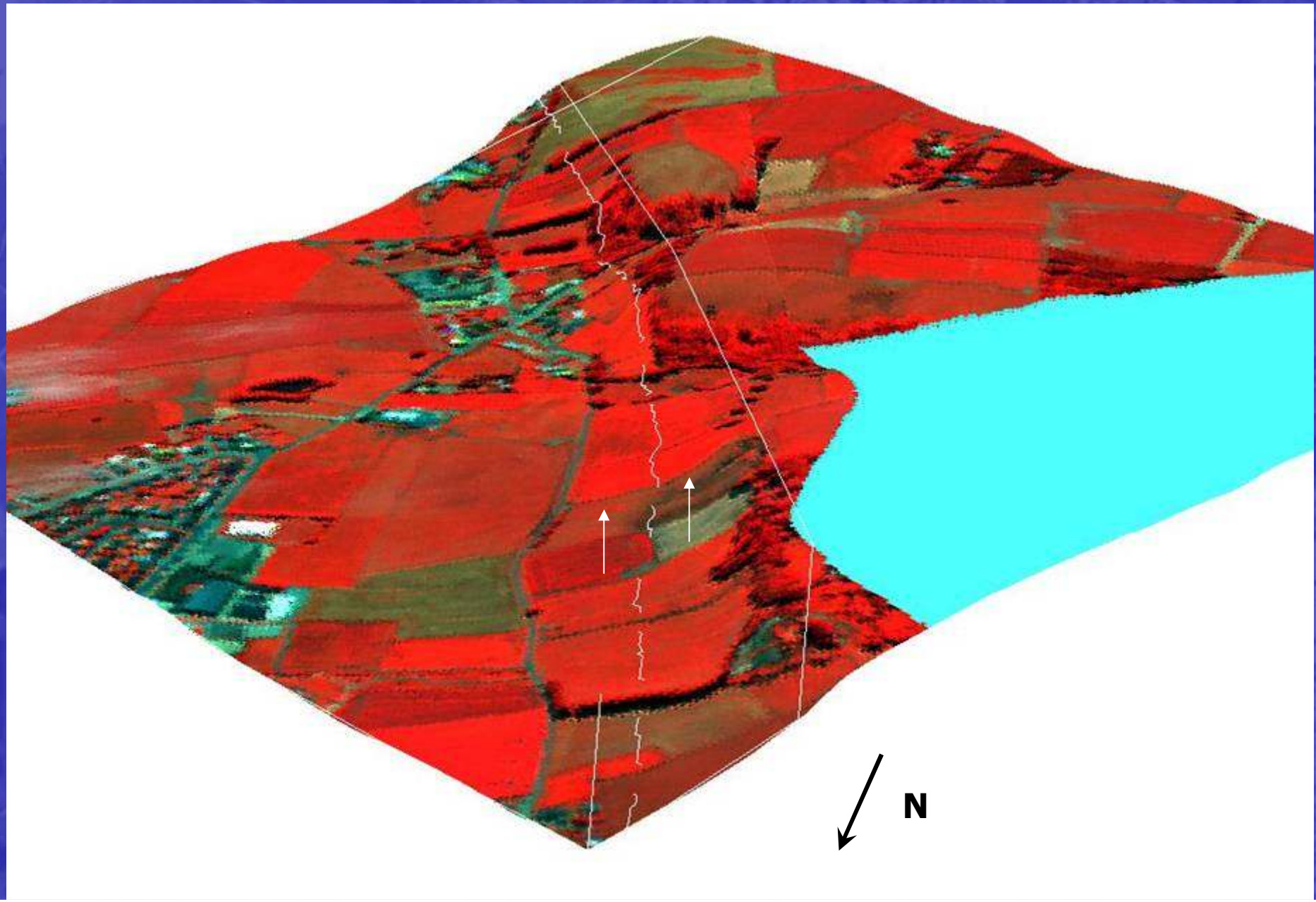
Bright target

Dark target

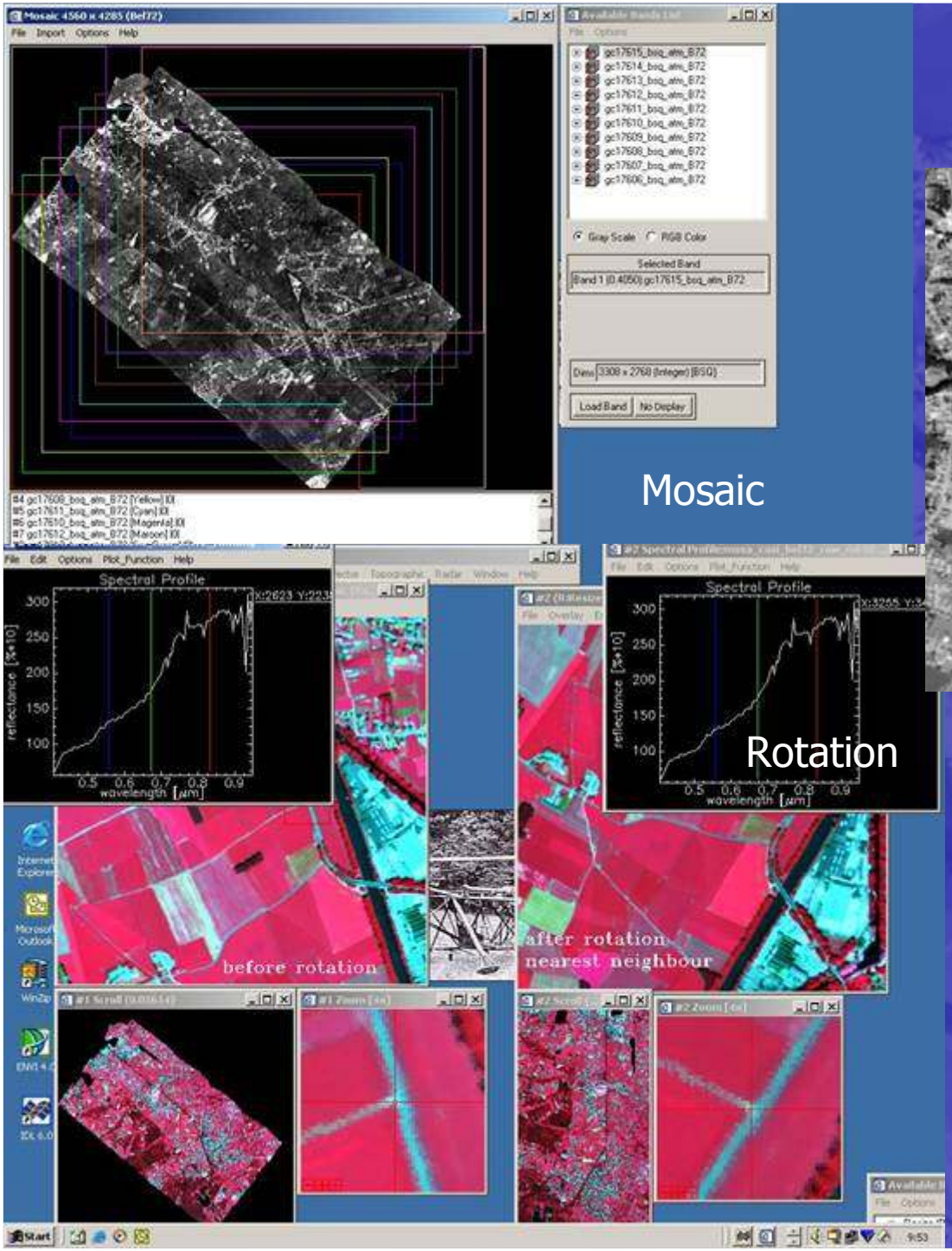
Field spectral signatures

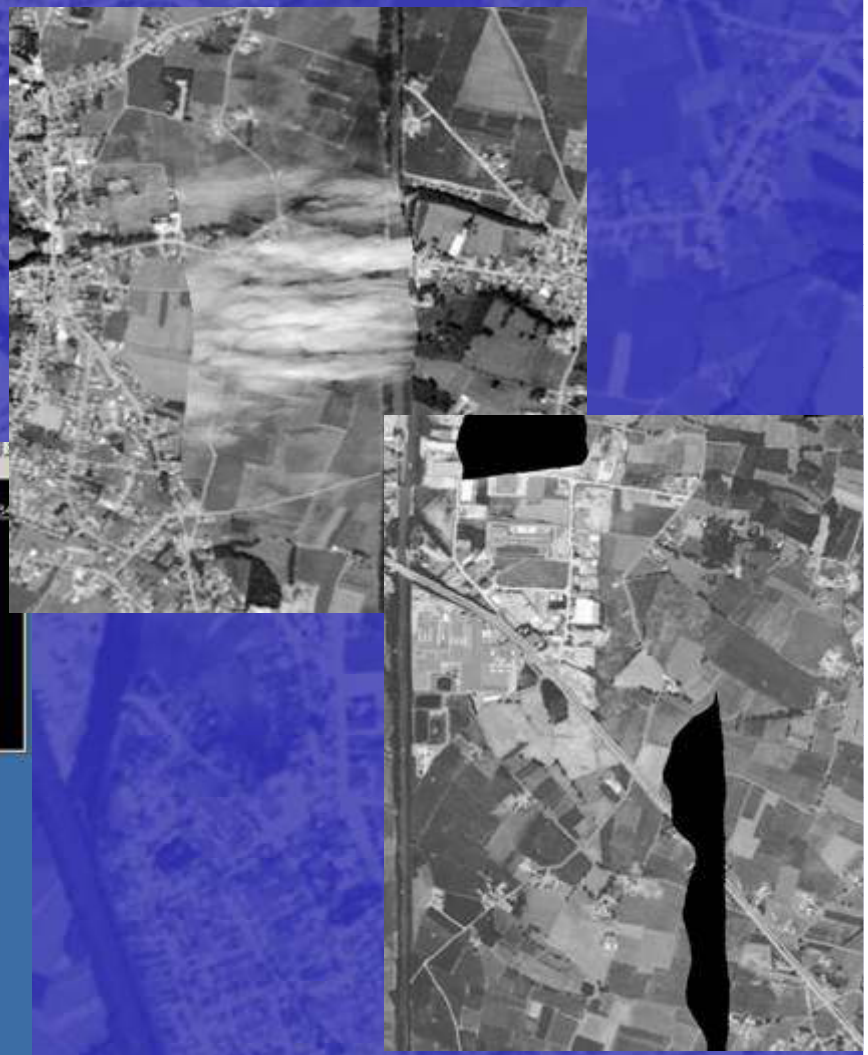


Morphological scarp and differences in vegetation signature related to wetness, near Houben, Bree. LIDAR DEM provided by VLM, 3m resolution.



Pre- processing





Masking of clouds and gaps between line

Data processing

colour composites of three single spectral bands or of linear combinations of 3 or more than 3 (NDVI, brightness indexes,…)

