Geological mapping and photogeological interpretation using ImageStation at the British Geological Survey

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History of ImageStation use at the British Geological Survey

- **1993-1999** (6 years) 1x Clix ImageStation (64 Mb RAM, 2Gb hard disc, 29” monitor, single 8mm exabyte tape backup). Added 2 external hard discs: 9Gb + 22Gb, 10x 8mm tape exabyte jukebox, air-conditioning.

- **1999-2004** (5 years) 4x Windows NT ImageStations. x1 production: (256Mb RAM, 9Gb system, x2 18Gb internal hard discs, 28” widescreen monitor; added 120Gb internal hard disc).

  x3 interpretation SSK. (128Mb RAM, 4.5Gb system, 9Gb internal hard discs, 8mm exabyte; upgraded memory 256Mb, replaced/repaired 3 of 4 exabyte drives).

- **2005- ???** Due for upgrade/expansion of facilities.

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Typical ImageStation projects at the British Geological Survey

- **UK geological map revision** many 1:50k sheets in England, Wales & Scotland
- **International geological mapping** Although satellite imagery & aerial photos are used a lot, generally only as hard copy in field with mirror stereoscopes. Main reason is limited budget and large size of project areas. Only some projects eg: Morocco (1:60k B&W), Tristan da Cunha volcanic hazards (1:83k B&W 1961 RAF)
- **Coastal Erosion & Landsliding** Holderness, Yorkshire (1:6k 1995); Walton-on-the-Naze, Essex (1:12k 1972, 1:5k 1994, 1:5k 1996); Sidestrand (1:10k) & Happisburgh (1:5k) North Norfolk
- **Environmental** – ICI Runcorn (1:5k), Pemberton Restored Coal Opencast Augmented Reality, Buxton Limestone Quarrying – Foundation of the Peak.
- **Comparison of DEMs from different sources** – Ordnance Survey, Digital Photogrammetry, NEXTMAP Britain (airborne interferometric SAR), LIDAR, ASTER, SRTM.

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Geological Map Revision United Kingdom

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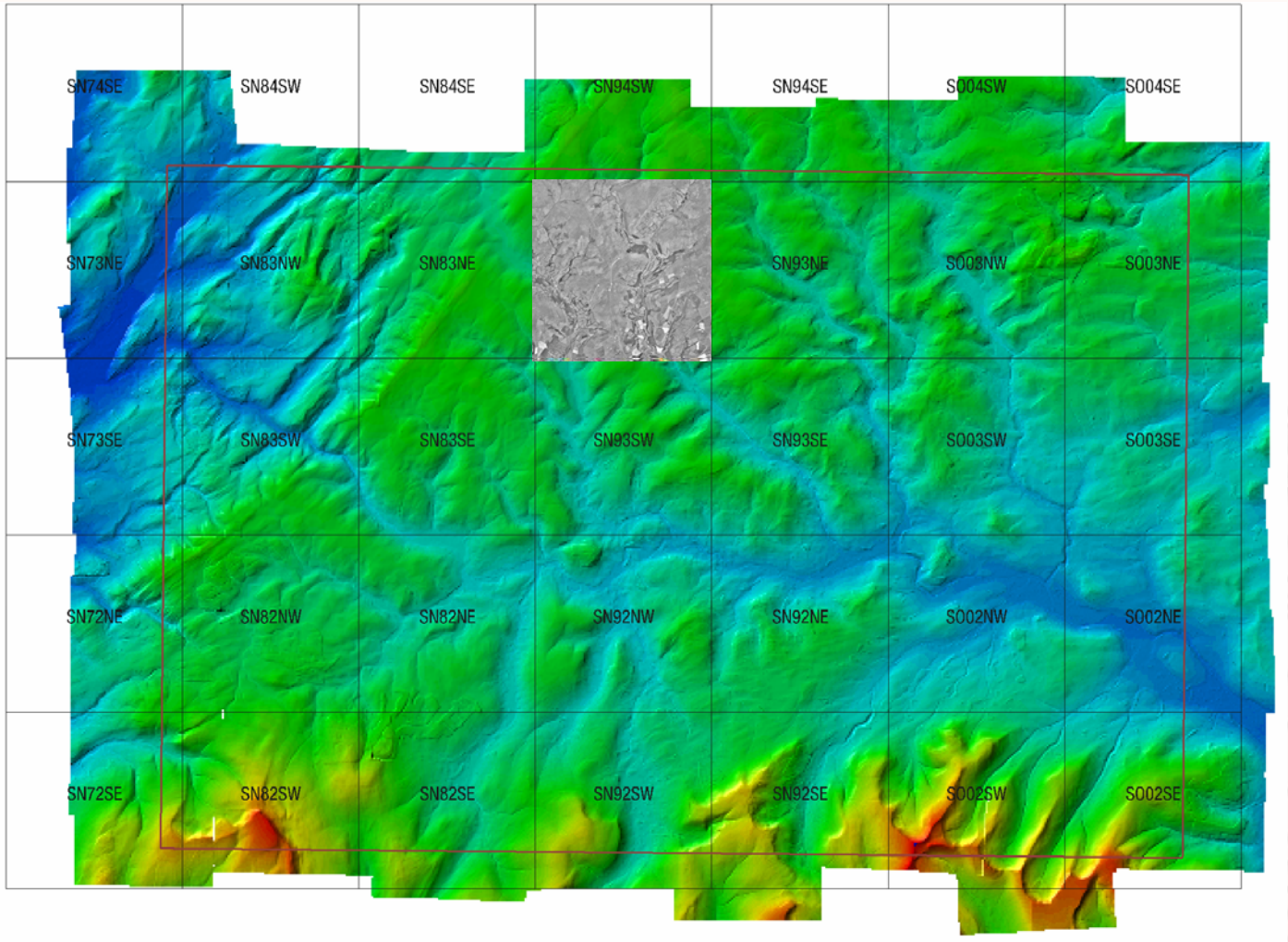
Brecon 1:50k sheet 213: DEM and orthophoto tiles created using ImageStation software including Orthopro



