



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

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changing Earth

Evaluation of ENVI Feature Extraction for geological mapping in arid environments

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Reasons for Evaluation of ENVI FX

- Thanks to ITT VIS for evaluation license & time extension
- Geological remote sensing data is very complex
- Traditionally manually interpreted on map or on screen
- Time consuming
- Subjective interpretations
- Standard digital classifications give mixed results
- Potential fast technique for regional scale mapping and interpretation

ENVI Feature Extraction Workflow

BGS Trial Workflow

Find Objects

Segment Images

Merge Segments

Refine Segments
and Merge

Compute Attributes

Extract Features

Define Features

Rule-Based
Classification

Supervised
Classification

Export Features

View Reports and Statistics

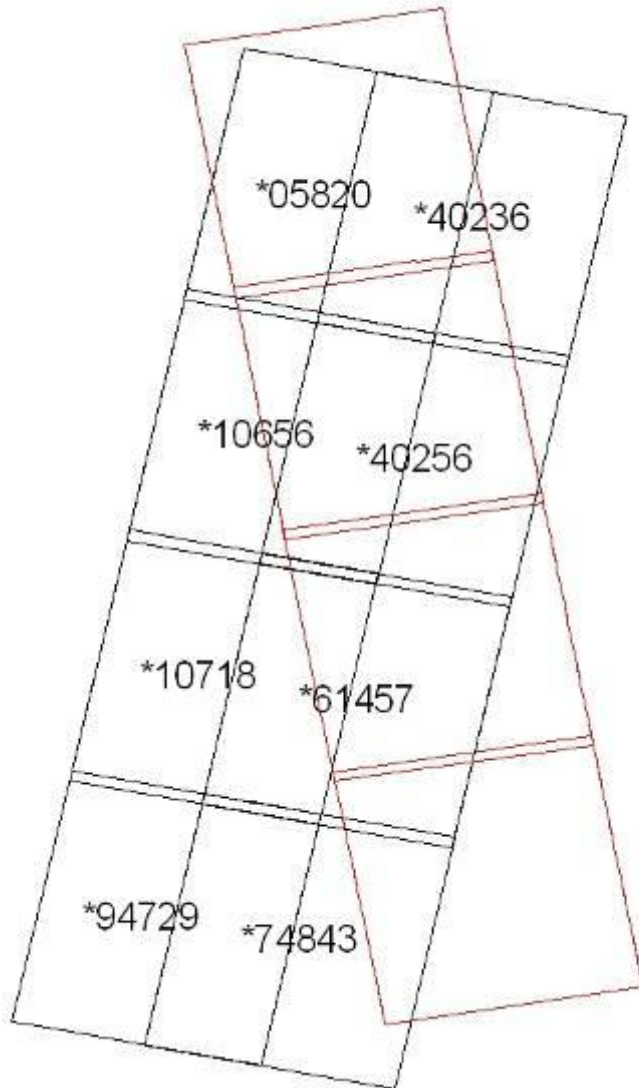
Geological Environments

- Saudi Arabia - sedimentary and metamorphic terrain with granite intrusions and Quaternary volcanics
- Morocco – sedimentary and metamorphic terrain with igneous intrusions
- Ethiopia – rifting volcanic terrain
- Tristan-da-Cunha – volcanic island in South Atlantic

Saudi Arabia

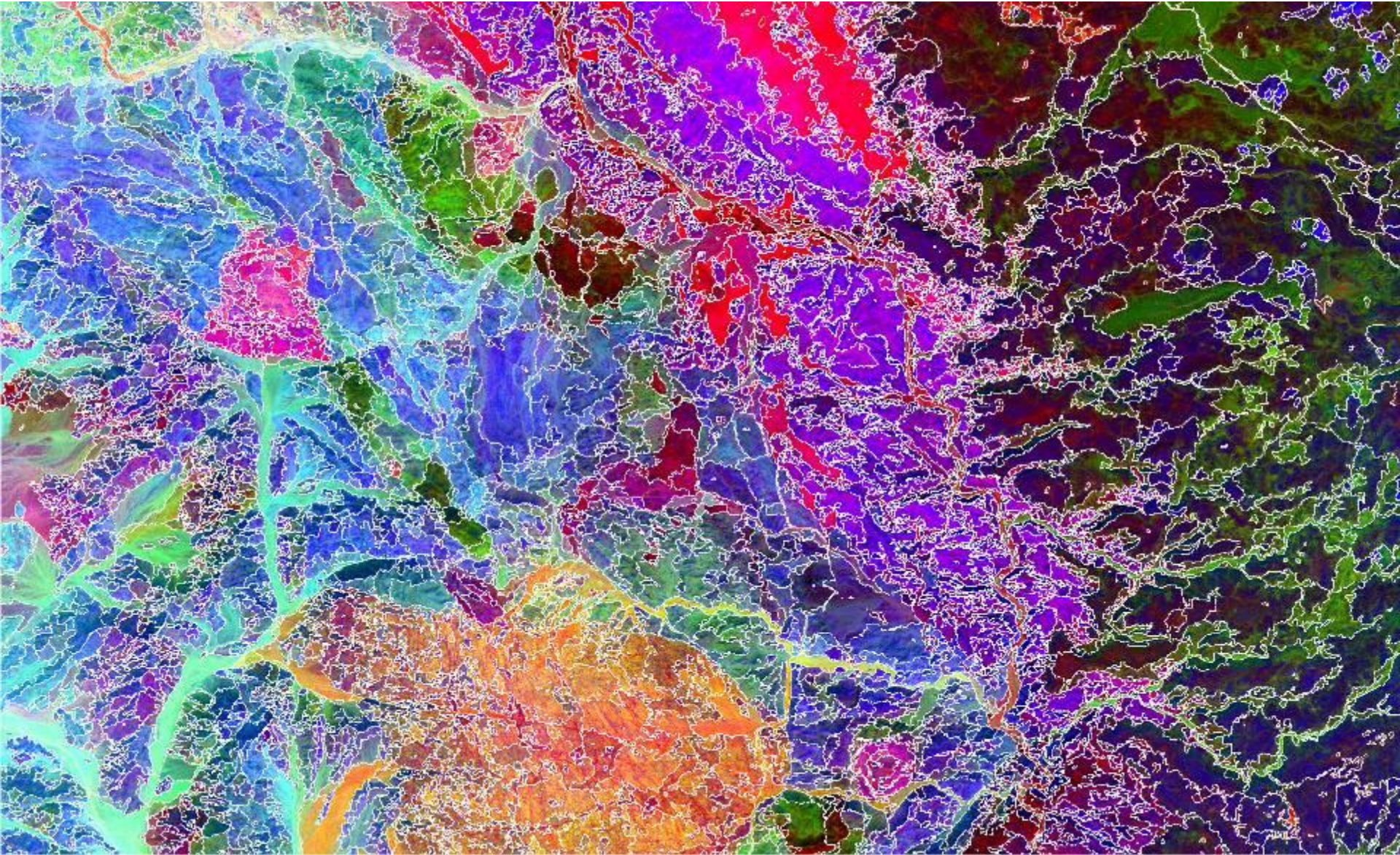


Saudi Arabia: Day ASTER

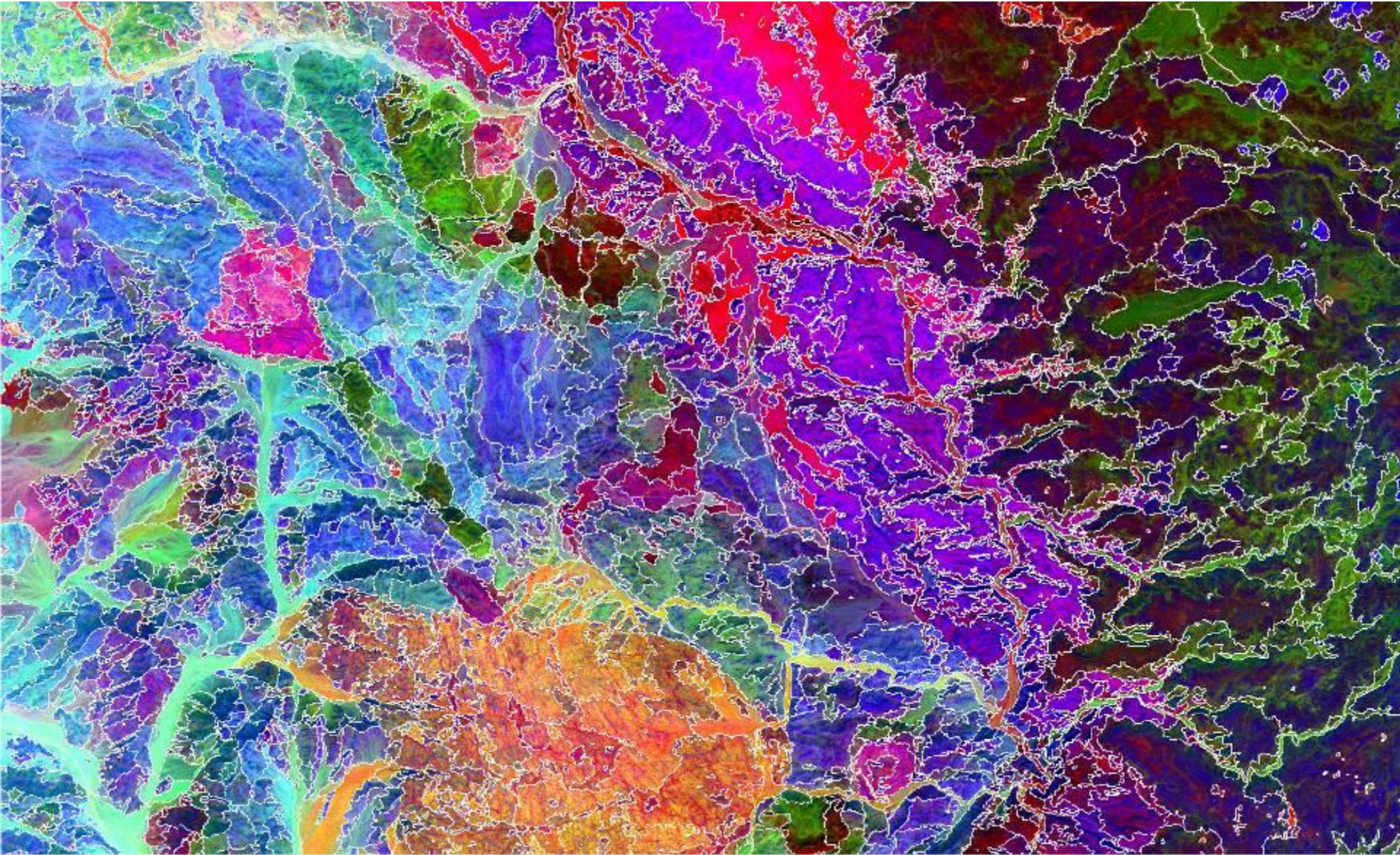


- RAW *.hdf files
- Orthorectified using SRTM
- Nearest Neighbour Image
- Bilinear Interpolation DEM
- VNIR (15m)
- SWIR (30m)
- TIR (90m)
- Atmospheric Correction

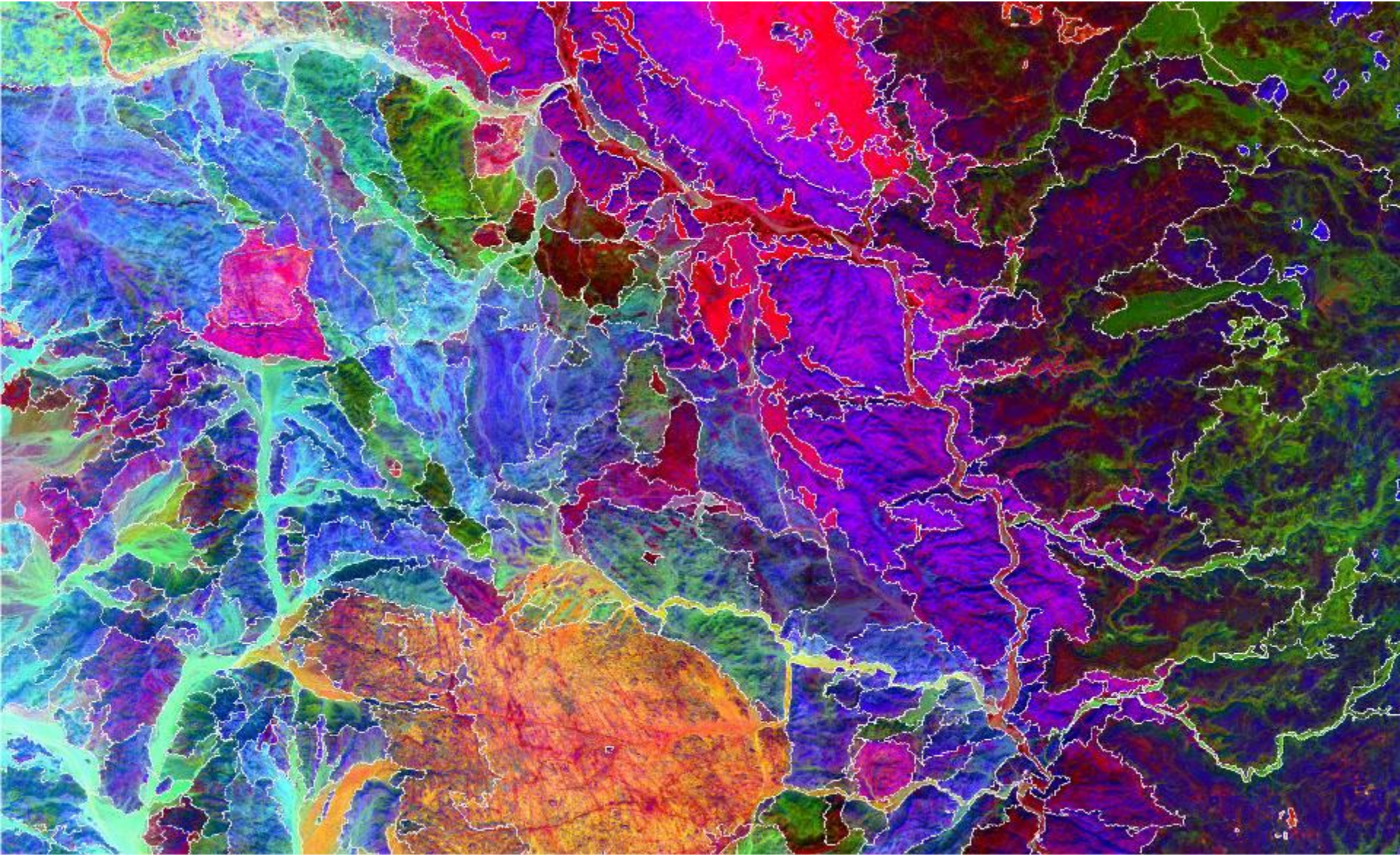
Saudi Arabia: ASTER taken 2001-11-02. Sub-area 1.
ENVI FX: segment=35 merge=90 on pc1-pc2-pc3