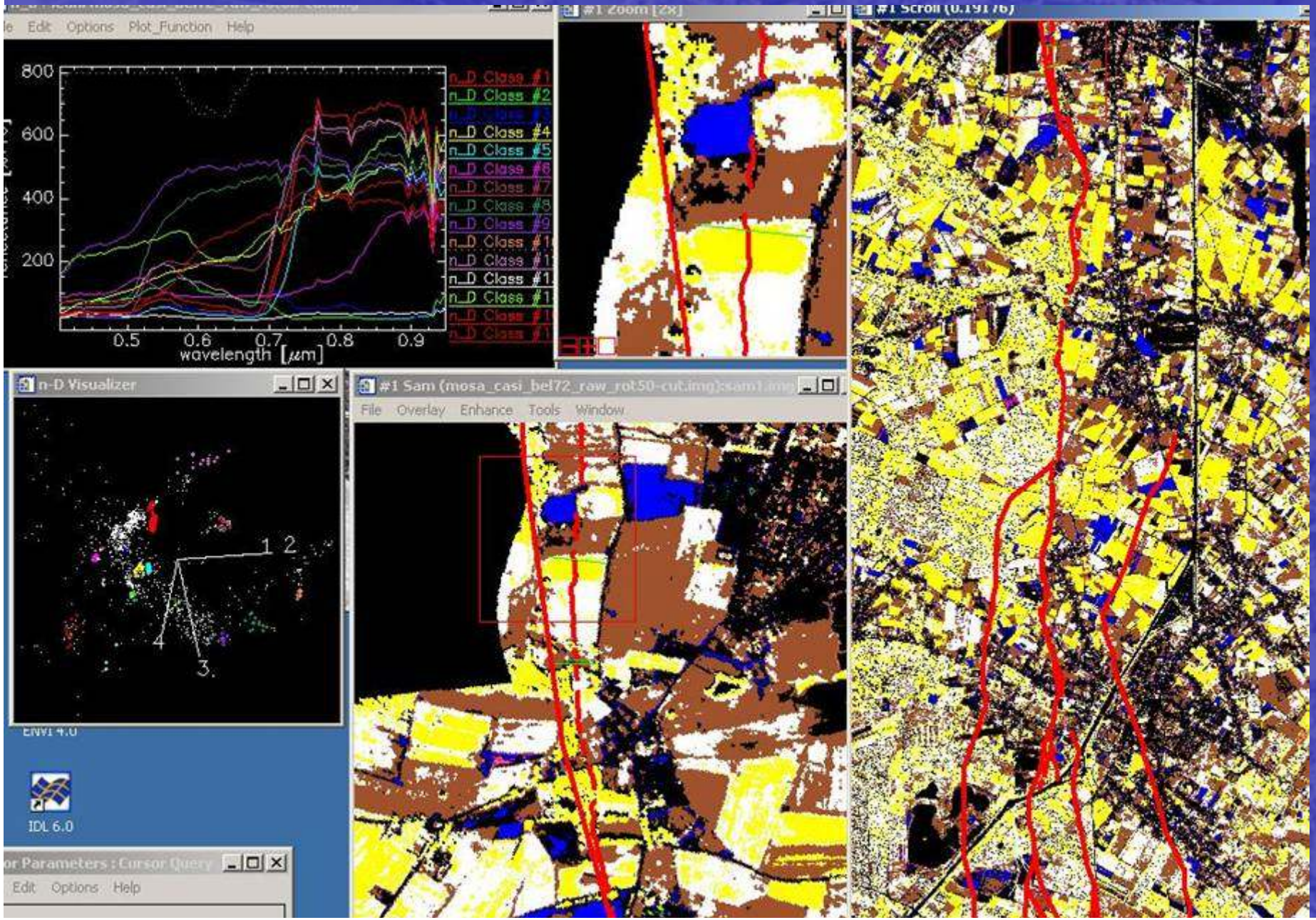
MNF minimum noise fraction colour composites.

