REGOLITH LANDFORM MAPPING IN WESTERN BURKINA FASO, USING AIRBORNE GEOPHYSICS AND REMOTE SENSING DATA IN A NEURAL-NETWORK

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WAXI- West African Exploration Initiative
IXOA- L'Initiative d'Exploration Ouest Africaine

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Why regolith mapping?

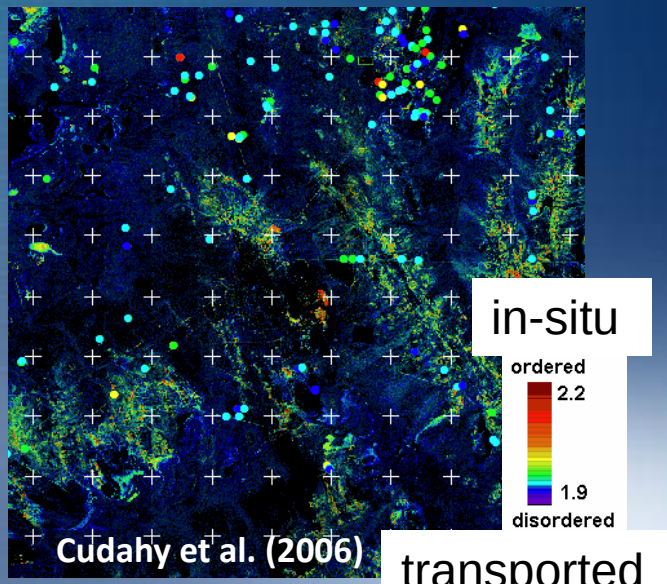
- Source of economically significant primary resources
- Impact on mineral exploration strategies
- Long-term landscape evolution and erosion modelling

Regolith mapping – traditional approaches

- Field-based surveys, well suited but:
  - lengthy & expensive for large areas → small-scale/insufficient detail
  - inaccessible terrain → missing information
  - subjective view of the person mapping → difficult to replicate
- Remote sensing approaches:
  - visual interpretation
  - spectral classification

...Remote sensing approaches

	Visual interpretation	Spectral classification
Data	Aerial photographs, Geoeye, Landsat, SPOT, geophysics	Multi- and hyperspectral imagery
Advantages	High level of detail with sufficient spatial resolution	Automated Objective
Disadvantages	Time-consuming Subjective	Vegetation cover

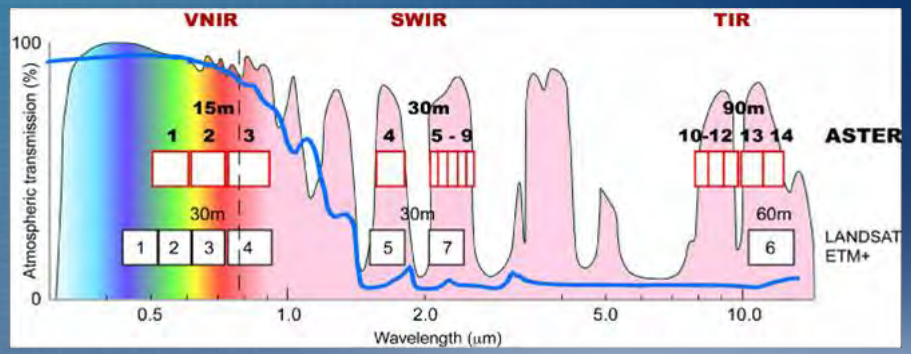


Typical landscapes of western Burkina Faso

Combination of several techniques

- Airborne Gamma-ray spectrometric surveying
  - Flight lines – 500 m spacing (gridded at 125 m)
  - K, eTH, eU as absolute concentrations + total count

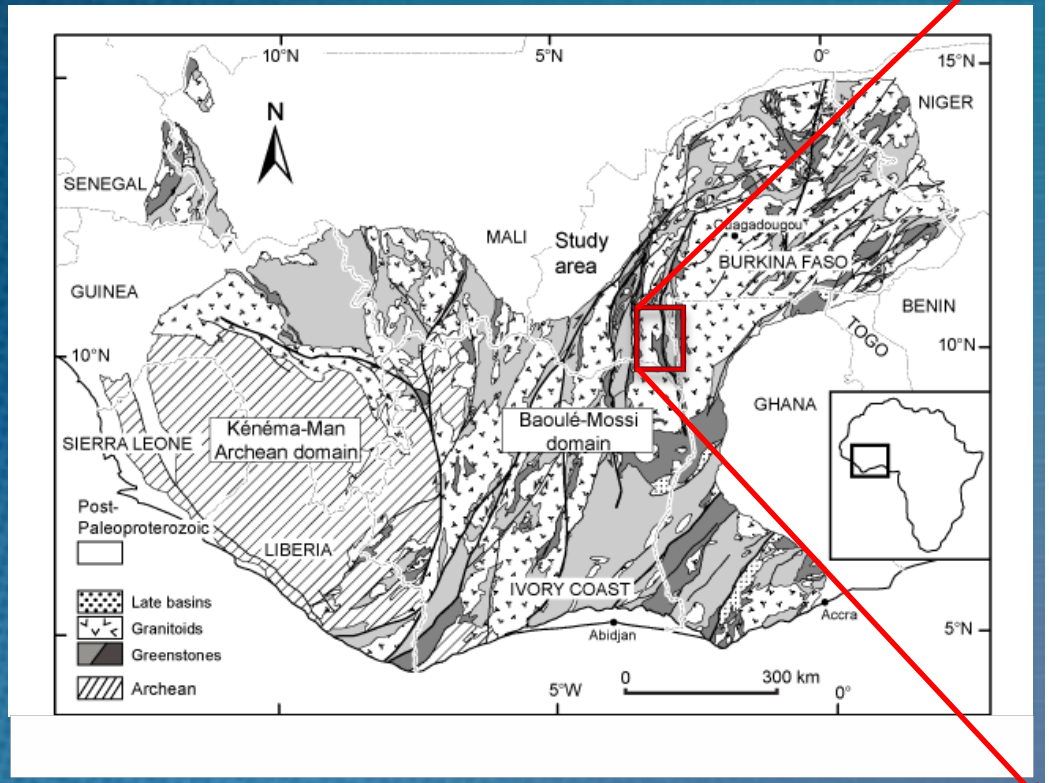
- Spaceborne imaging radar data
  - SRTM – Global elevation dataset (90 m)
  - ALOS PALSAR, RADARSAT-2 polarimetric data (12 – 30 m)
- Spaceborne multi-spectral data
  - ASTER – 14 bands (15 – 90 m)
  - Landsat 7 ETM+ – 7 bands (15 – 60 m)