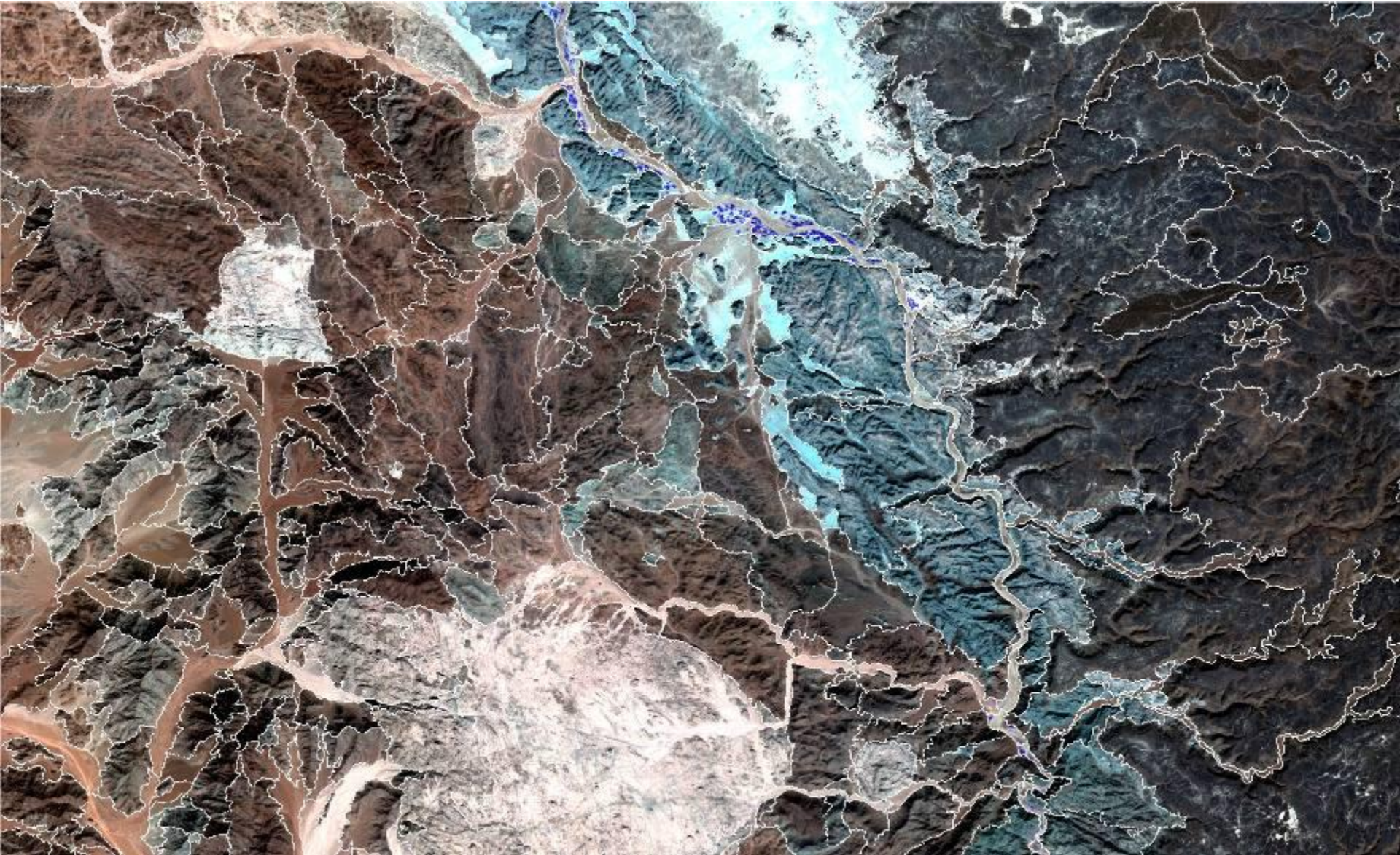
Saudi Arabia: ASTER taken 2001-11-02. Sub-area 1.
ENVI FX: segment=35 merge=95 on pc1-pc2-pc3



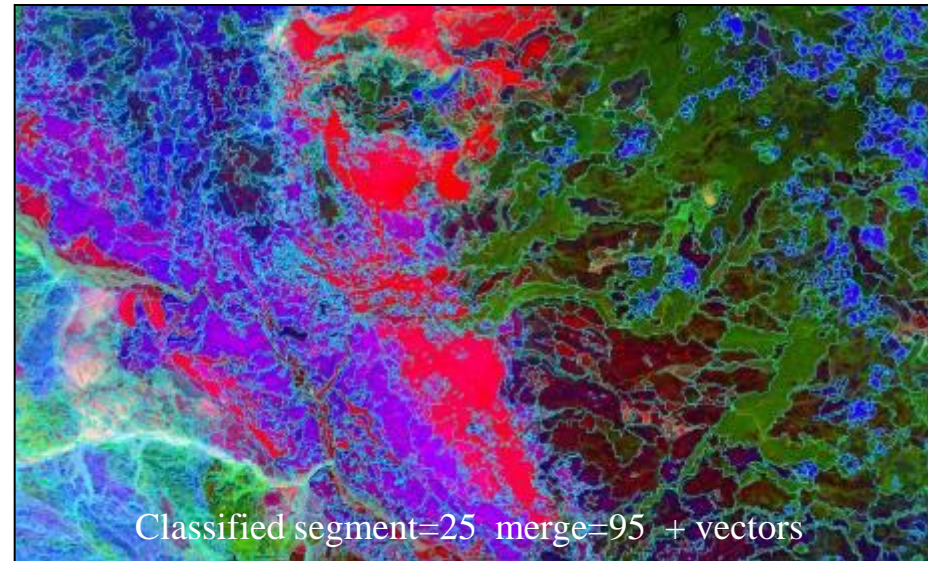
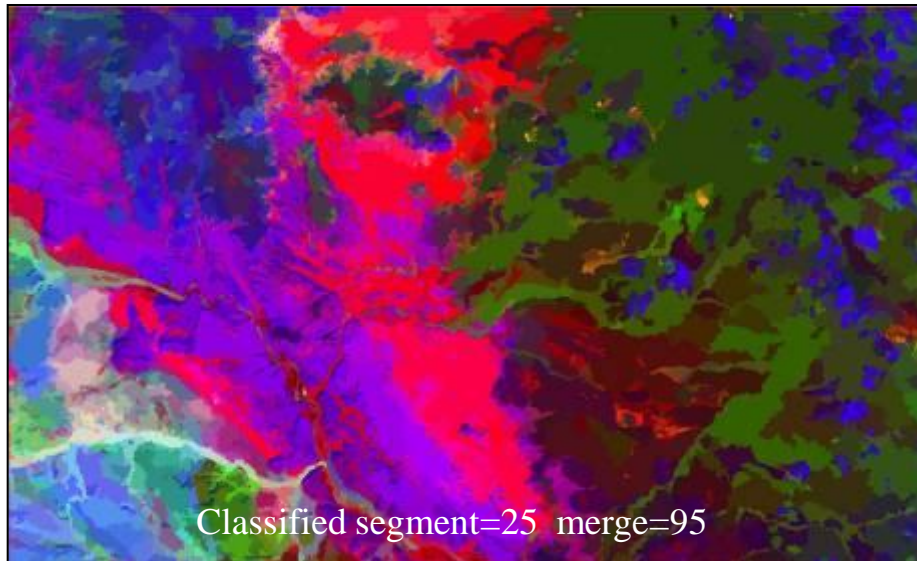
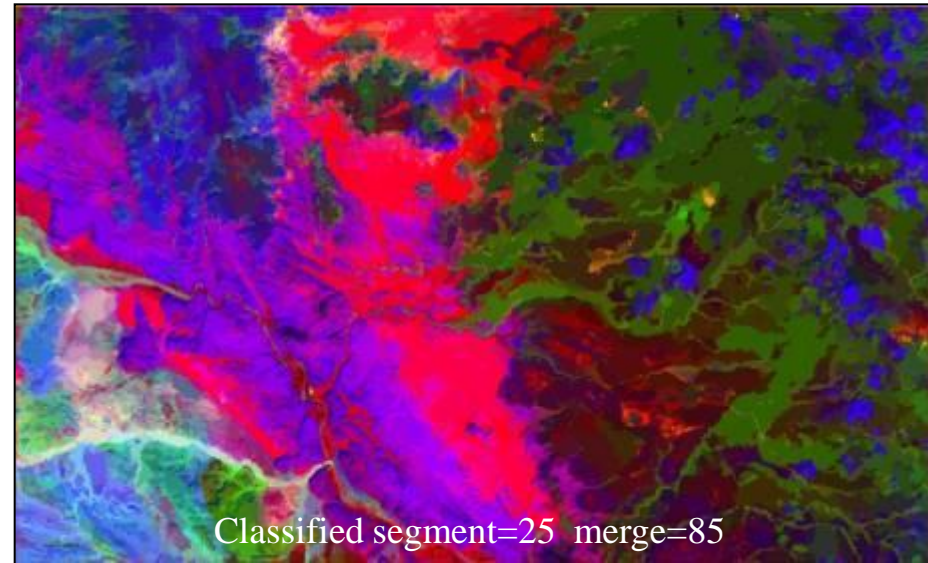
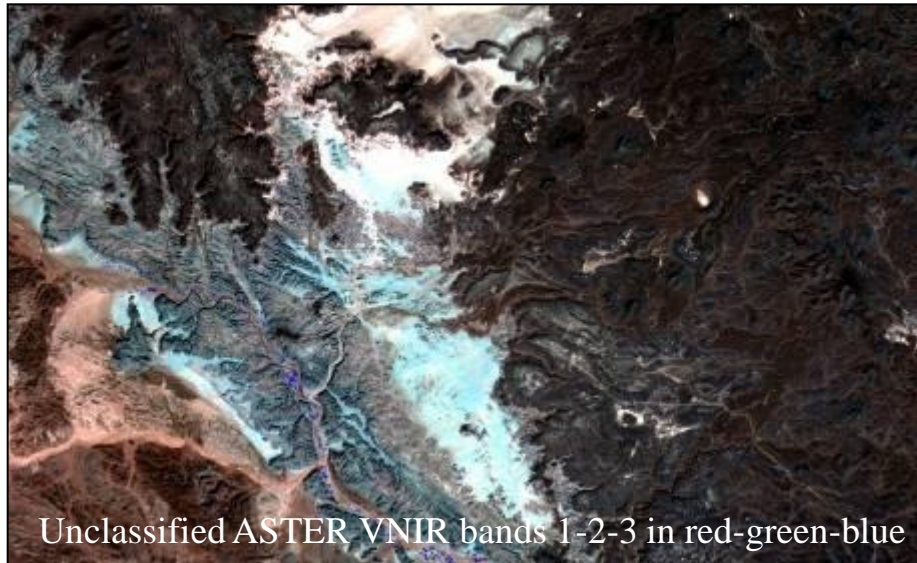
Saudi Arabia: ASTER taken 2001-11-02. Sub-area 1.
ENVI FX: segment=35 merge=99 on pc1-pc2-pc3



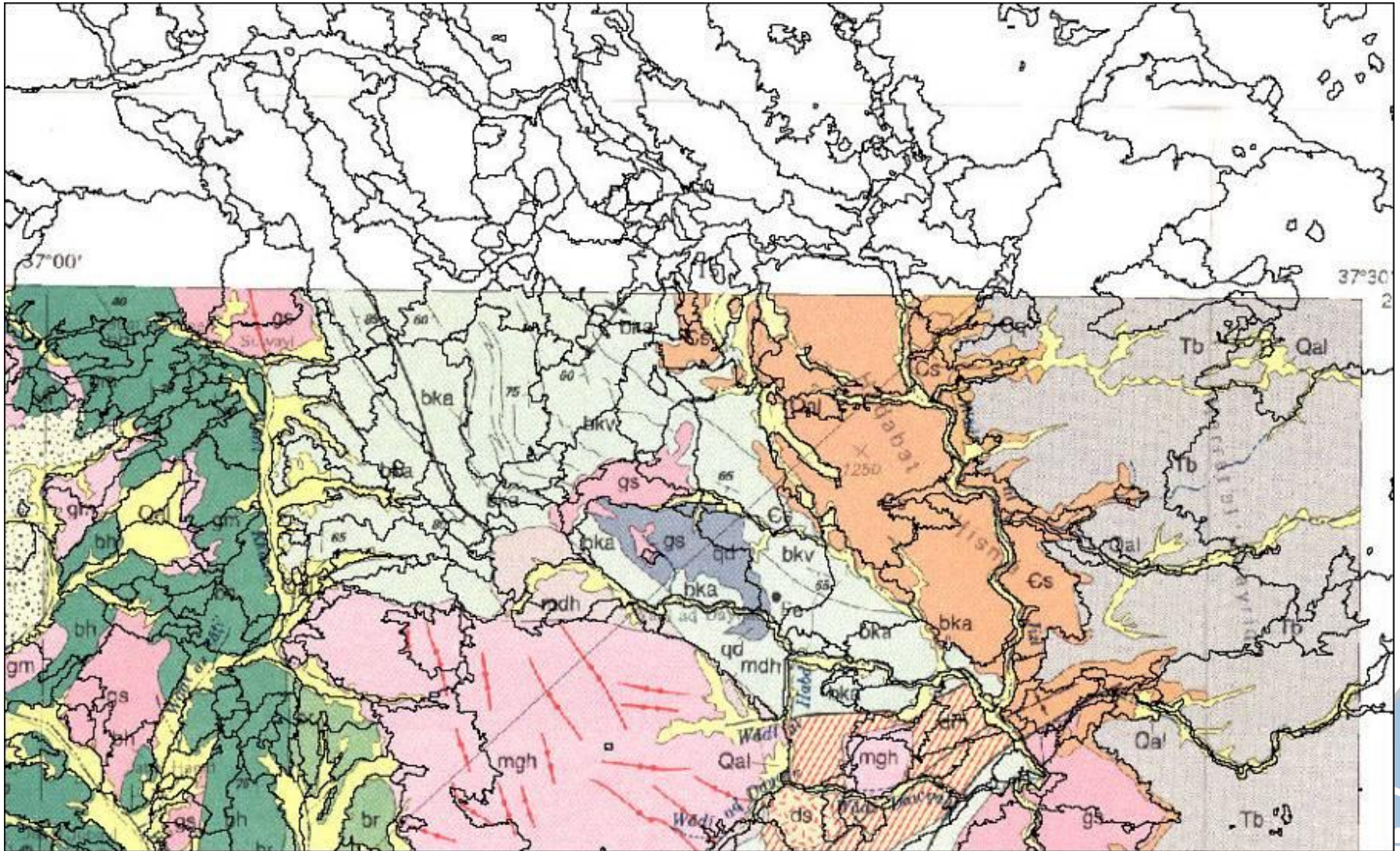
Saudi Arabia: ASTER taken 2001-11-02. Sub-area 1.
ENVI FX: segment=35 merge=99 on VNIR bands 1-2-3