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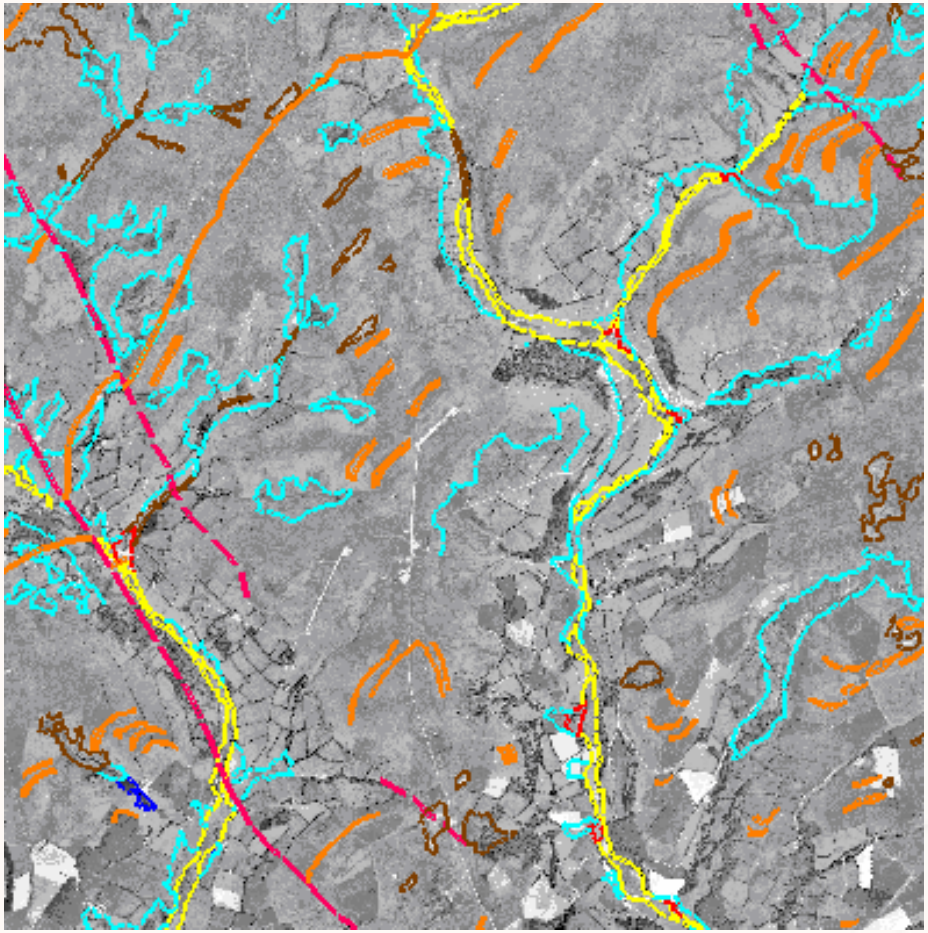
SN93NW: 5km x 5km orthophoto tile showing ImageStation Interpretation