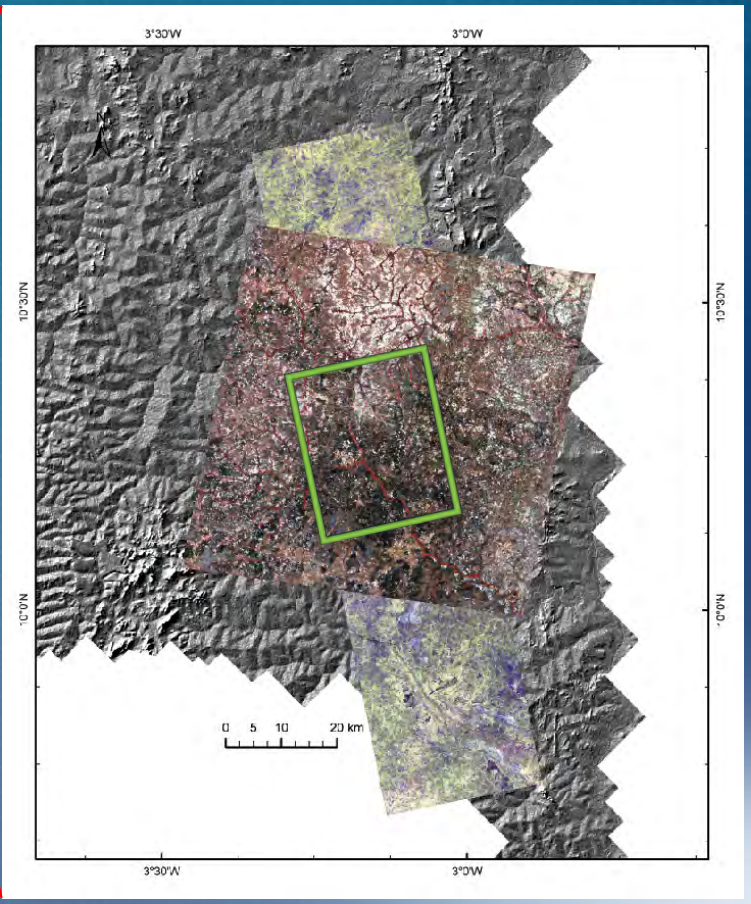


Landsat and ASTER bands plotted on model atmosphere (JPL)

Primary aim is to develop an automated/semi-automated procedure for the mapping of different regolith units using airborne geophysics and satellite remote sensing data.

western Burkina Faso

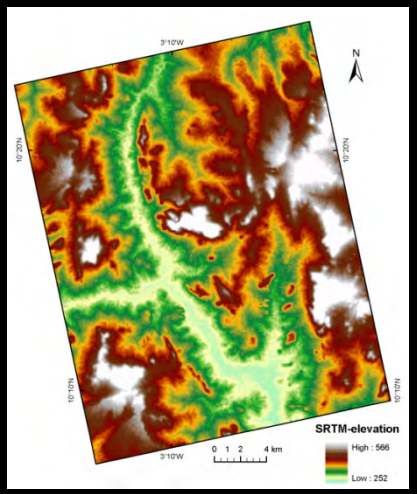




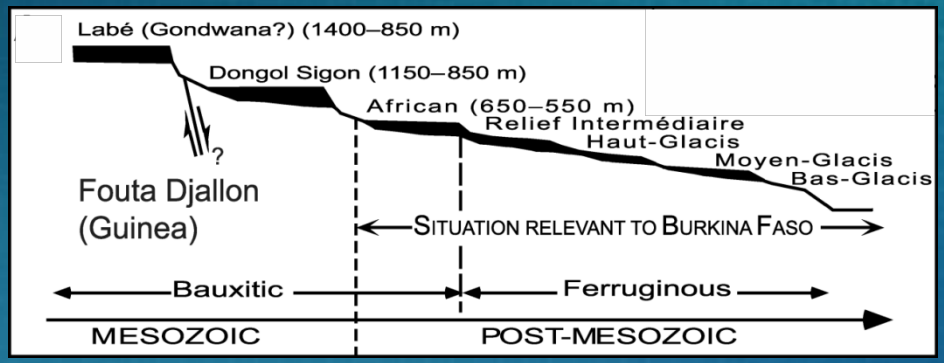
SIGAfrique (BRGM)