Saudi Arabia: ASTER taken 2001-11-02. Sub-area 2. ENVI FX: Classified using pc1-pc2-pc3

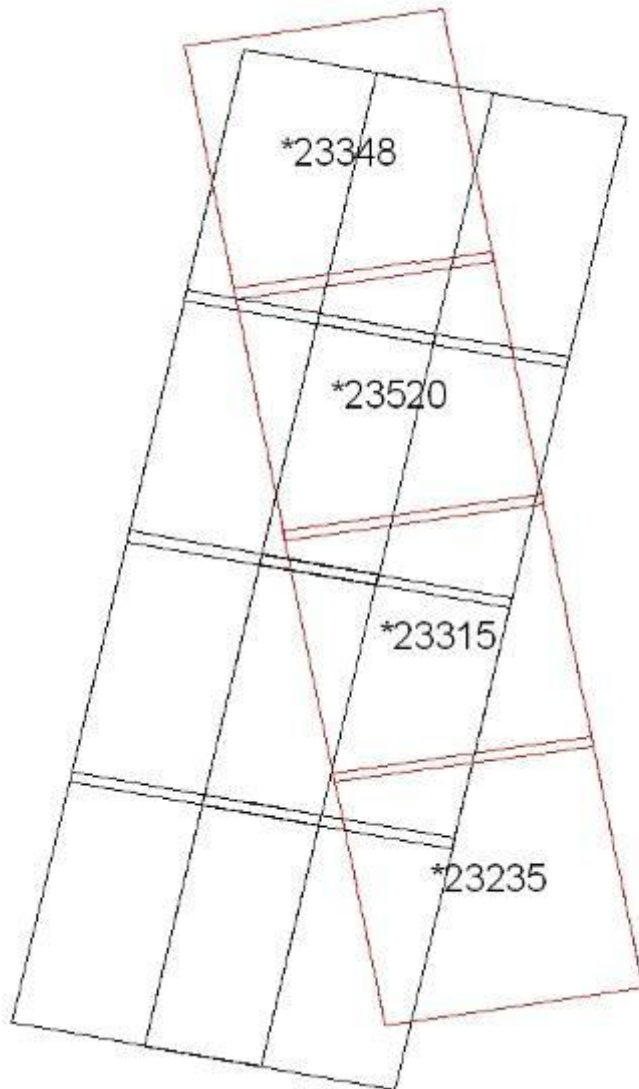


Comparison of sub-area 1 results with geological map

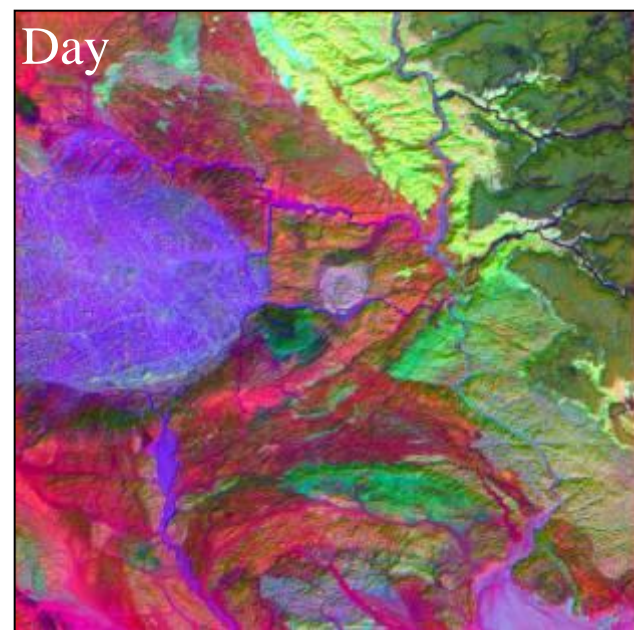


Extract from 1:250,000 geological map of the Al Wajh Quadrangle, Sheet 26B, Kingdom of Saudi Arabia (Davies, F.B. 1985)

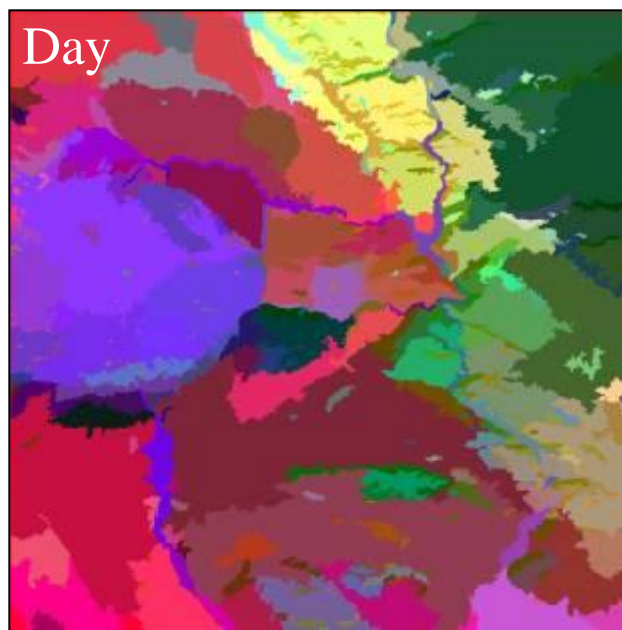
Saudi Arabia: Night ASTER



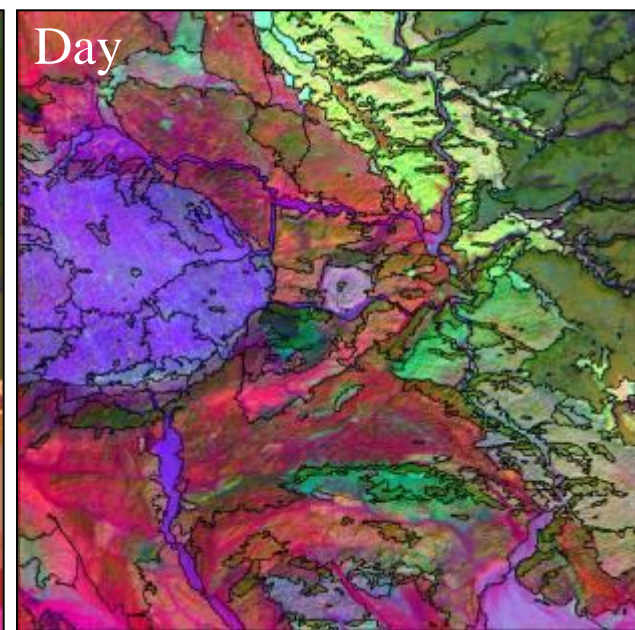
- RAW *.hdf files
- Orthorectified using SRTM
- Nearest Neighbour Image
- Bilinear Interpolation DEM
- TIR (90m)
- Atmospheric Correction



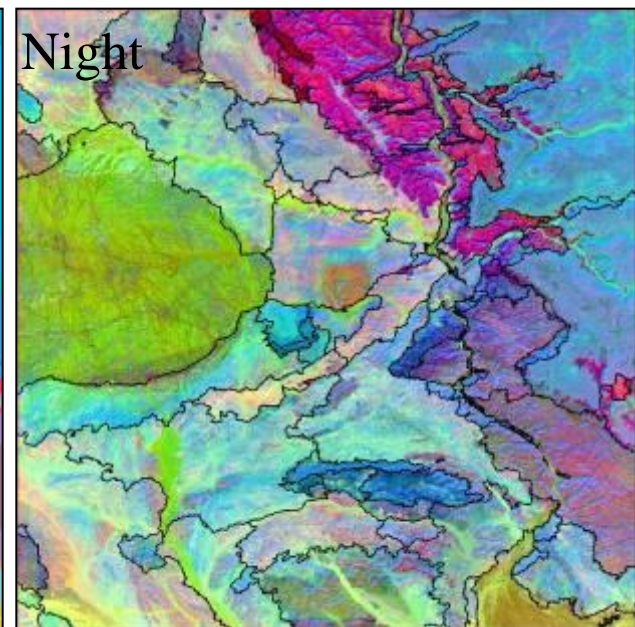
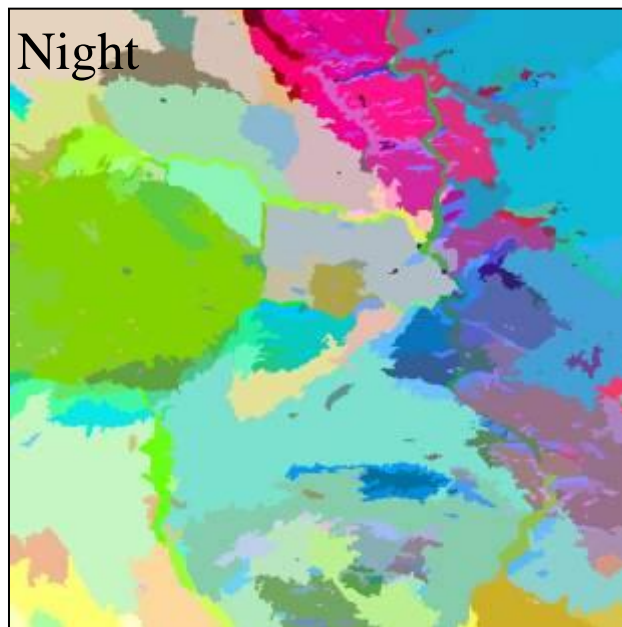
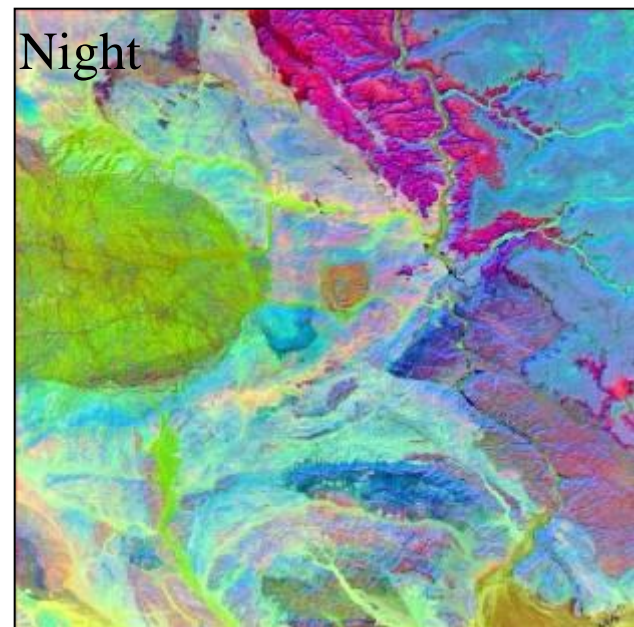
PC 3:2:1