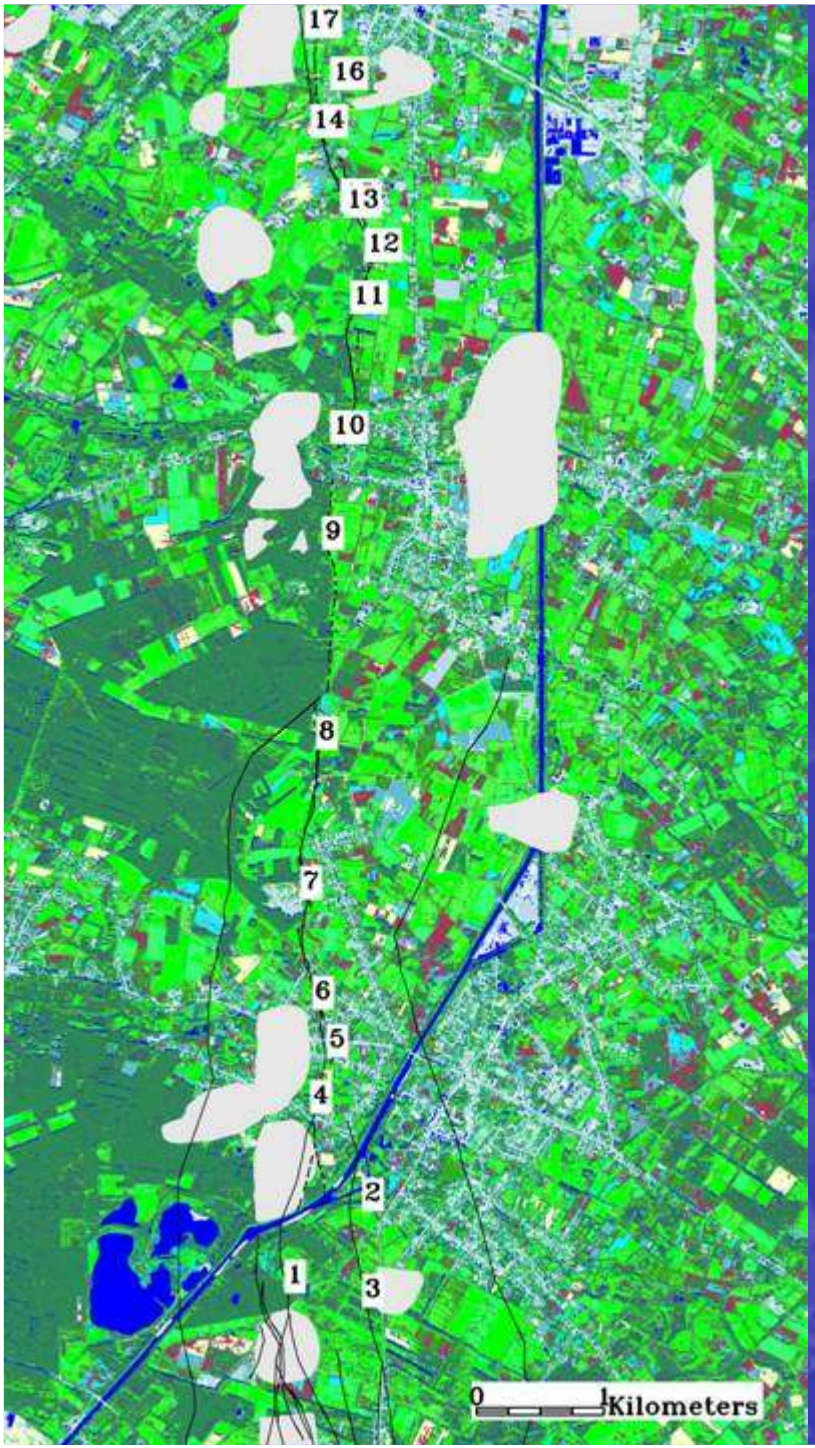
The classical ENVI « hourglass » MNF-PPI-nD visualizer-SAM