Study area

Digital elevation model

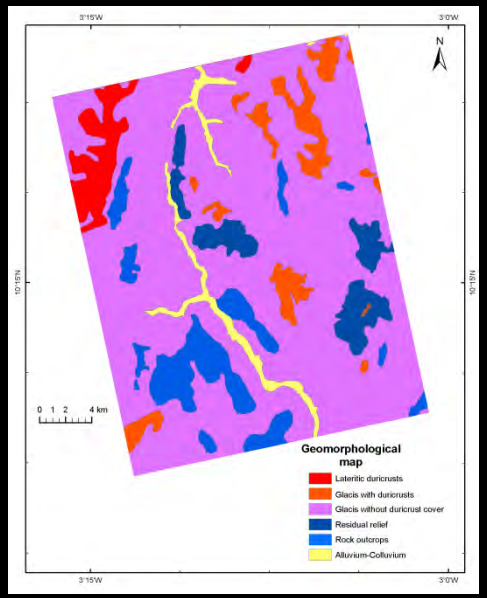


Regional chronosequence of lateritic surfaces



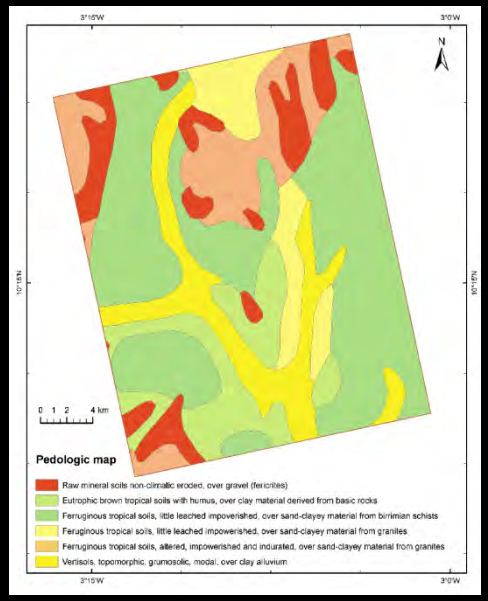
Gunnell (2003)