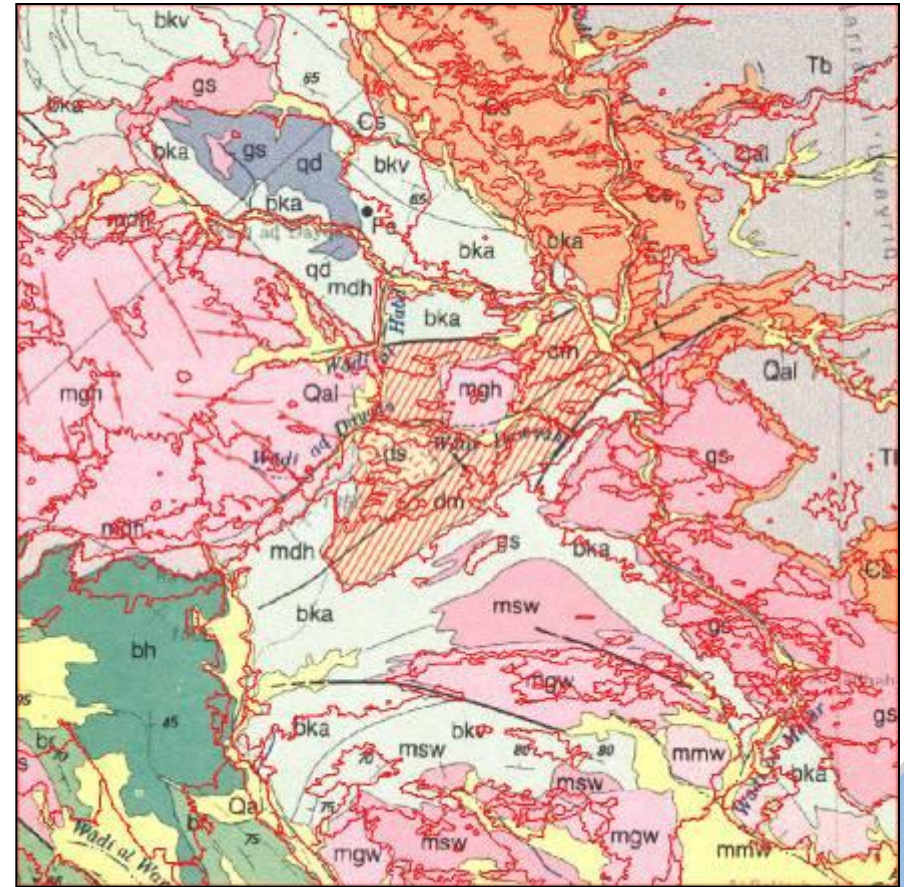
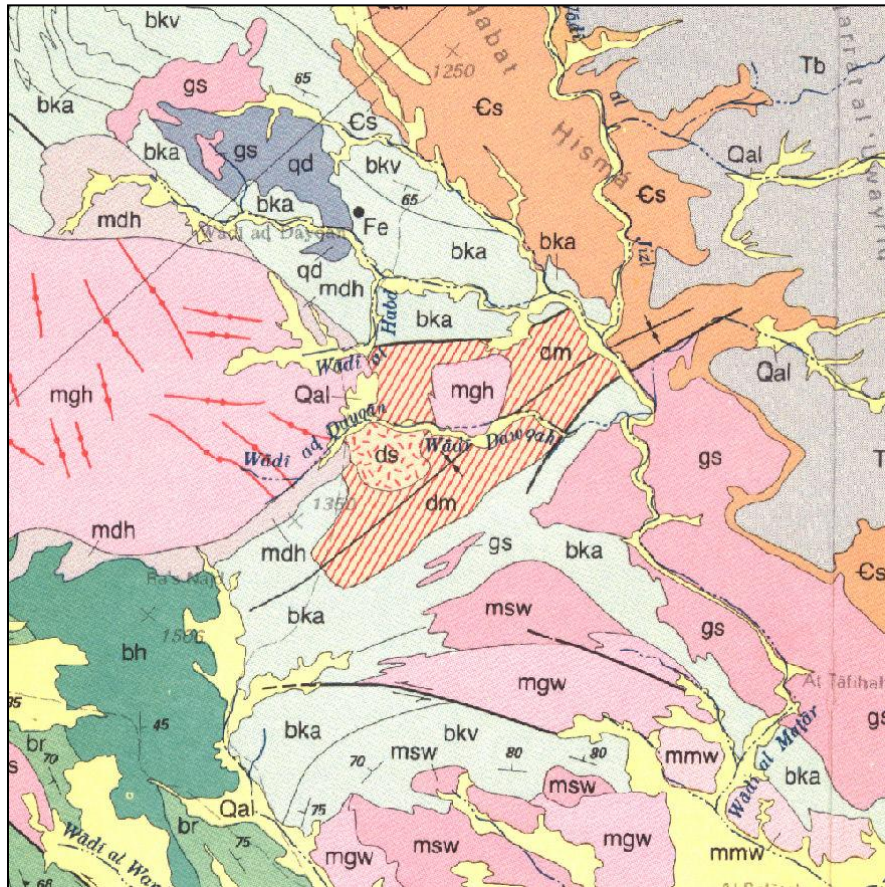
Classified S35:M99



FX vectors S35:M99



Comparison of sub-area 3 results with geological map

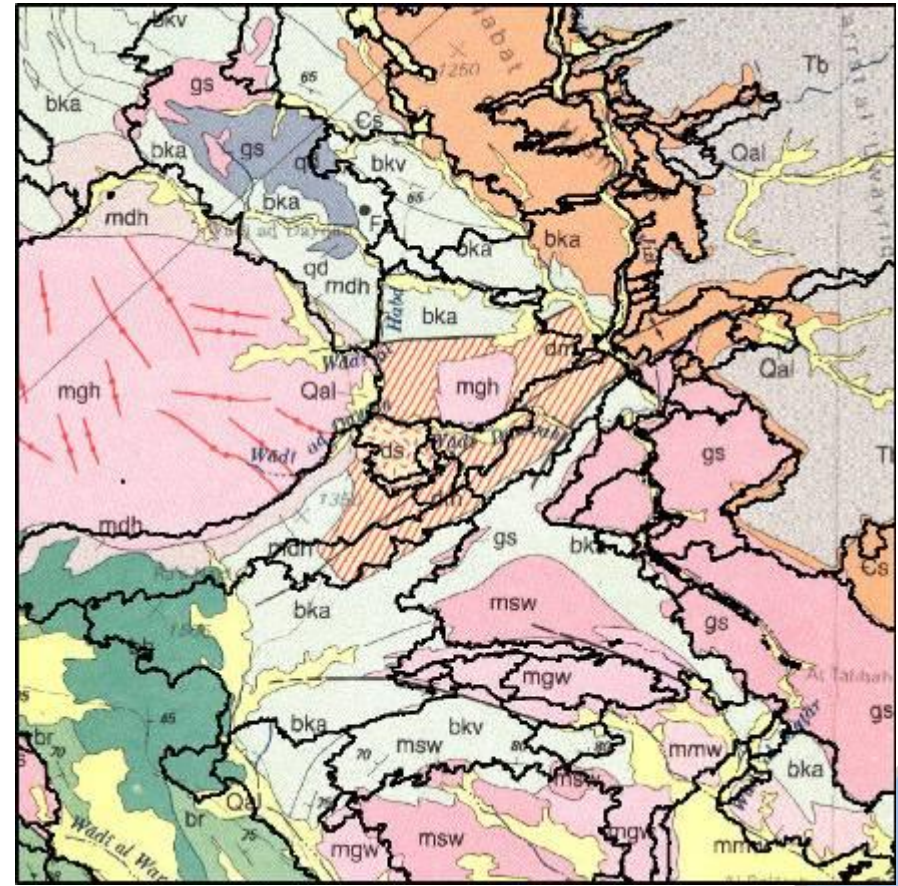
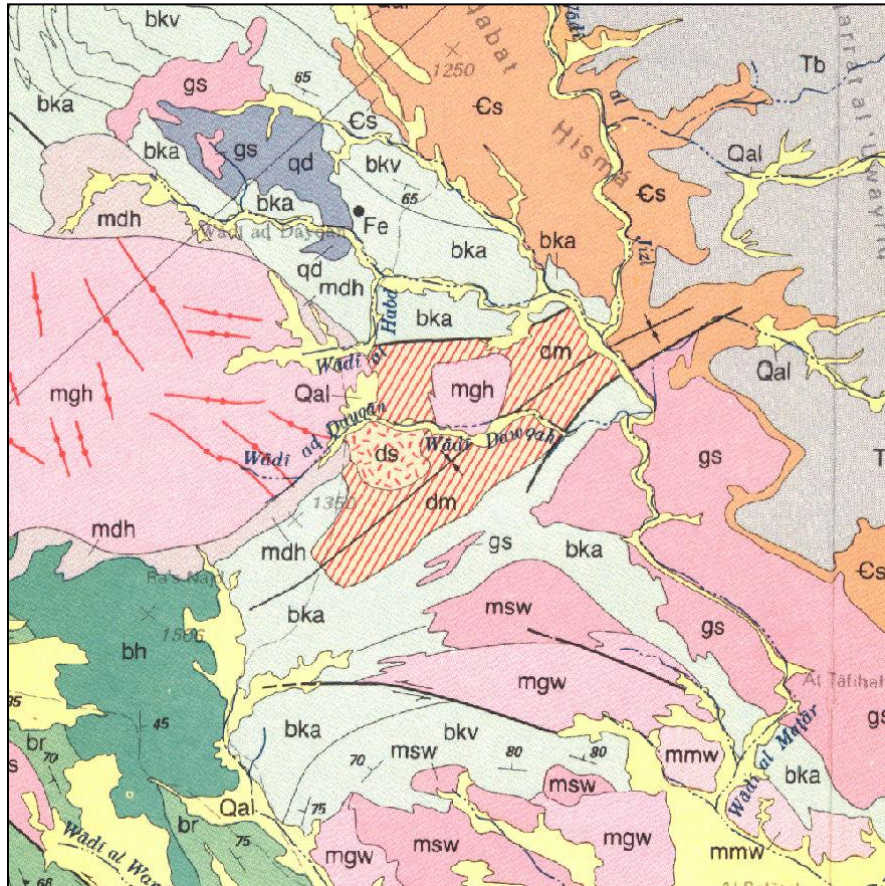


Day S35:M99 results

Extract from 1:250,000 geological map of the Al Wajh Quadrangle, Sheet 26B, Kingdom of Saudi Arabia (Davies, F.B. 1985)



Comparison of sub-area 3 results with geological map

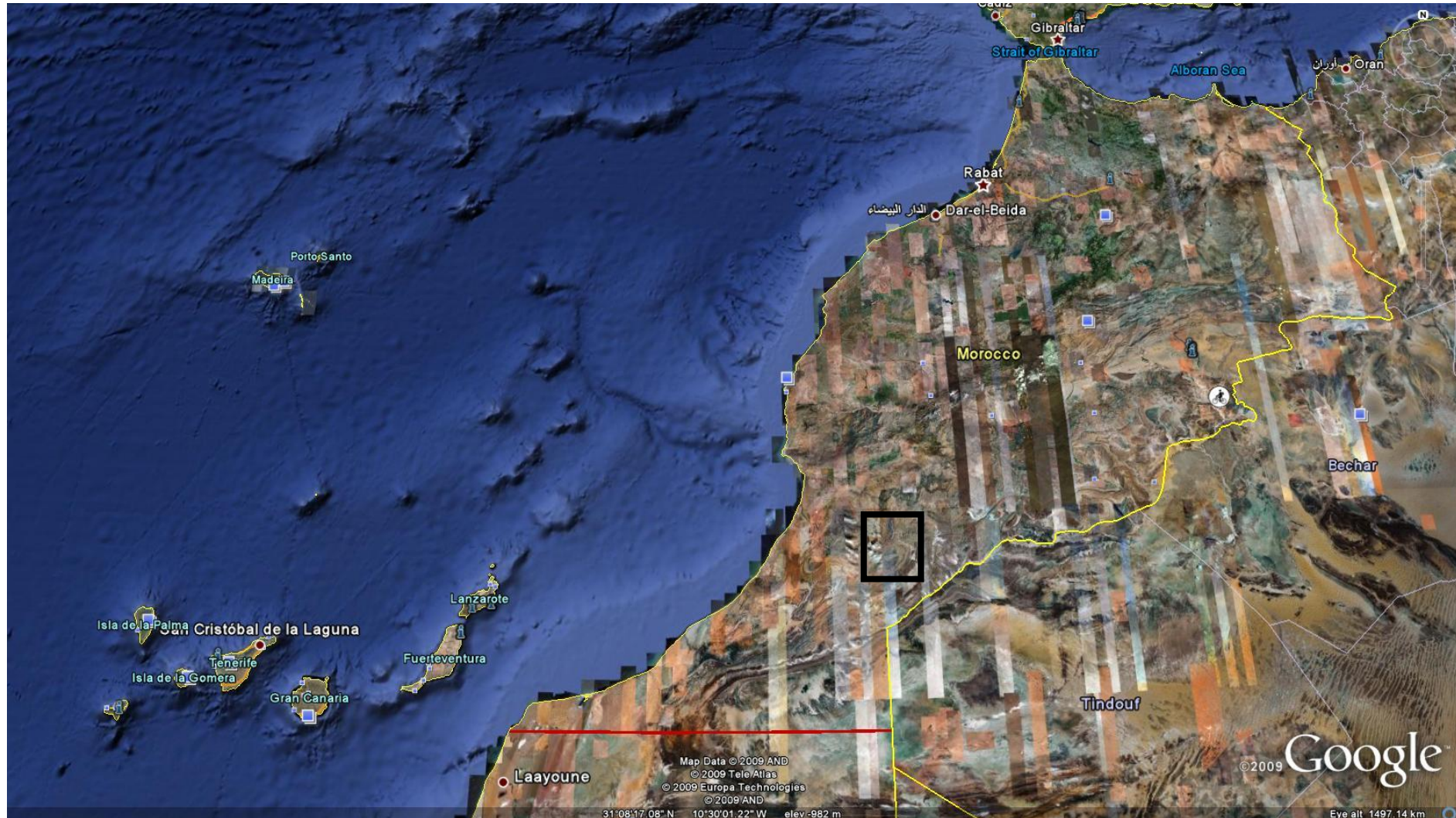


Day and Night S35:M99 results

Extract from 1:250,000 geological map of the Al Wajh Quadrangle, Sheet 26B, Kingdom of Saudi Arabia (Davies, F.B. 1985)



Morocco: Sedimentary and metamorphic with igneous intrusions



Morocco study area with geological map



Schists
(browns & pale-green)