3D visualisation (using the LIDAR DEM provided by the VLM)

Unsupervised classifications

Minimum Noise Fraction – Pixel Purity Index- nD visualizer- SAM classification





Interpretation

1. Spectral contrast spreading in two contiguous meadows east of De Bek. The fault trace was evidenced by geophysical methods.

2. Contrast in the grass of a football field north of Armenbos.

3. Small scarp on bare soil .

4. Contrast in a meadow. No a priori knowledge of the presence of a fault and no topographic feature. To be checked .

5. Well known trace visible in morphology

6. Known trace with visible surface expression

7. Possible passage of a fault (not known)

8. Known fault position in trench n. 4

9. Clearing with change in signature of natural vegetation and change of slope

10. Valley of Itter at Rooiermole/Slagmolen. Nice spectral contrasts in a meadow. This is due to a change in the red edge (red-NIR) shape and position, and to the accurate position and depth of the red absorption and green reflection. This is a new discovery and an electric profile will be realised to cross-check the presence of a fault.

11. Palaeo thalweg cut by the fault east of Steenberg.. Confirmed by trench 3.

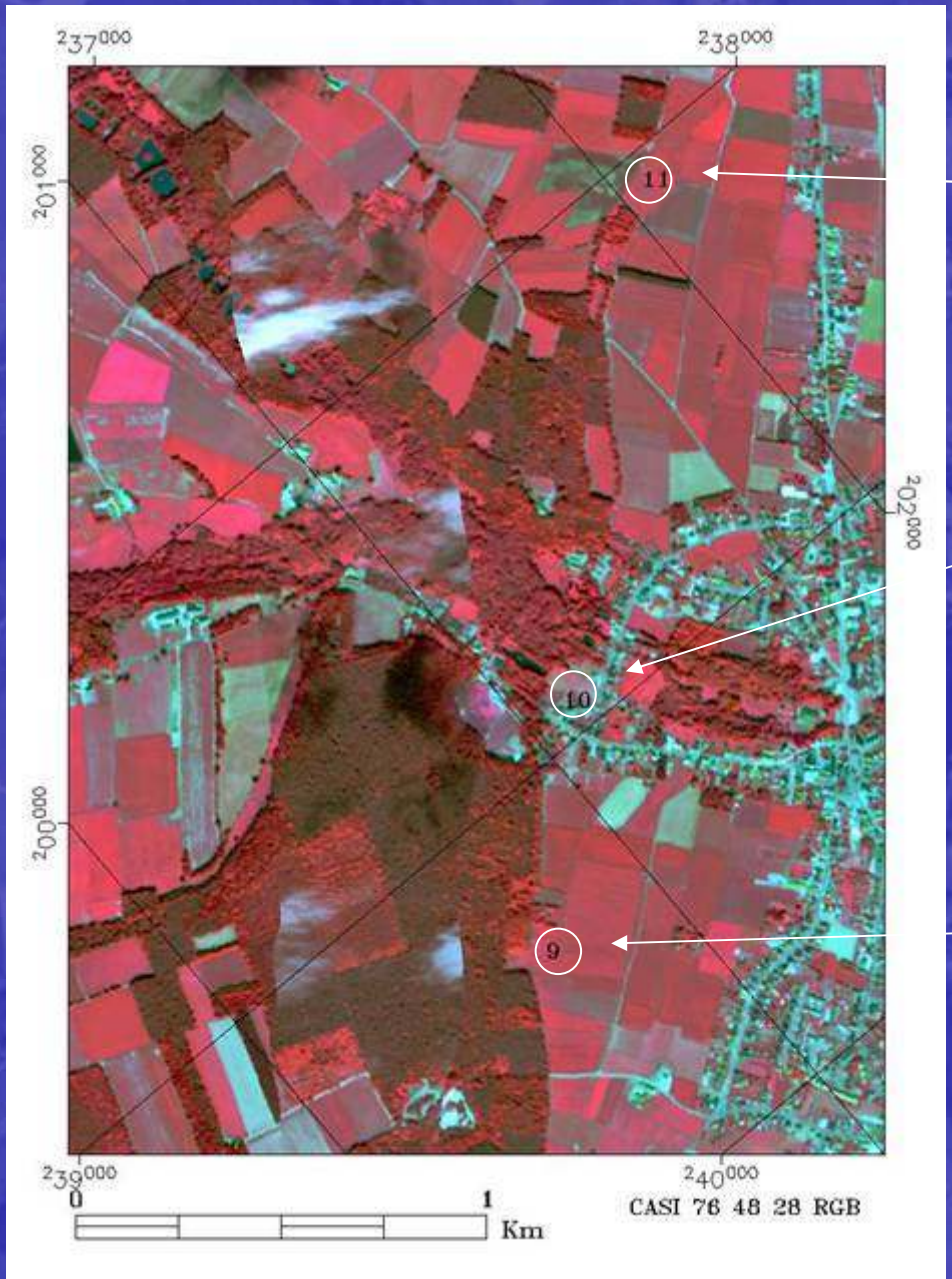
12. Contrasts in the forest close to site 11

13. Scarp (man made ?)

14. Contrasts visible in the Infra Red range only. To be checked. . Marked scarp and difference in spectral signature.Well known contrast in the vicinity of Trenches 1 and 2 .

16,17. Site where the faults separates in 3 branches near Bree. One of them is well evidenced.