Geomorphological map



IGB & IGN

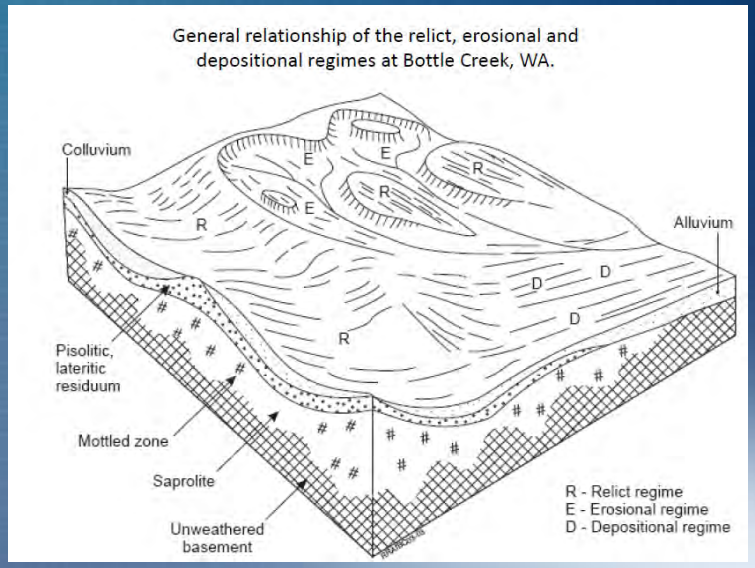
Morphopedological map



IRD

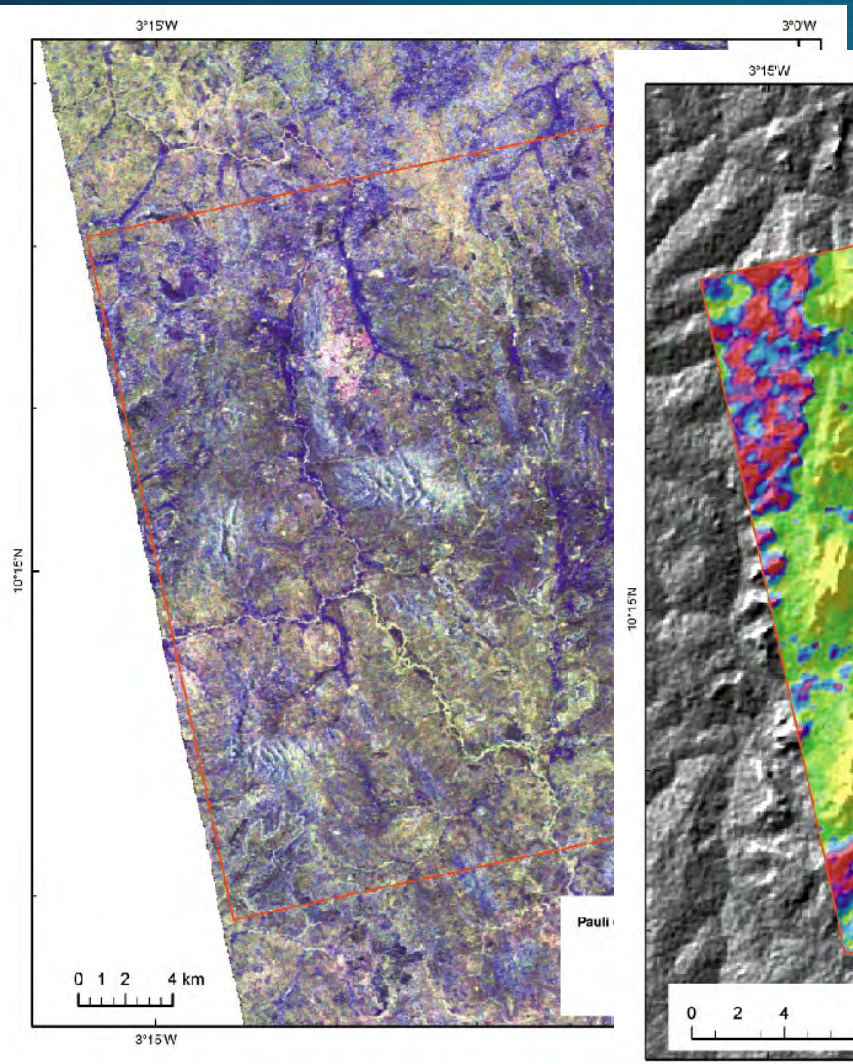
1 : 500,000

Regimes of regolith formation

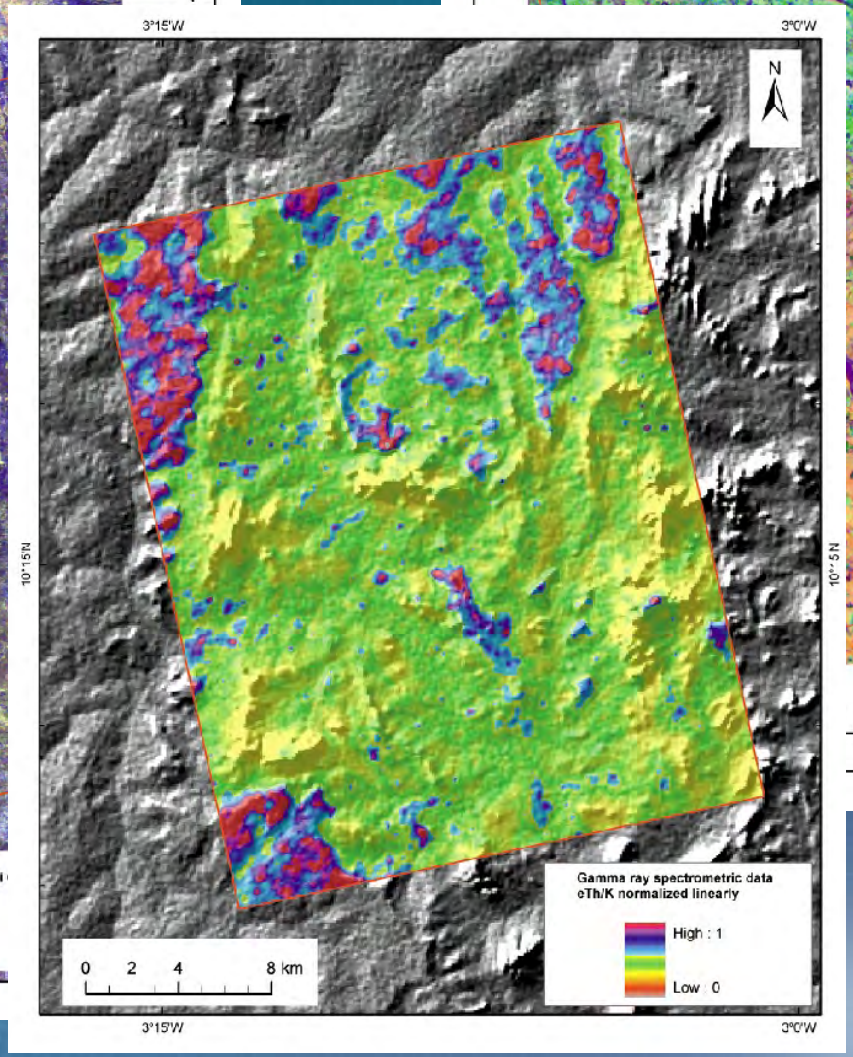


Churchward (2005)

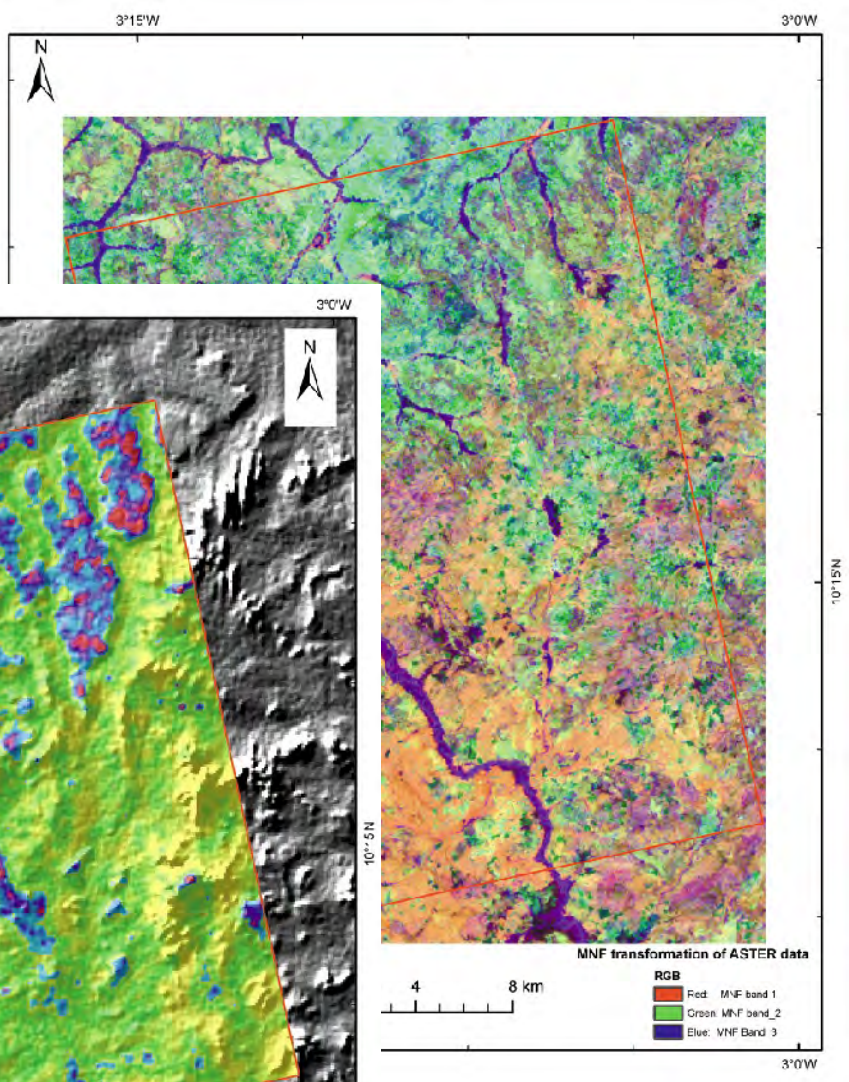
Geophysical and remote sensing data used