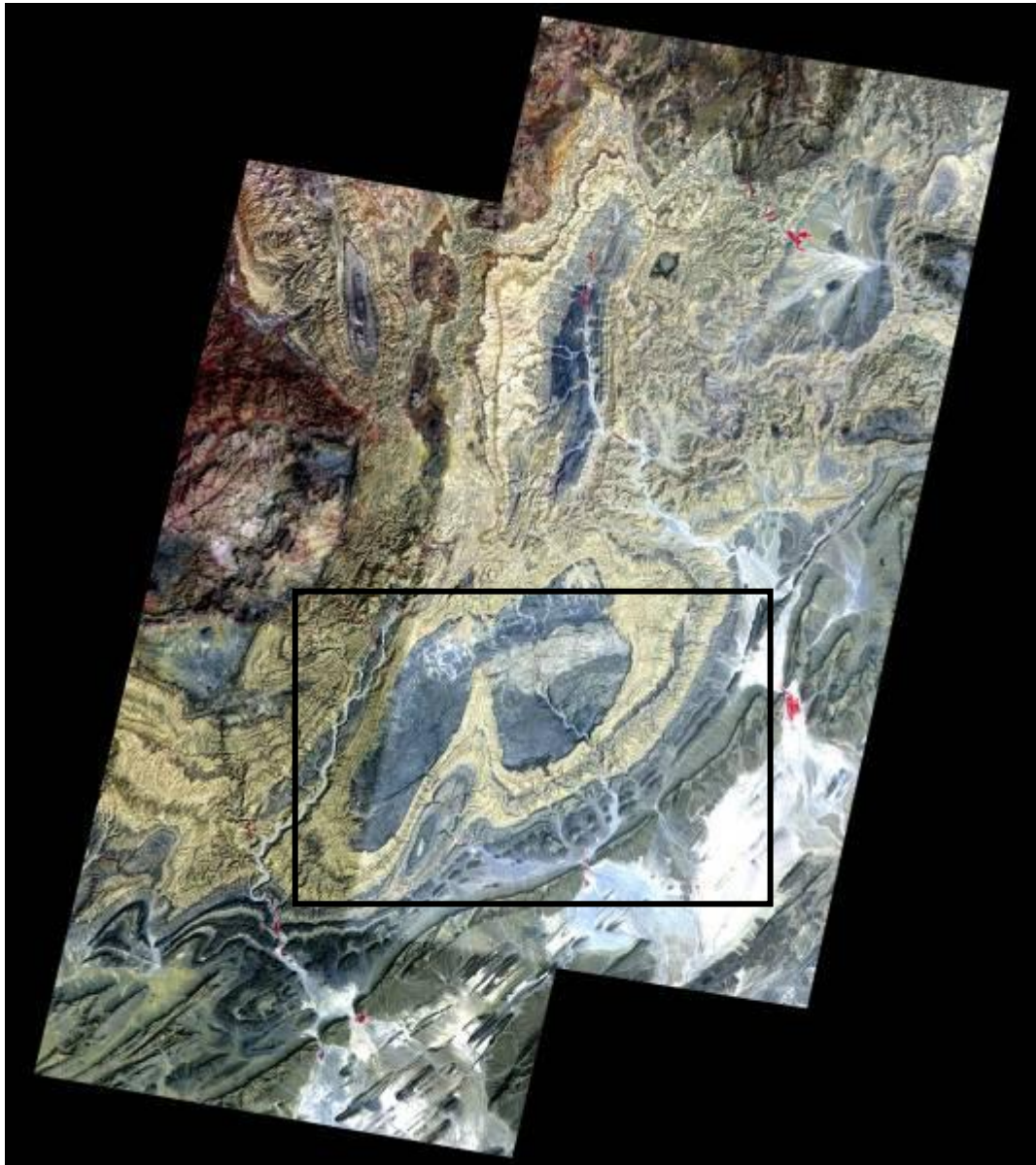
Granites & granodiorites
(reds & pale pinks)

Quartzites
(dark green)

Extract from 1:500,000 geological map of Morocco, Marrakech Sheet (Division de la Géologie, Ministère de la Production Industrielle et des Mines, 1955)



Morocco: ASTER mosaic of 4 scenes

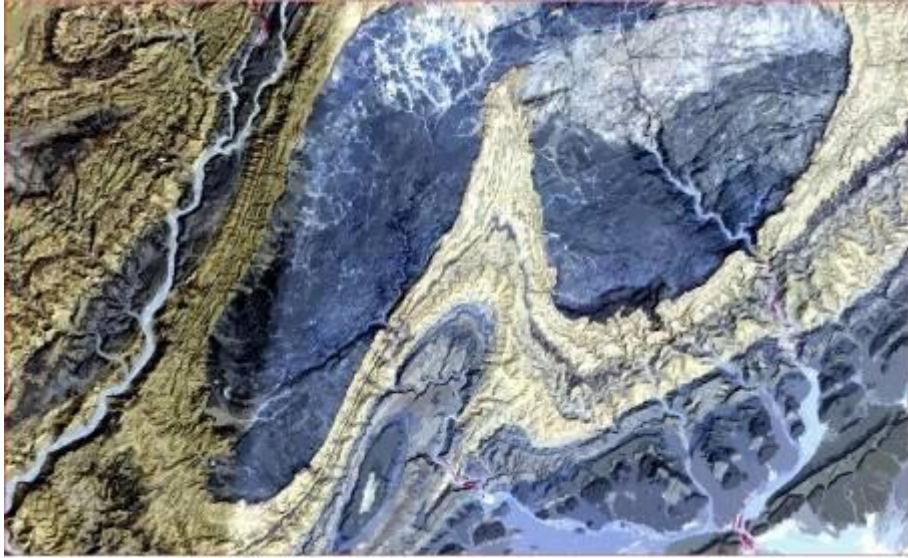


**Orthorectified using ENVI
(SRTM as ground control)**

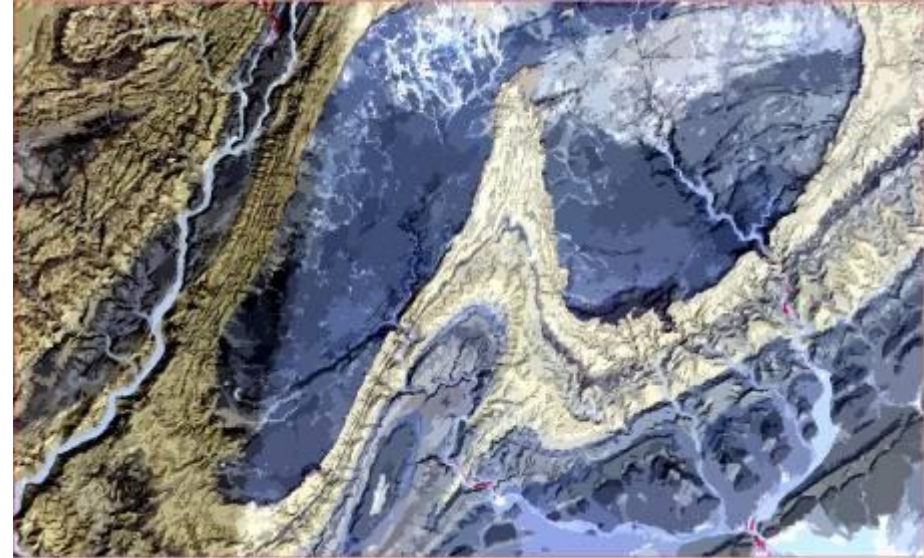
**Stacked VNIR + SWIR 9 bands
(30m pixels)**

**Mosaic not balanced to see what
effect it would have on ENVI Fx**

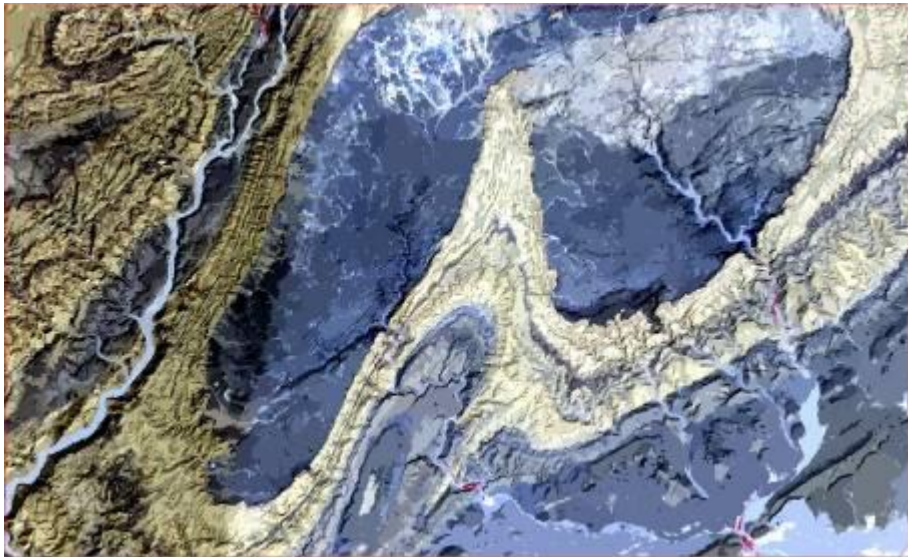
Morocco ASTER 231 ENVI FX Classified Results



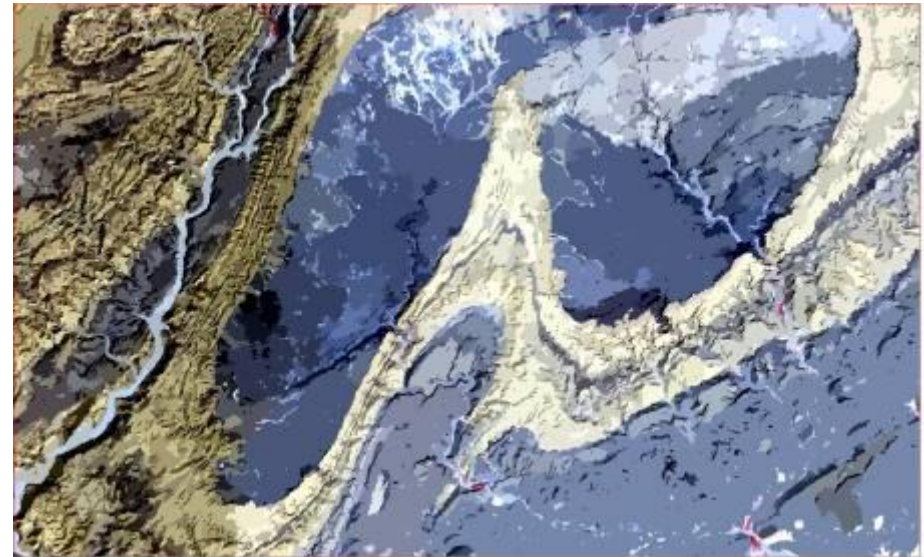
Classified: Segment 25 Merged 70



Classified: Segment 25 Merged 90



Classified: Segment 35 Merged 80



Classified: Segment 45 Merged 90

Afar Volcanic Terrain



Afar Volcanic Terrain: Topographic Structure

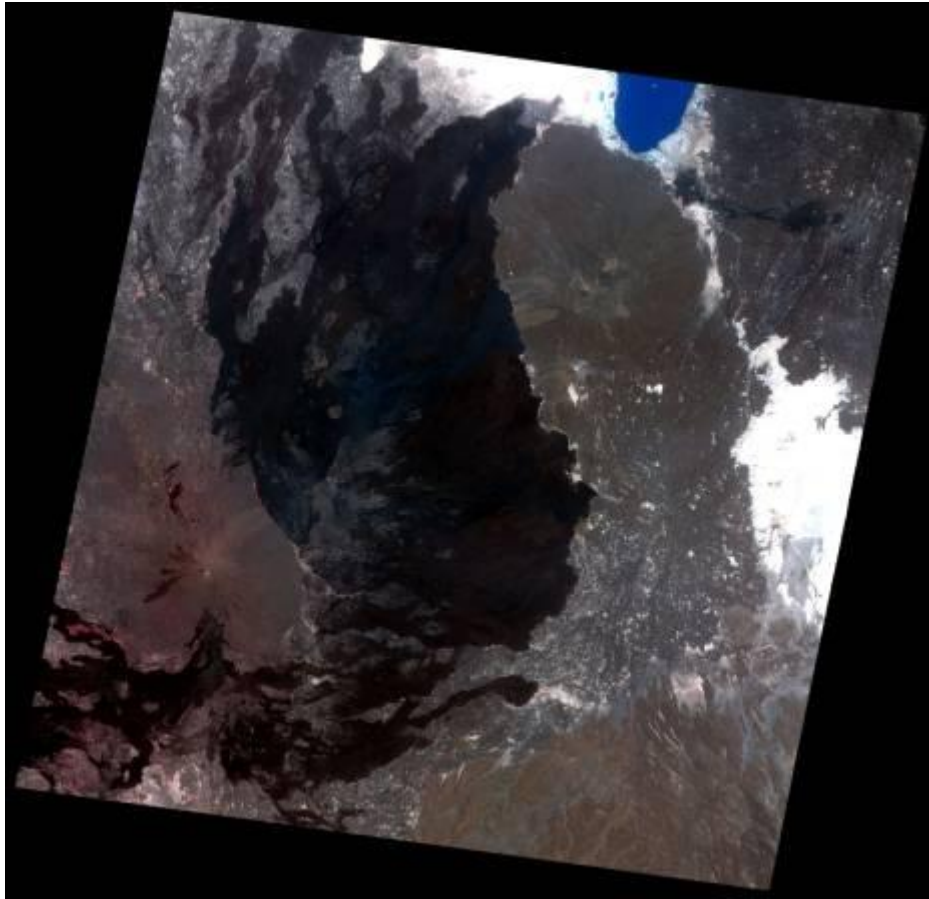


Afar Volcanic Terrain: Geological Features

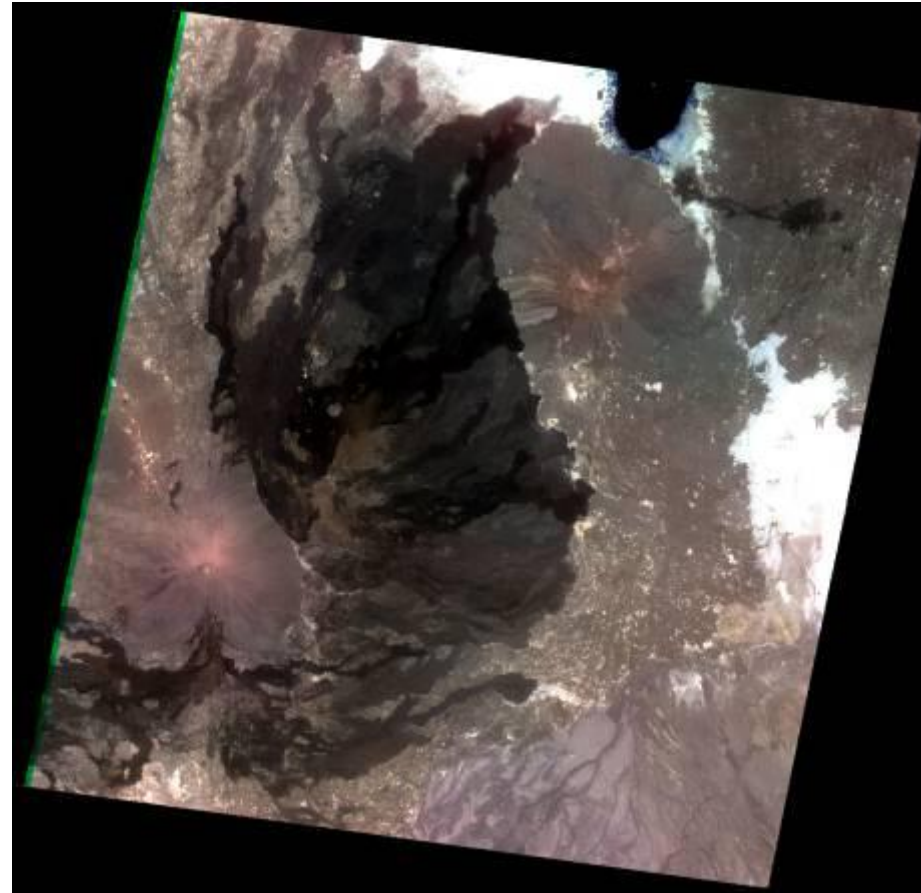


Afar Volcanics: ASTER taken 2005-06-19

Stacked VNIR +SWIR (9 bands)