Examples of three different expressions of the fault trace in the landscape

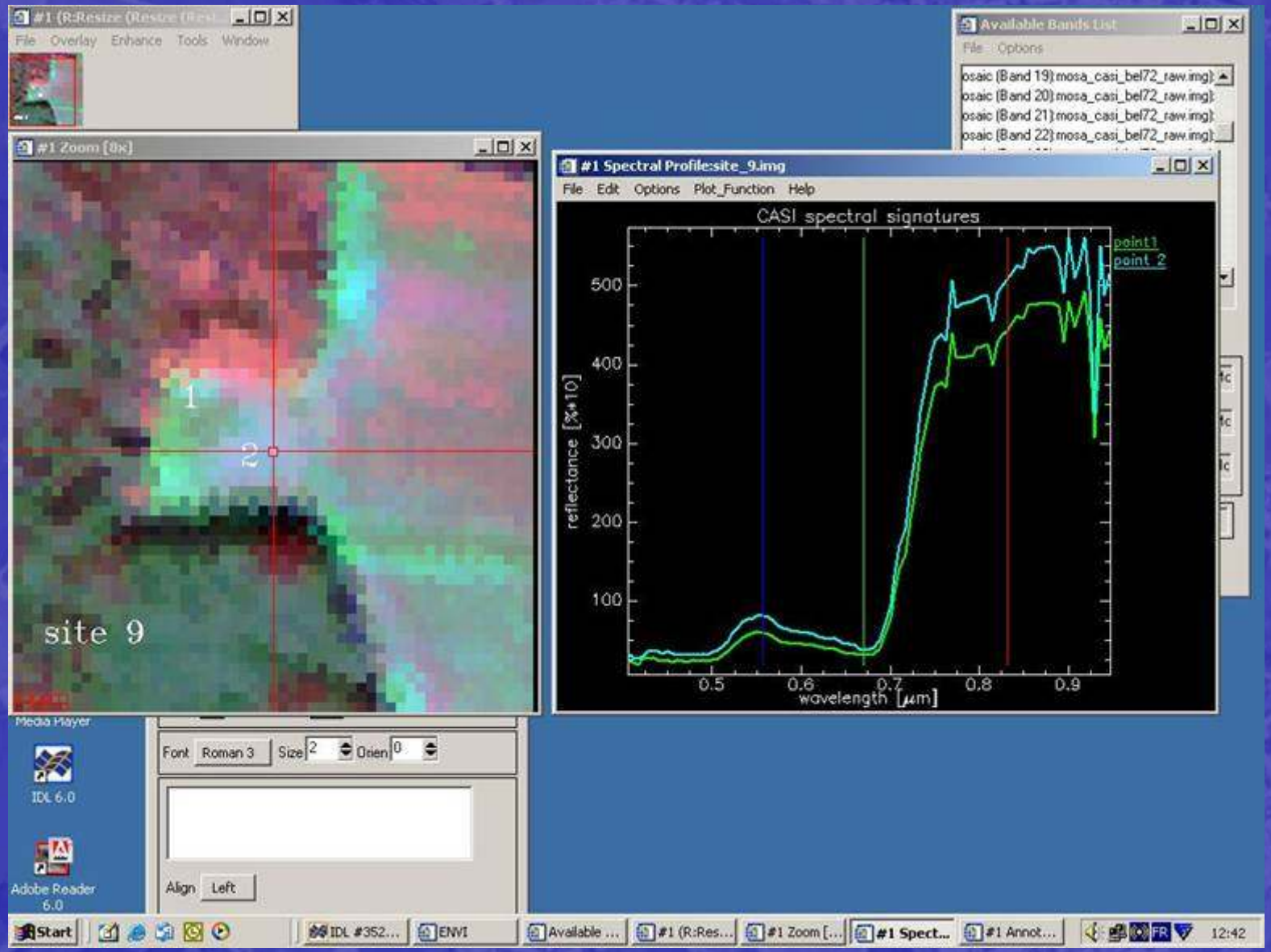


11. Palaeo thalweg cut by the fault. Small scarp. Confirmed by trench 3.

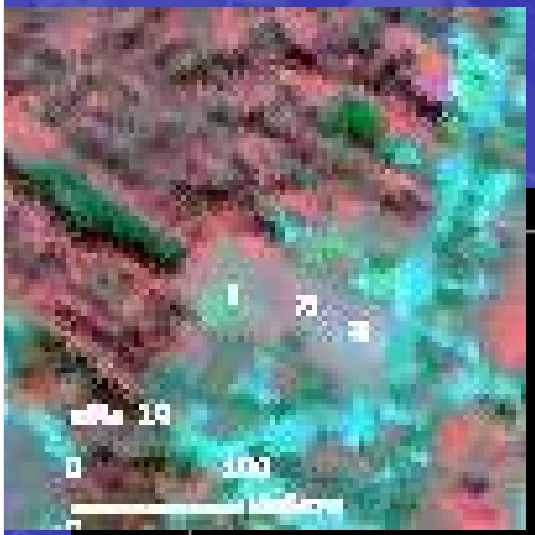
10. Meadow with variations of the spectral signature of grass. Flat area. New discovery: to be investigated

9. Clearing with a difference of wetness expressed in natural vegetation spectral signatures and small slope

Example of site 9



Site 10: three different vegetation curves



To conclude:

The location of the fault traces in the Roer graben are know with precision in places where geophysical profiles have been realized, or where trenches have been opened.

Regional and local effects on topography as well as raw variations in the composition, chemistry and wetness of soils and on the overlying vegetation are sometimes important enough to be visible on air photos and satellite imagery, needing no further (hyper)spectral investigation.

The same effects can be also quite subtle and not even detectable on low resolution DEM's and multispectral imagery. It was thus useful to test new methodologies like hyperspectral airborne surveys to complete the cartography of active faults in the area.

Though no general rule could be outlined, it has been demonstrated that the complex variations of soils and vegetation linked to the presence of active faults can be locally evidenced on the base of hyperspectral image processing.


Thank you
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