ALOS PALSAR – Pauli decomposition image



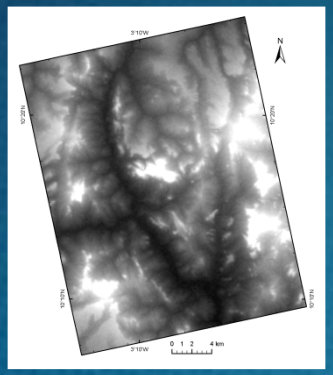
Gamma-ray spectrometry + DEM



Minimum noise fraction ASTER First – three bands

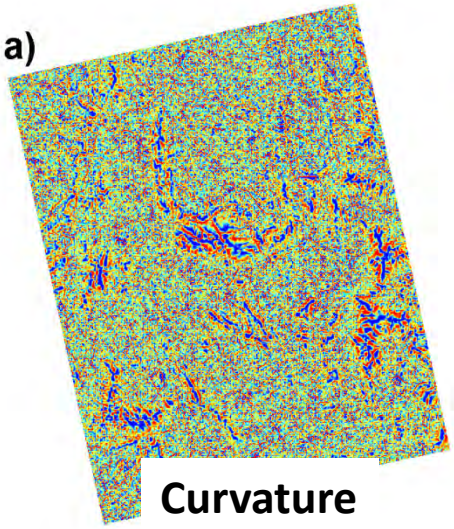
Geomorphometry

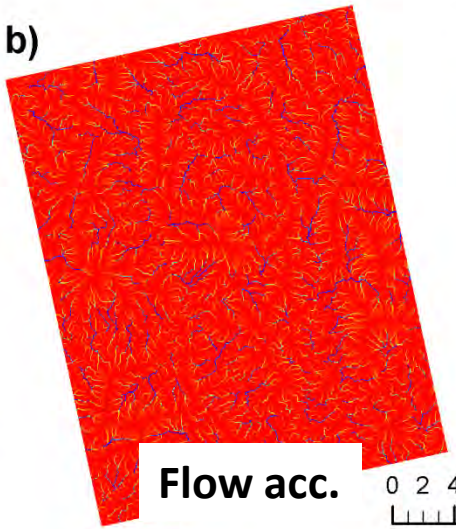
- Automation requires quantitative topographic information
- Characterise regolith units using morphometric variables extracted from DEM

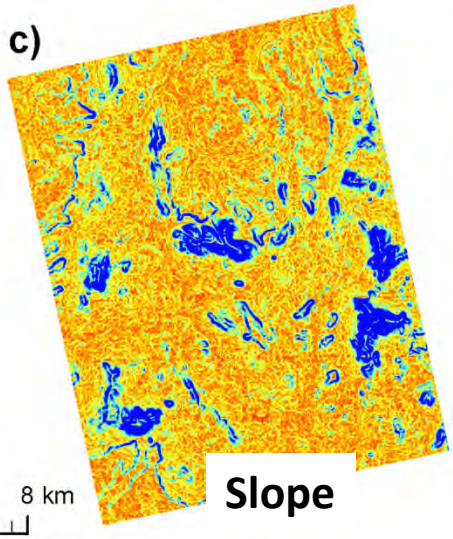


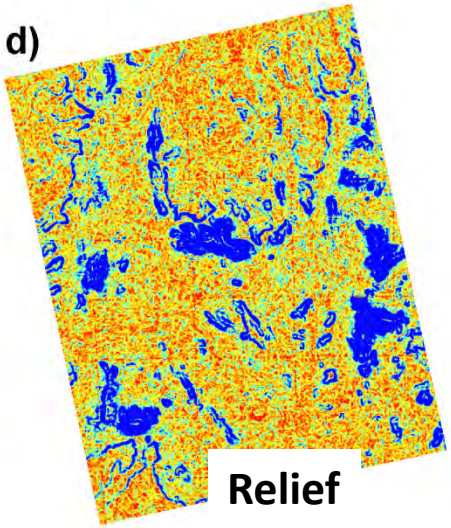
30 m DEM

Morphometric variable	Description
Curvature (1/m)	Second derivative of the elevation
Flow accumulation	Number of cells flowing into each other
Slope (°)	Magnitude of the steepest gradient
Relief (m)	Range of elevation
Aspect (°)	Slope direction facing









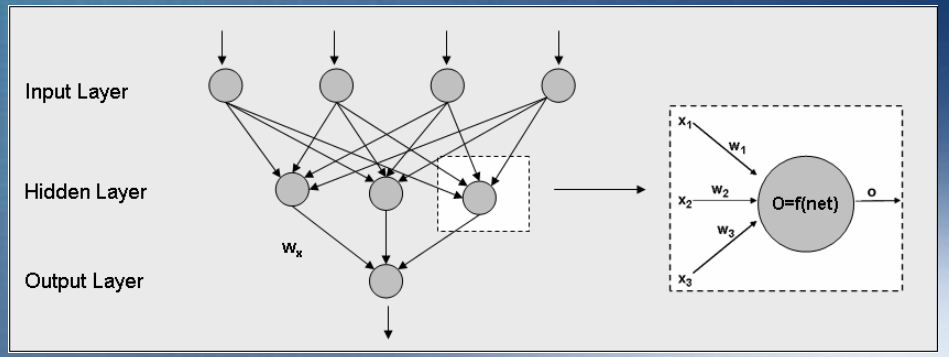
Input variables

Classification

- Automatically assign pixels to the regolith classes:
  - high glacis
  - low glacis
  - residual terrain and rock outcrops
  - alluvium-colluvium