ASTER VNIR bands 3-2-1 in red-green-blue



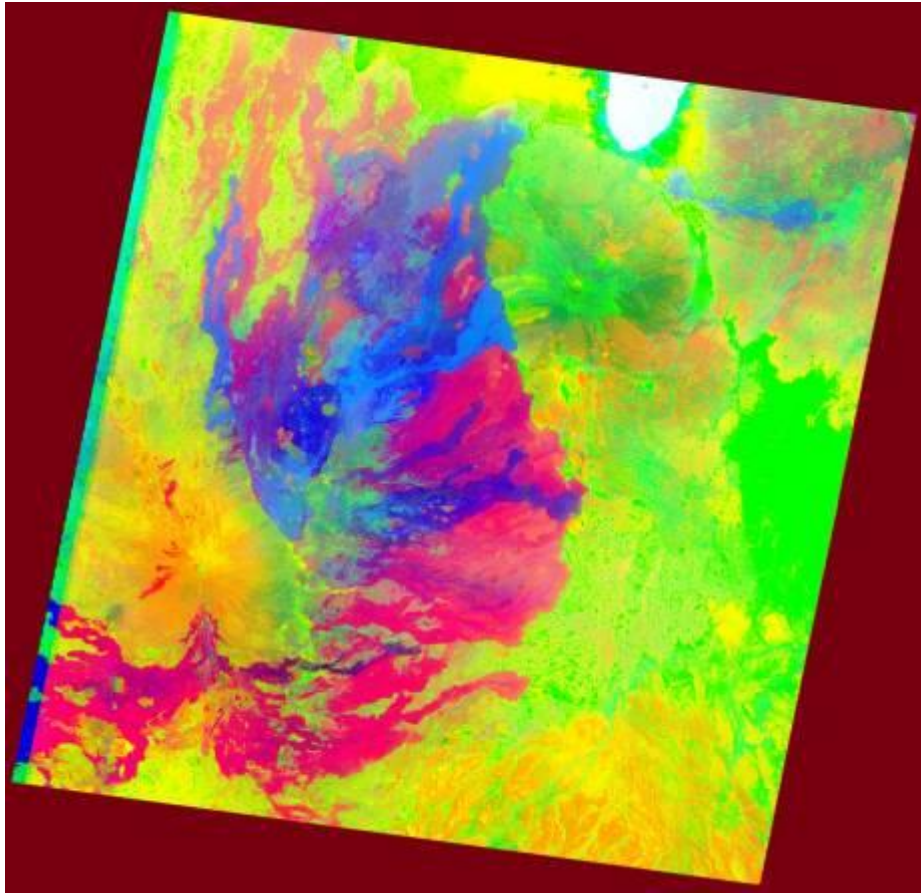
ASTER SWIR bands 9-6-4 in red-green-blue

Raw ASTER data supplied by Afar Rift Consortium Project:
(Universities of Leeds, Bristol, Cambridge, Edinburgh, Oxford)

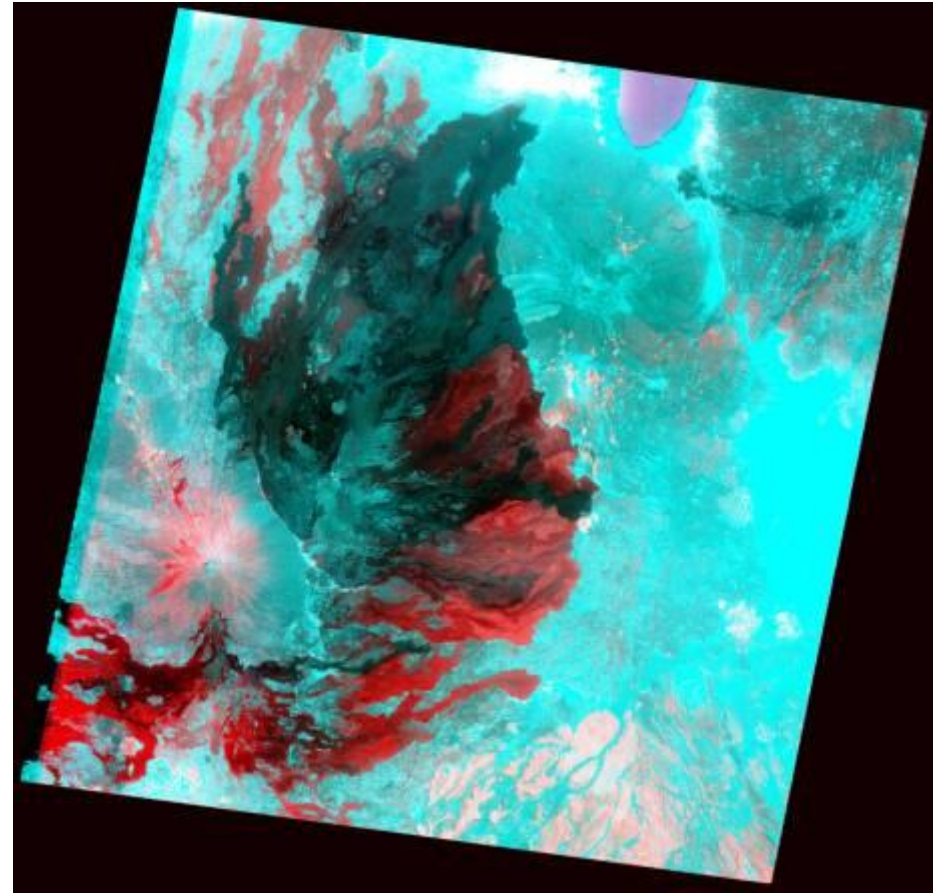


Afar Volcanics: ASTER taken 2005-06-19

Stacked VNIR +SWIR (9 bands)



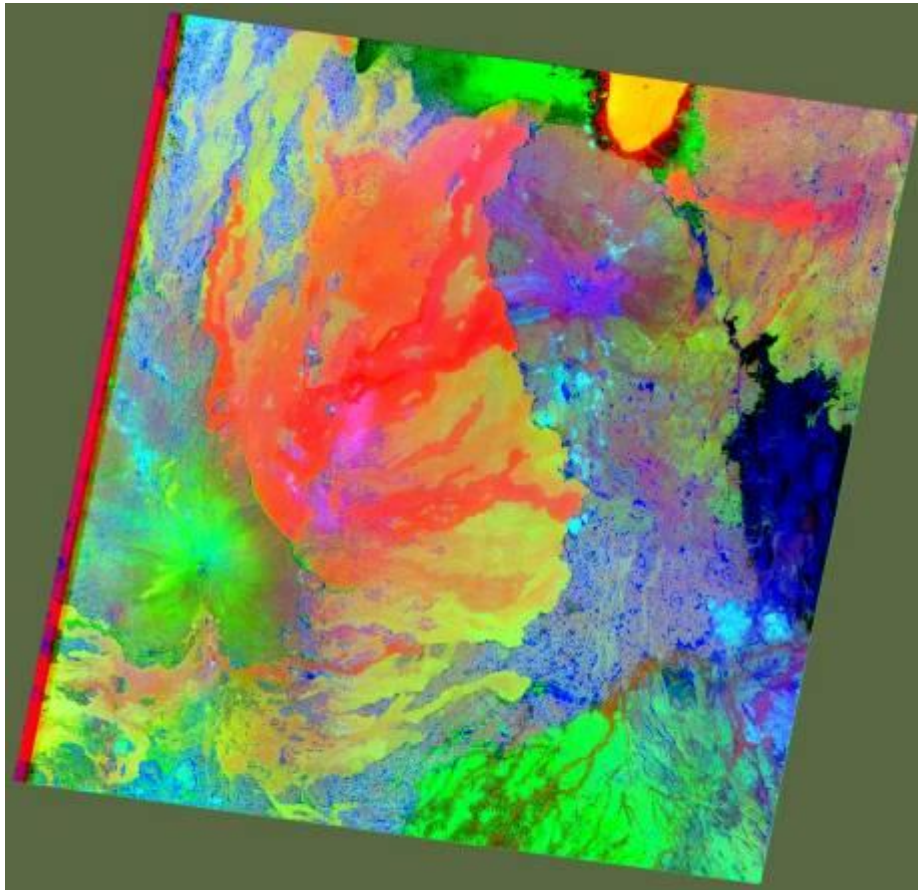
ASTER hybrid image pc3-dc1-pc2 in red-green-blue



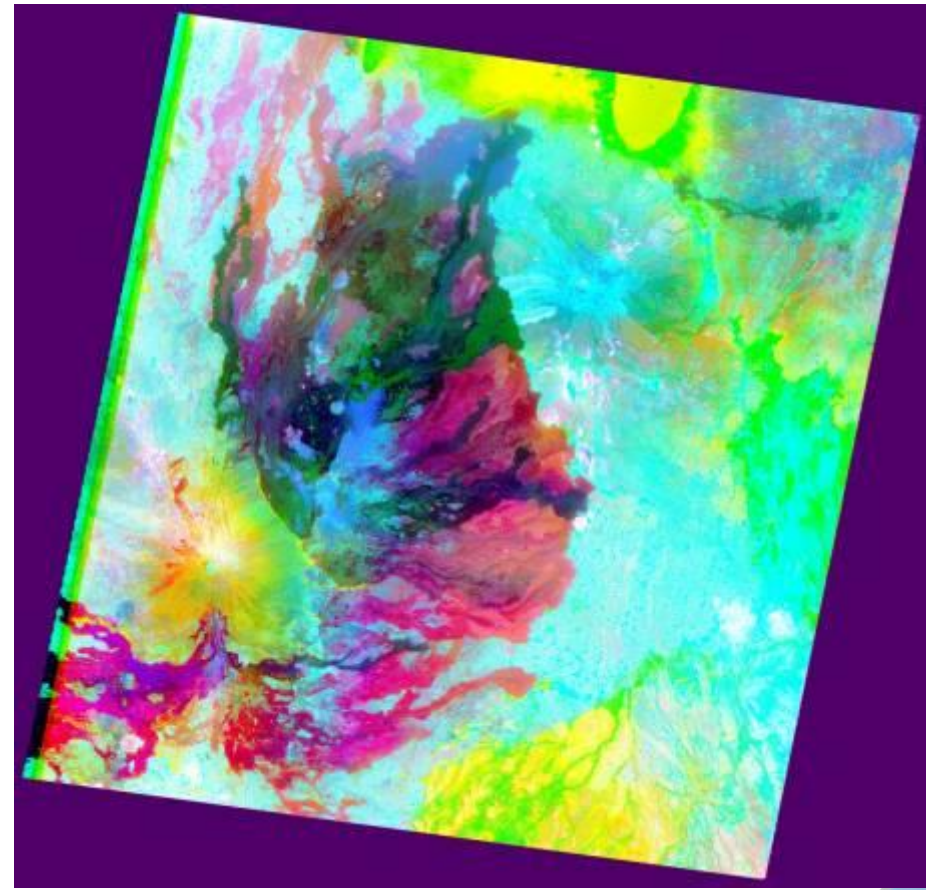
ASTER hybrid image pc3-dc2-pc1 in red-green-blue

Afar Volcanics: ASTER taken 2005-06-19

Principal Components VNIR +SWIR (9 bands)

