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

ENVI FX: Classified using pc1-pc2-pc3

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

Classified segment=25  merge=85

Classified segment=25  merge=95

Classified segment=25  merge=95 + vectors
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
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

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 & granodiroites** (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
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)
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

Path194 row86 taken 1999-10-22
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

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<tr>
<th>Good points</th>
<th>Limitations</th>
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<tr>
<td>• Optimal segmentation ratio 25-35</td>
<td>• Can only use small to moderate sizes (≤ 3000 x 3000 pixels)</td>
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<td>• Optimal merge &gt;90</td>
<td>• Need to experiment</td>
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<tr>
<td>• Interactive viewing for segmenting and merging</td>
<td>• Image specific</td>
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<tr>
<td>• Multi-layered approach</td>
<td>• No interactive merge capability</td>
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<tr>
<td>• Preliminary results suggest ENVI Feature Extraction module shows promise for geological applications</td>
<td>• Needs smoothing algorithm outside rule-based classification</td>
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