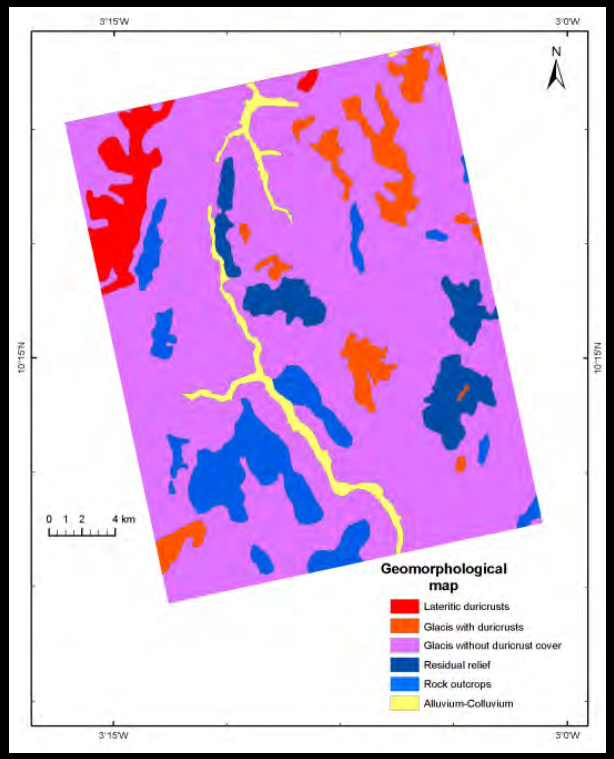
- ADVANGEO – Multiperceptron feed-forward artificial neural network:
  - ability to learn complex patterns in input data
  - robust classification method
  - supervised non-linear classification
  - Input layers: K, eU, eTh, eTh/K, elevation, slope, relief, curvature, H, A, alpha (ALOS PALSAR) ASTER 14 bands, or Landsat 7 bands

Scheme of neural network classification algorithm



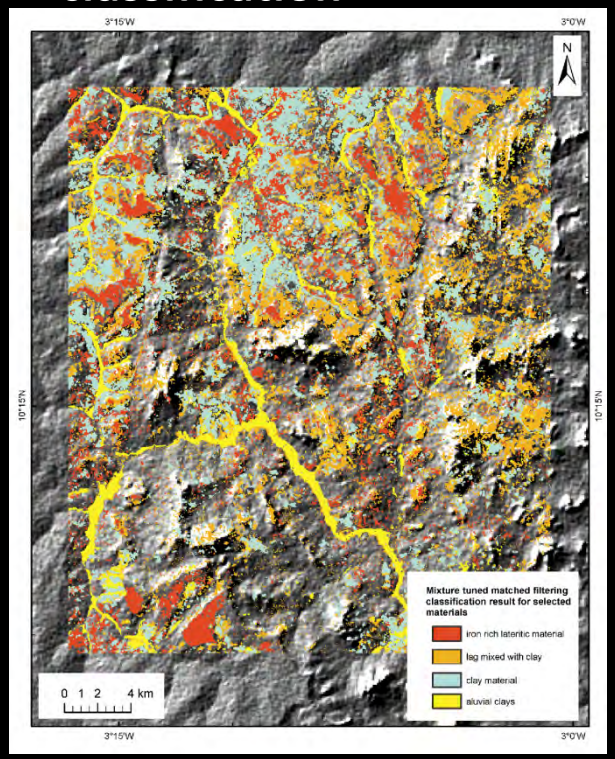
Results

1: 500,000 geomorphology



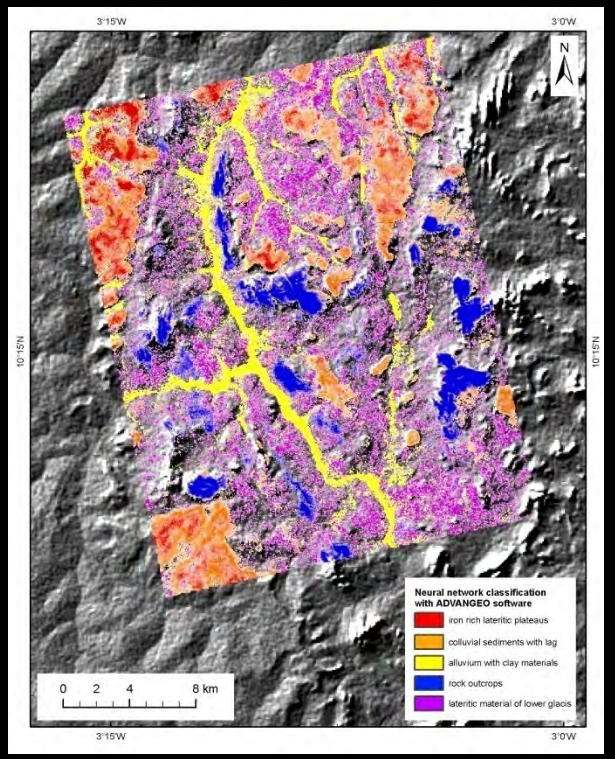
- lateritic duricrusts
- glacis with duricrusts
- glacis without duricrusts
- residual relief/rock outcrop
- alluvium

ASTER - Mixture tuned matched filtering classification



- lateritic duricrusts
- lag mixed with clay
- clay rich zones
- alluviual clays mixed with vegetation