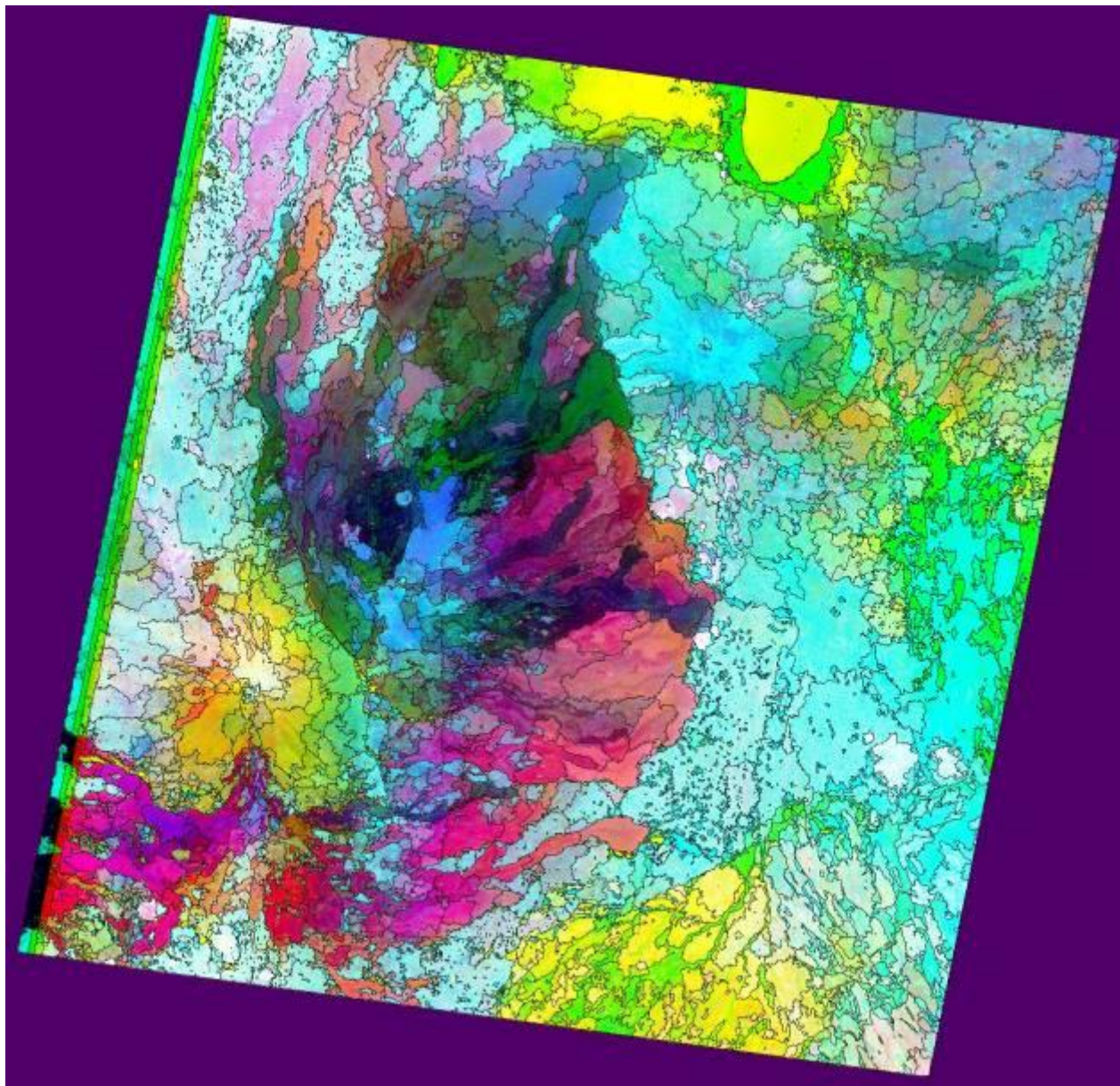


ASTER false-colour composite image pc2-pc3-pc5



ASTER false-colour composite image pc3-pc1-pc5

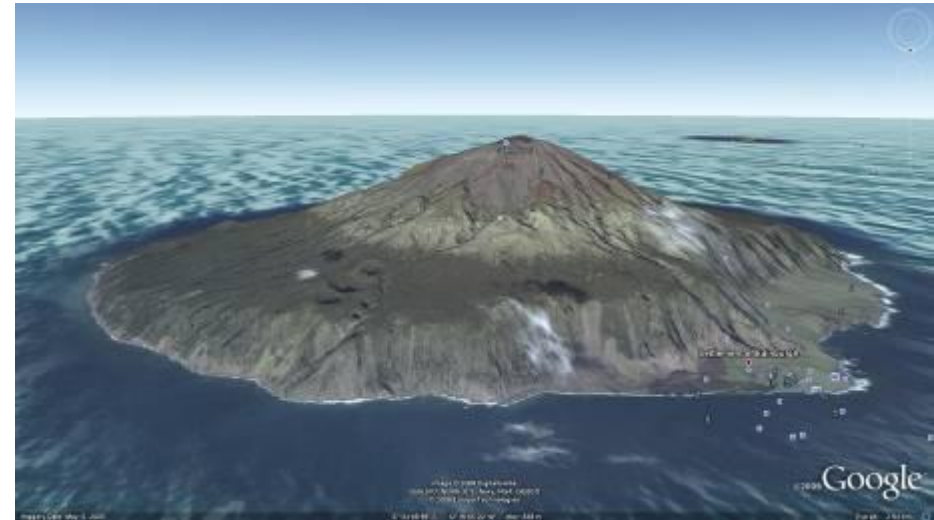
Afar Volcanics ASTER pc315 ENVI FX Classified Result



Segment 25 Merged 70



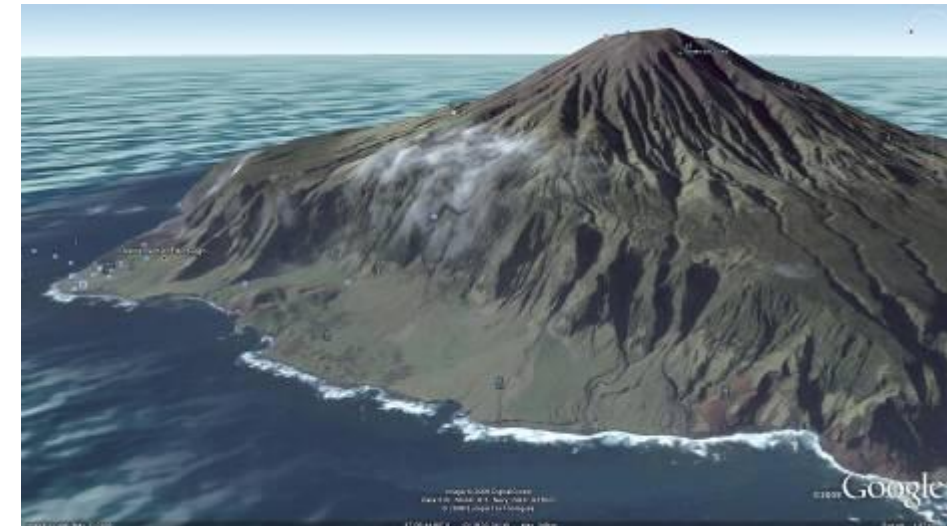
Tristan-da-Cunha: Volcanic Island in South Atlantic Ocean