ADVANGEO neural network algorithm

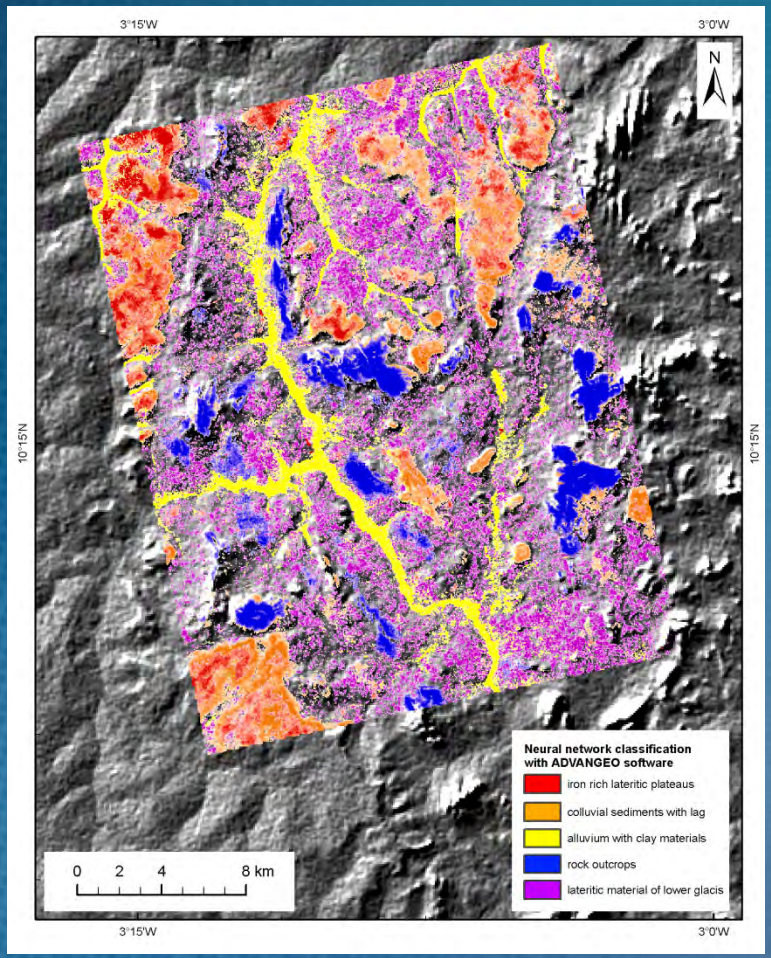


- Fe-rich duricrust (high glacis)
- colluvial Fe-rich duricrust sed.
- lateritic material (low glacis)
- residual relief/rock outcrop
- alluvial sediments

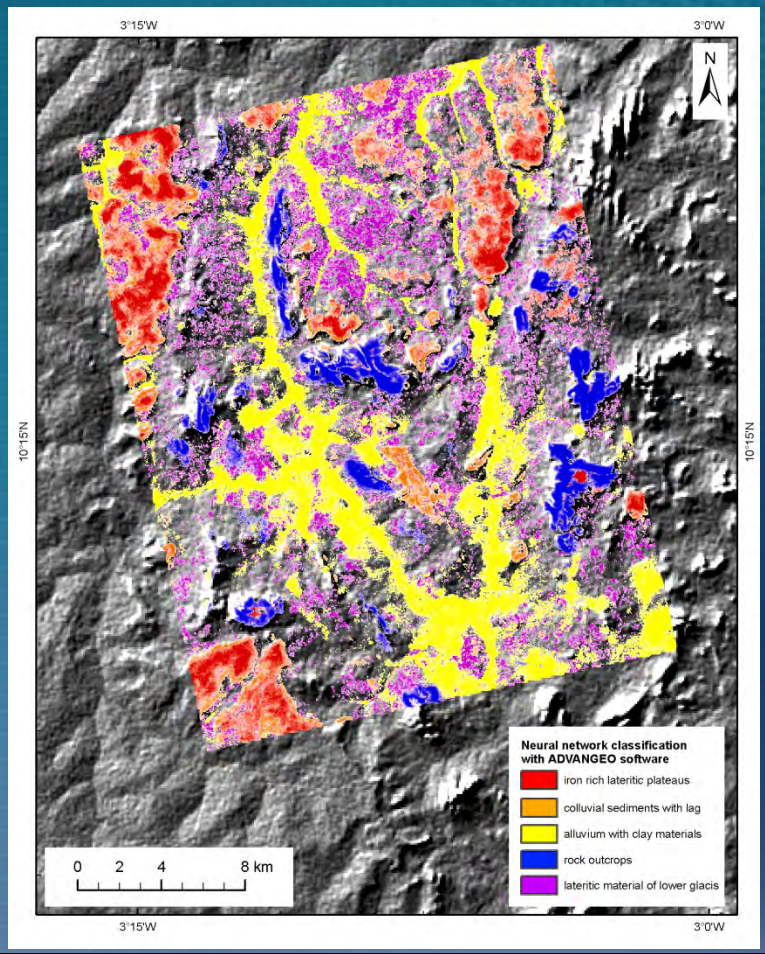
Comparison between Landsat and ASTER

Input bands	O.A. (%)	K
ASTER 14b	60.57	0.32
Landsat 7b	56.32	0.26

ASTER



Landsat 7 ETM+



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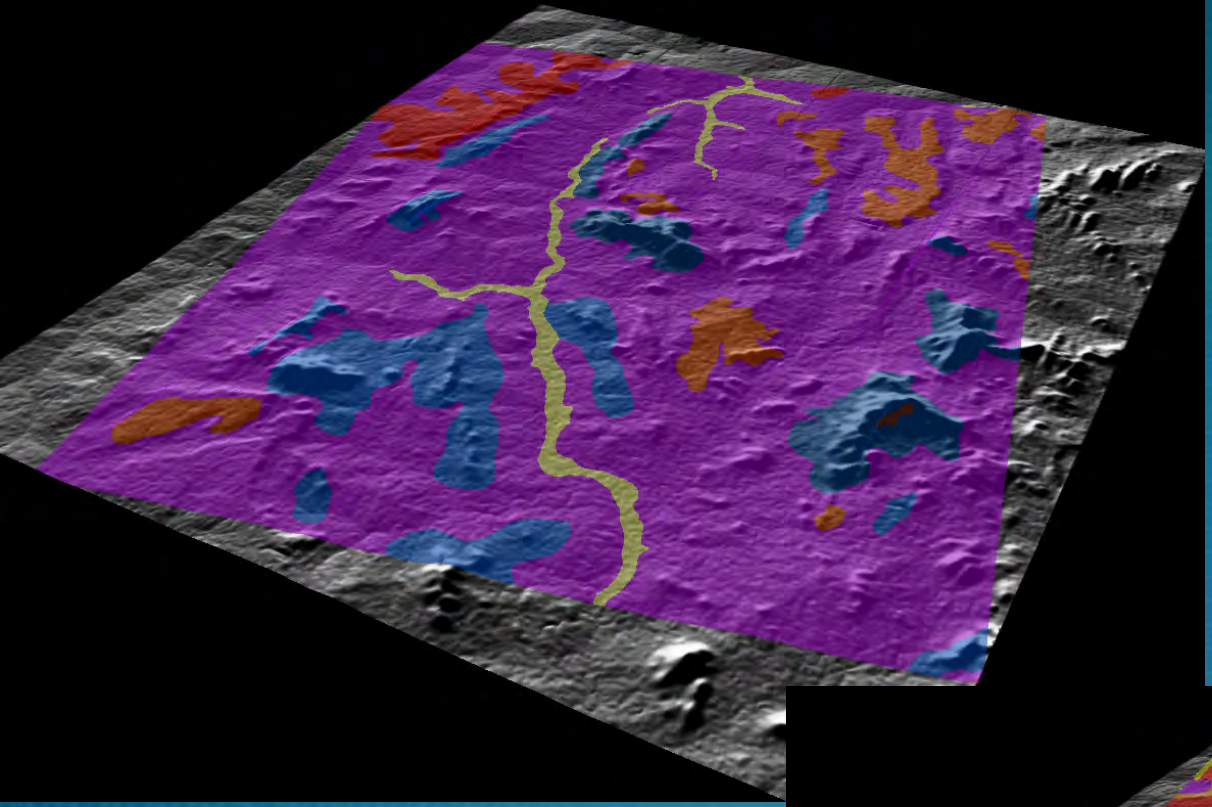

SRTM-derived topography draped with the geomorphological 1 : 500,000 scale map (IGB & IGN).

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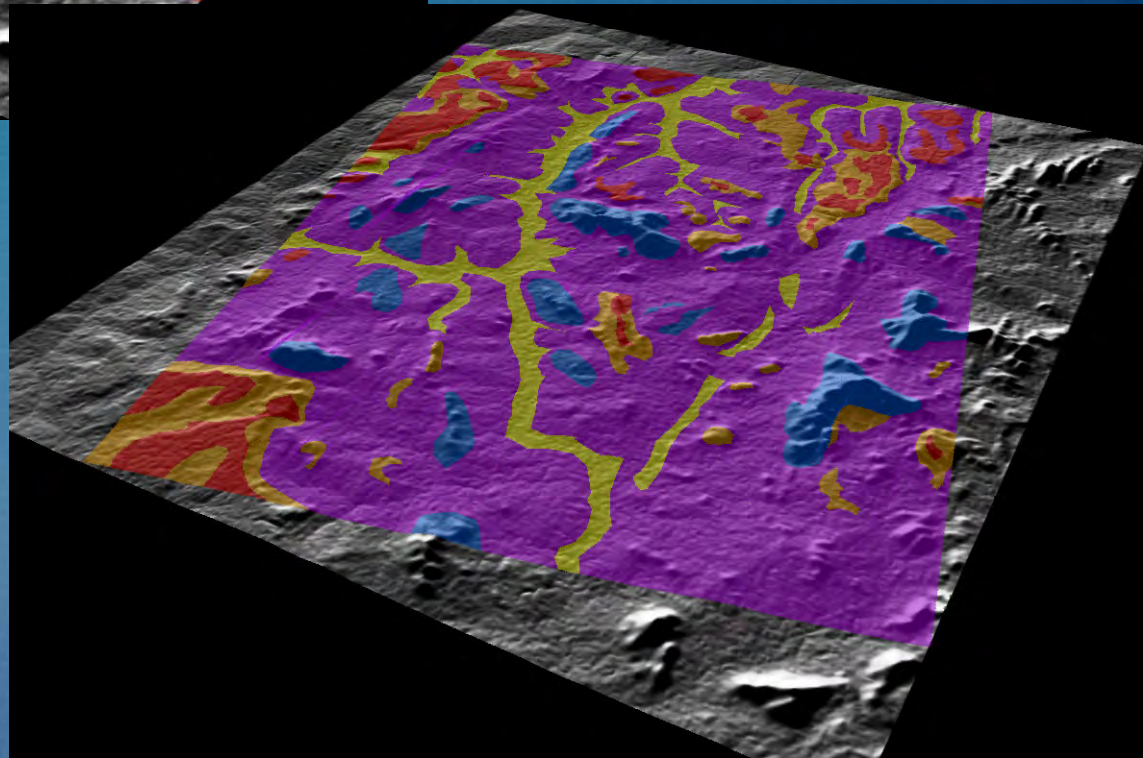
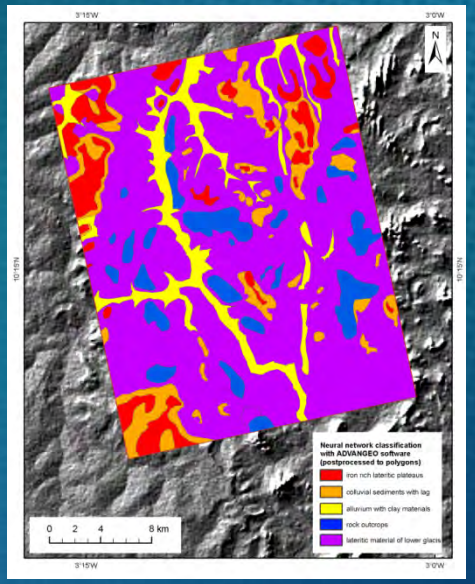


Vectorized output of the neural network classification draped over the SRTM topography

Summary and future work

- Best results were obtained by combined analysis of the multivariate dataset using ADVANGEO neural network algorithm
  - Airborne gamma-ray spectrometric data
  - SRTM elevation data and its derivatives
  - Polarimetric radar data
  - Multi-spectral ASTER data
- Landsat and ASTER data provide comparable neural network classification results
- Elevation data and its derivatives are an essential component in the classification
- Ongoing field checking and ground truthing during the WAXI project



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Thank you!

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