View south

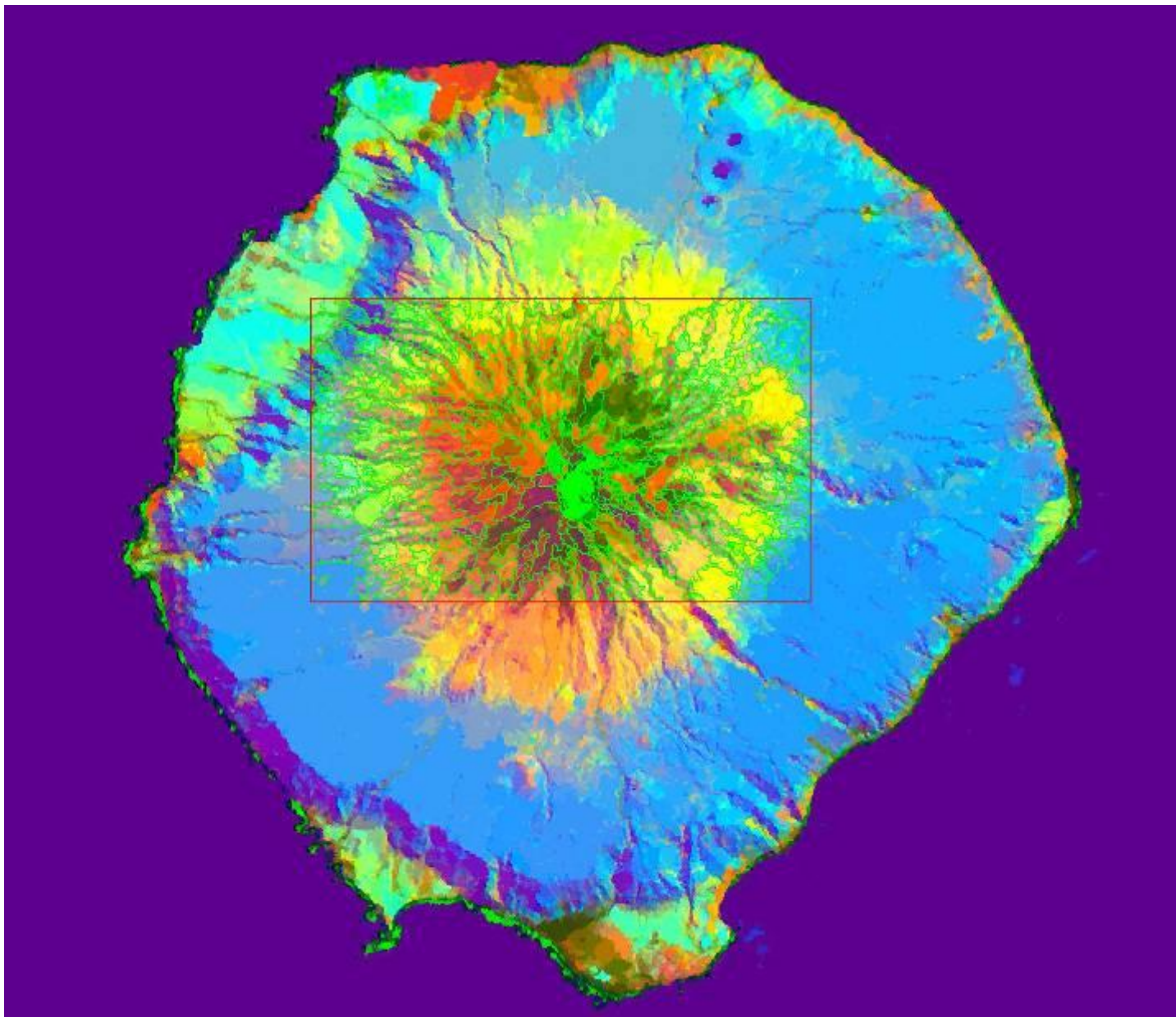


View north

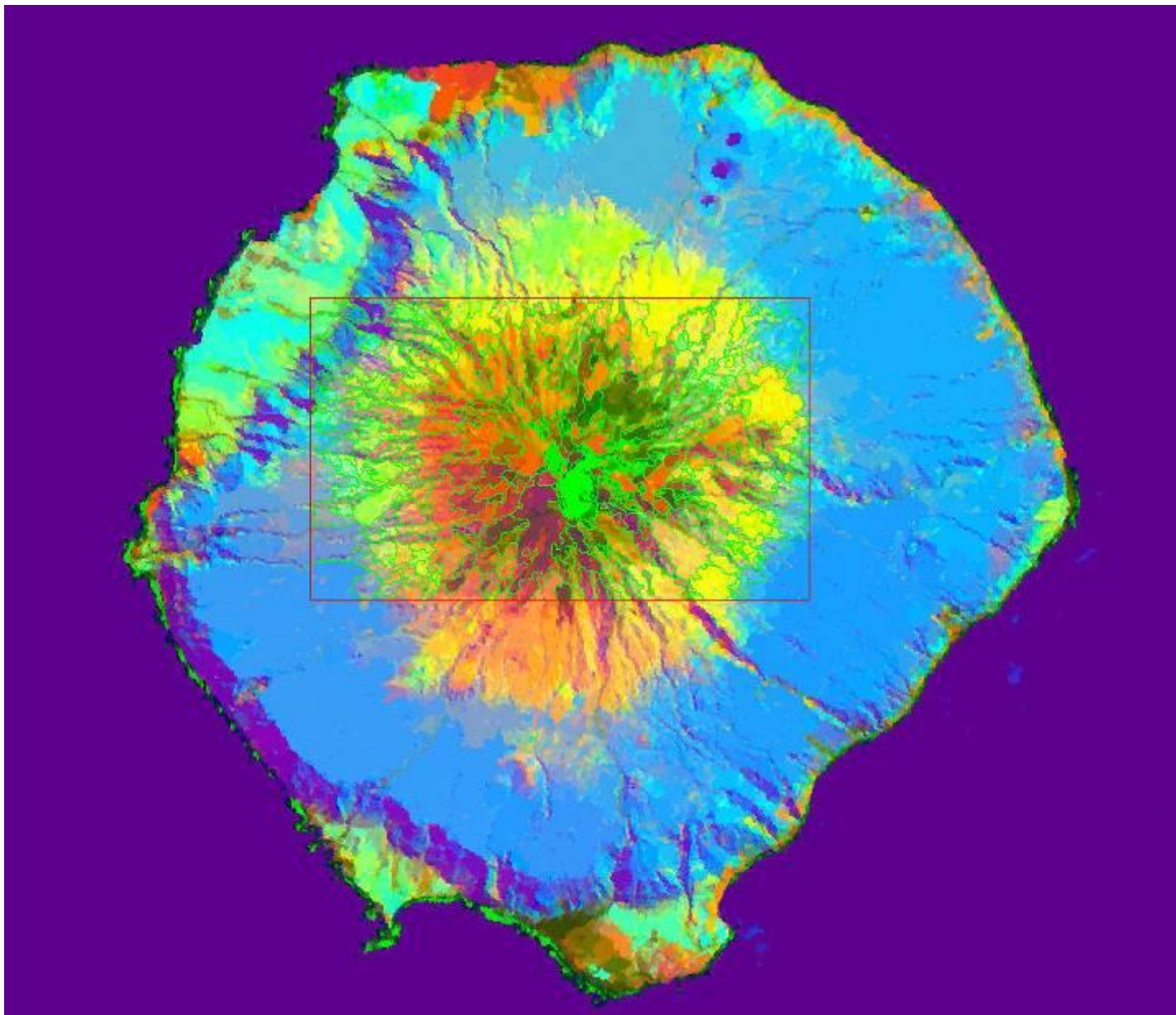


View east

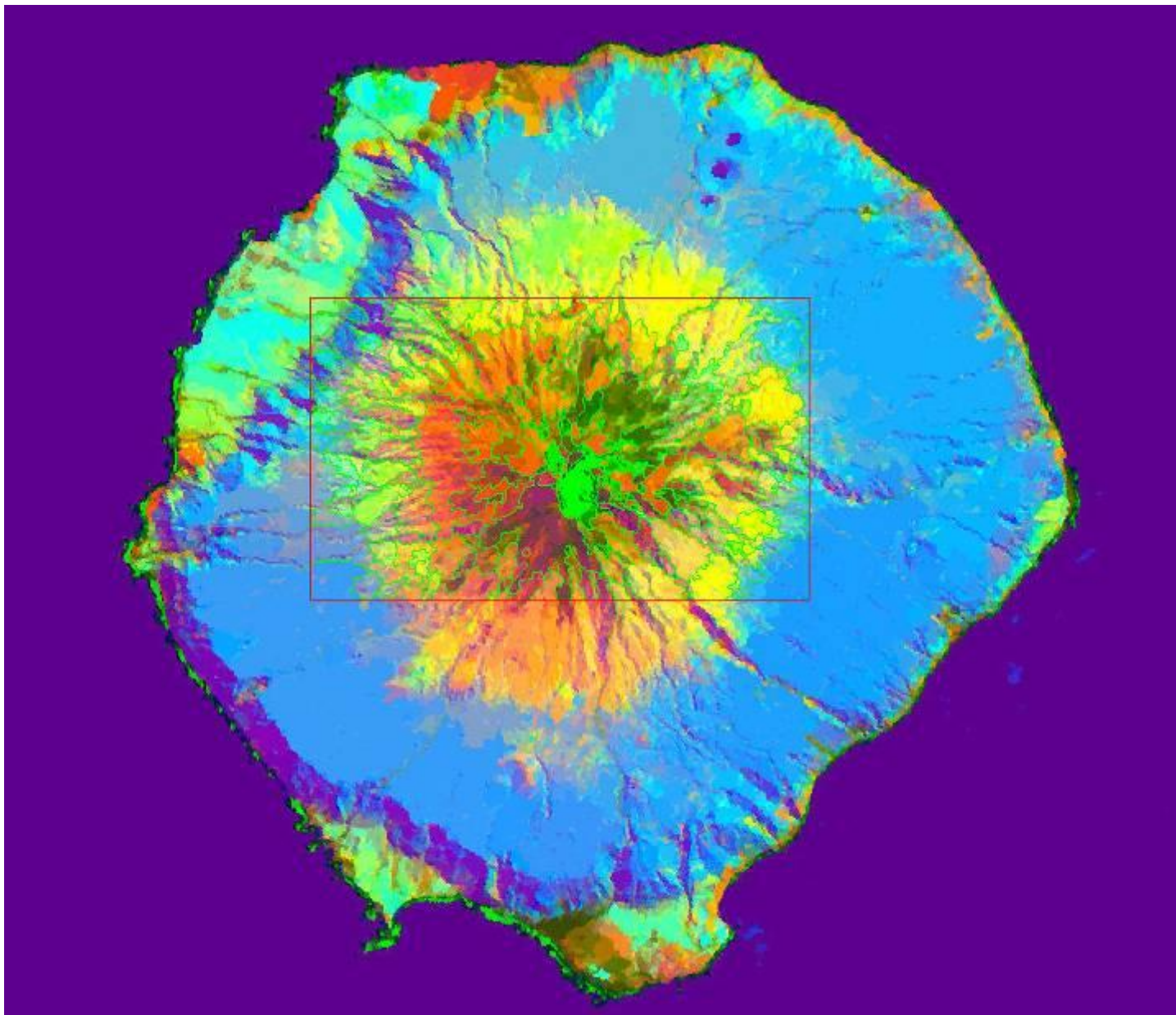
Tristan-da-Cunha: Landsat PC 321 ENVI FX: s80 m85



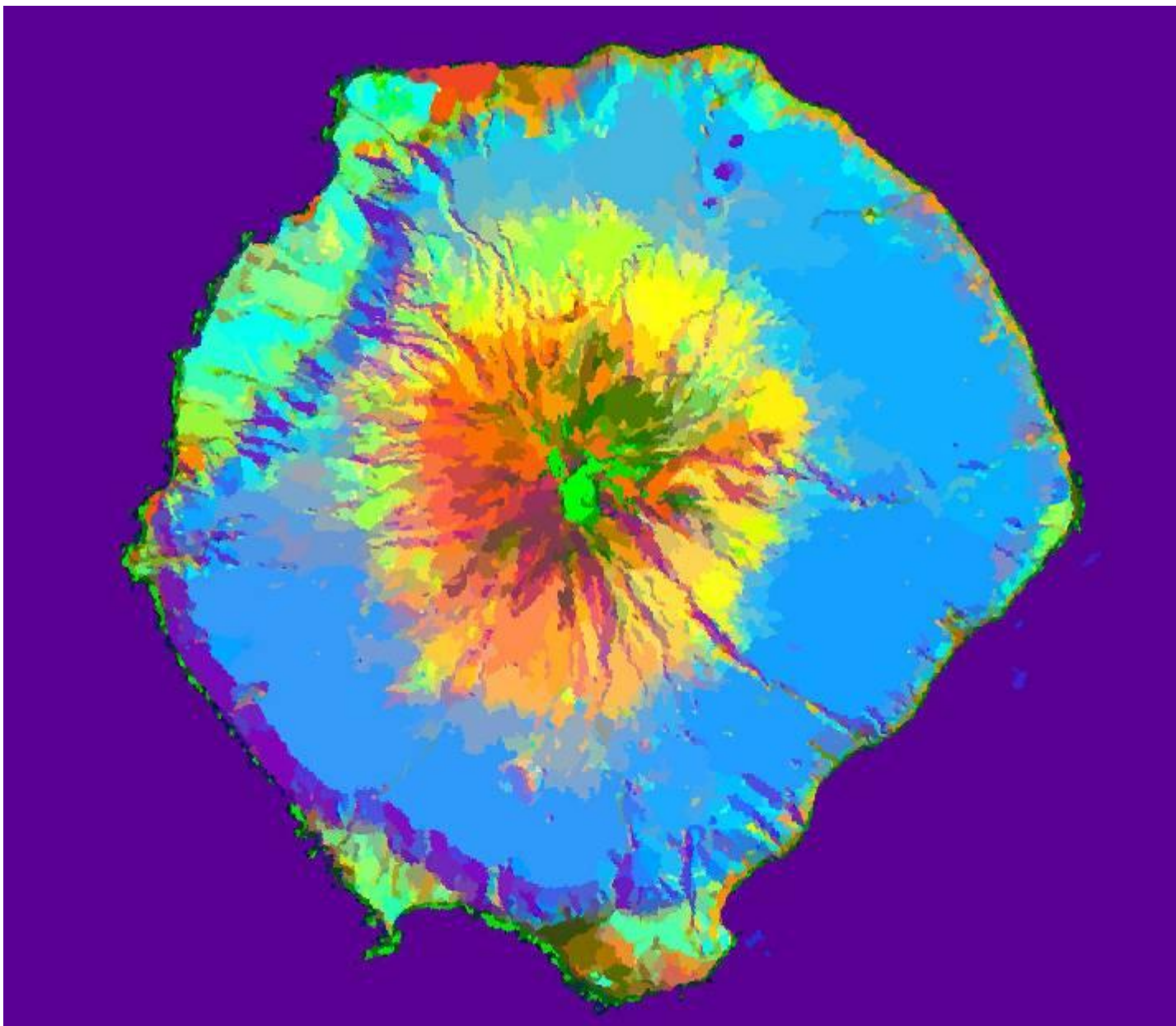
Tristan-da-Cunha: Landsat PC 321 ENVI FX: s80 m90



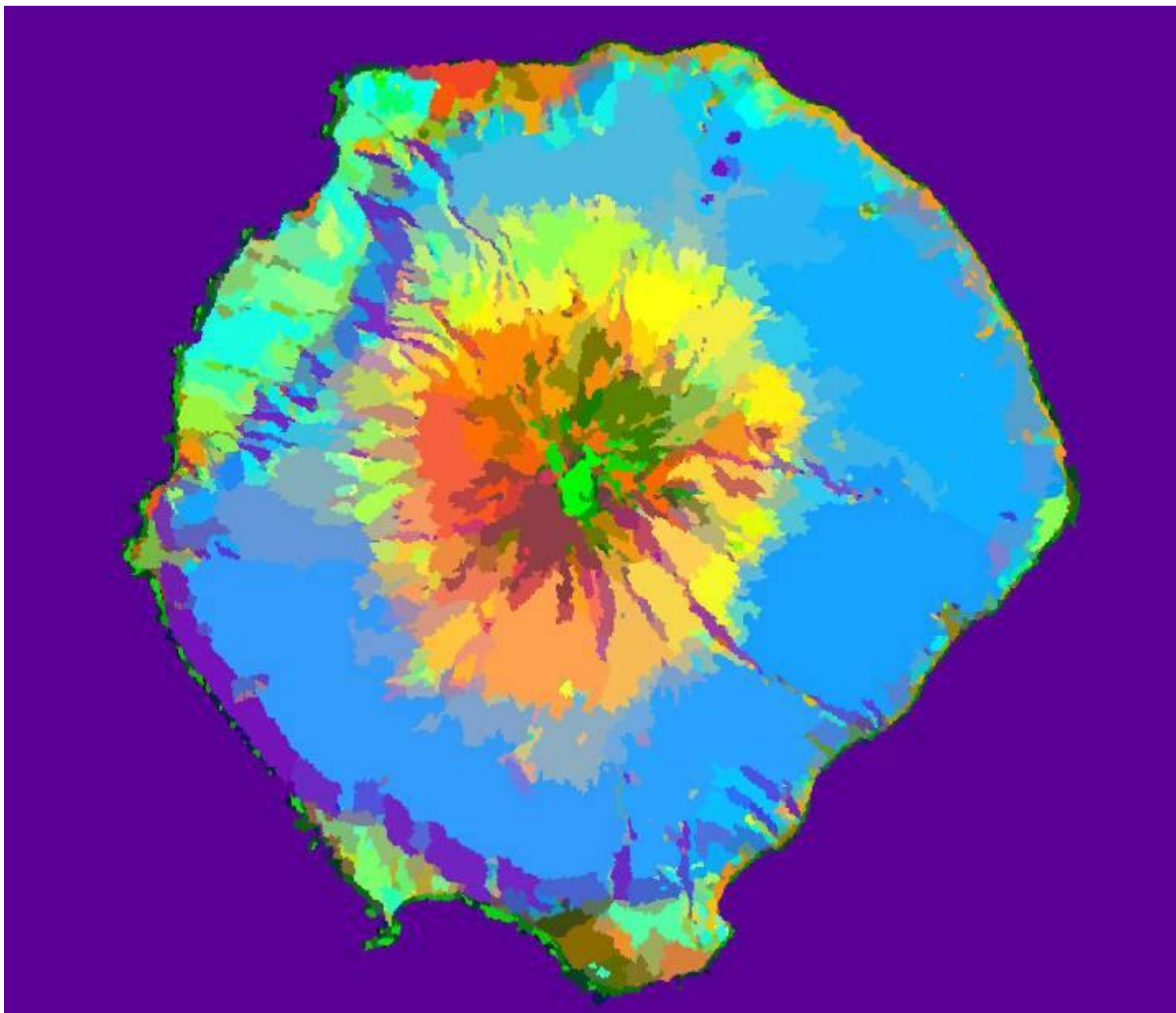
Tristan-da-Cunha: Landsat PC 321 ENVI FX: s80 m95



Tristan-da-Cunha: Landsat PC 321 classified s80 m85



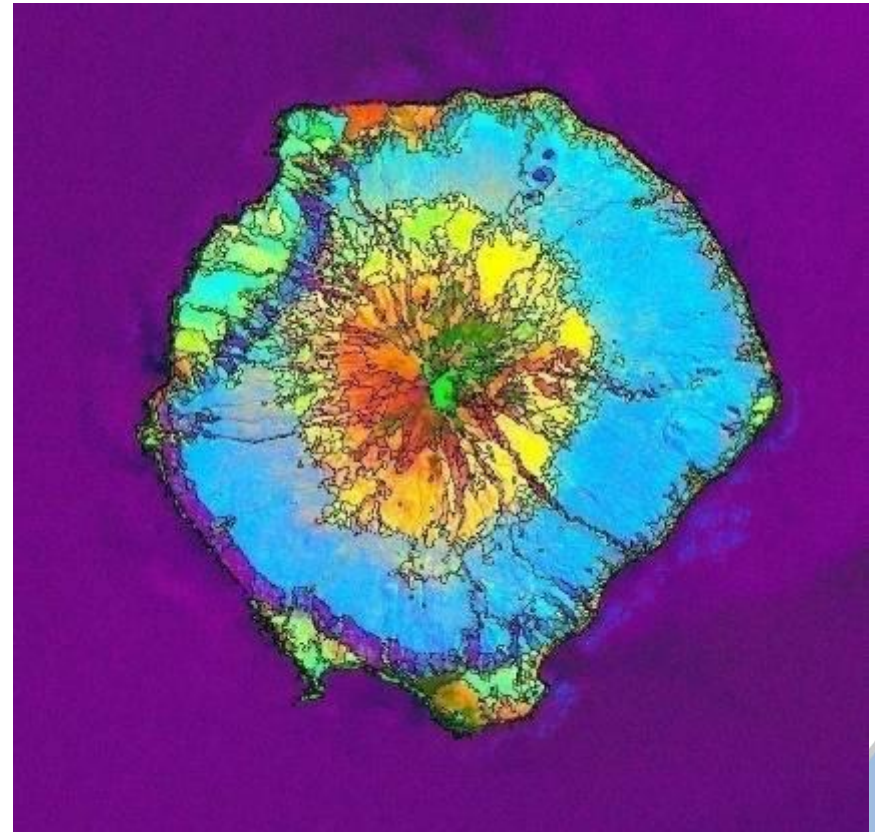
Tristan-da-Cunha: Landsat PC 321 classified s80 m95



Tristan-da-Cunha: Landsat ETM path194r086 taken 1999-10-22



Bands 321 + vectors
Segment 80 merge85



PC 321 + vectors
segment 80 merge 85

Conclusions

- Better to use 3-band visually discriminating composite images (i.e. PCA, Decorrelation, MNF)
- Promising results in volcanic terrain e.g. Afar, Ethiopia
- Tristan-da-Cunha results excellent
- Morocco results moderate
- Saudi Arabia results good to fair

Conclusions

Good points

- Optimal segmentation ratio 25-35
- Optimal merge >90
- Interactive viewing for segmenting and merging
- Multi-layered approach

Limitations

- Can only use small to moderate sizes ($\leq 3000 \times 3000$ pixels)
 - Need to experiment
 - Image specific
 - No interactive merge capability
 - Needs smoothing algorithm outside rule-based classification
-
- Preliminary results suggest ENVI Feature Extraction module shows promise for geological applications