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Geological Mapping South Downs: ImageStation digital photogrammetry, interpretation & field checking. Visualised using ERDAS Imagine

Drift geology: clay-with-flint (orange) and head (pink) combined with colour orthophoto draped on modelled O.S. 5m contours

Solid geology: Various formations in the Upper Chalk interpreted from ImageStation and field-checked

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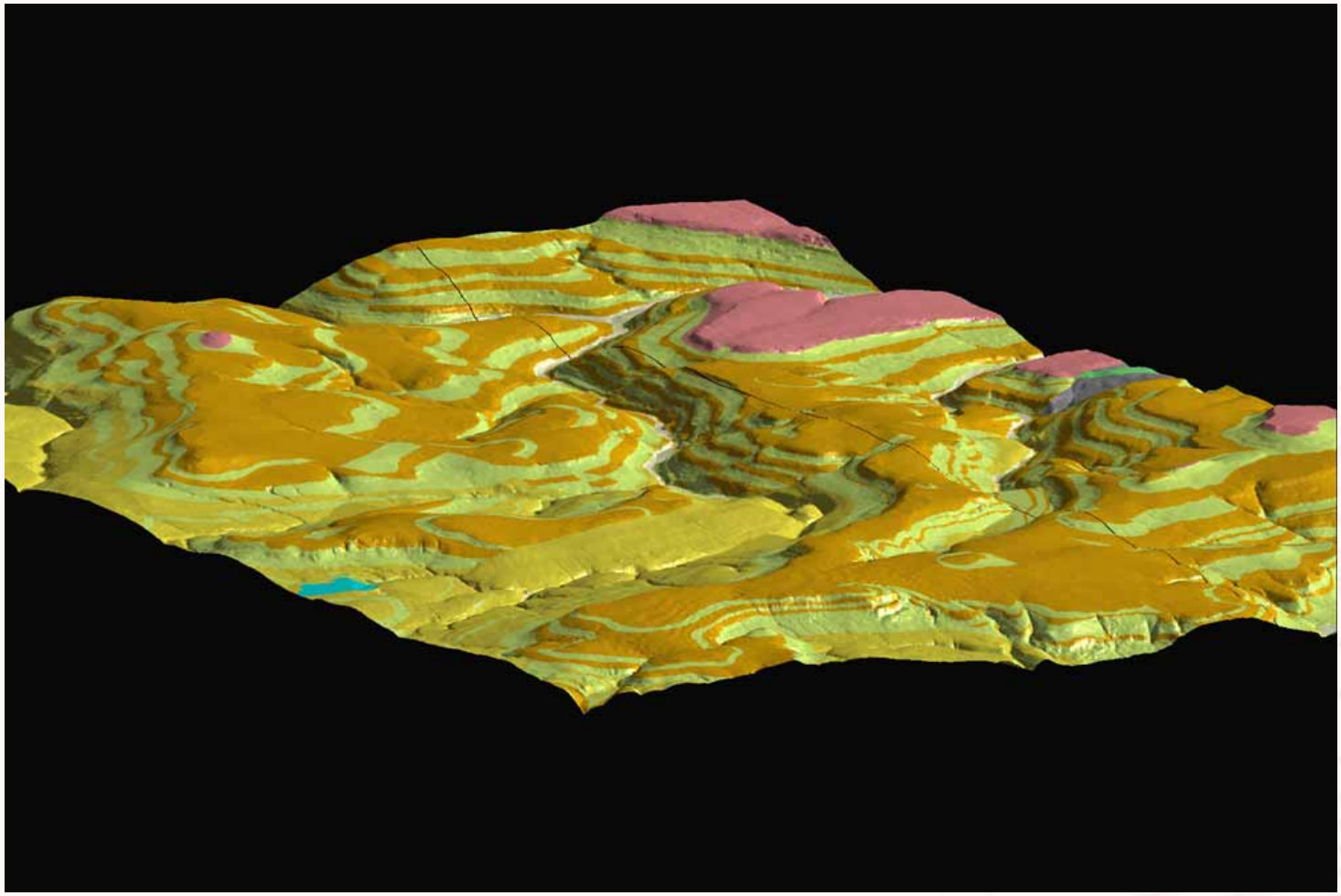
Huddersfield: Checking of old 1:50k maps MicroStation drape of geology on DEM



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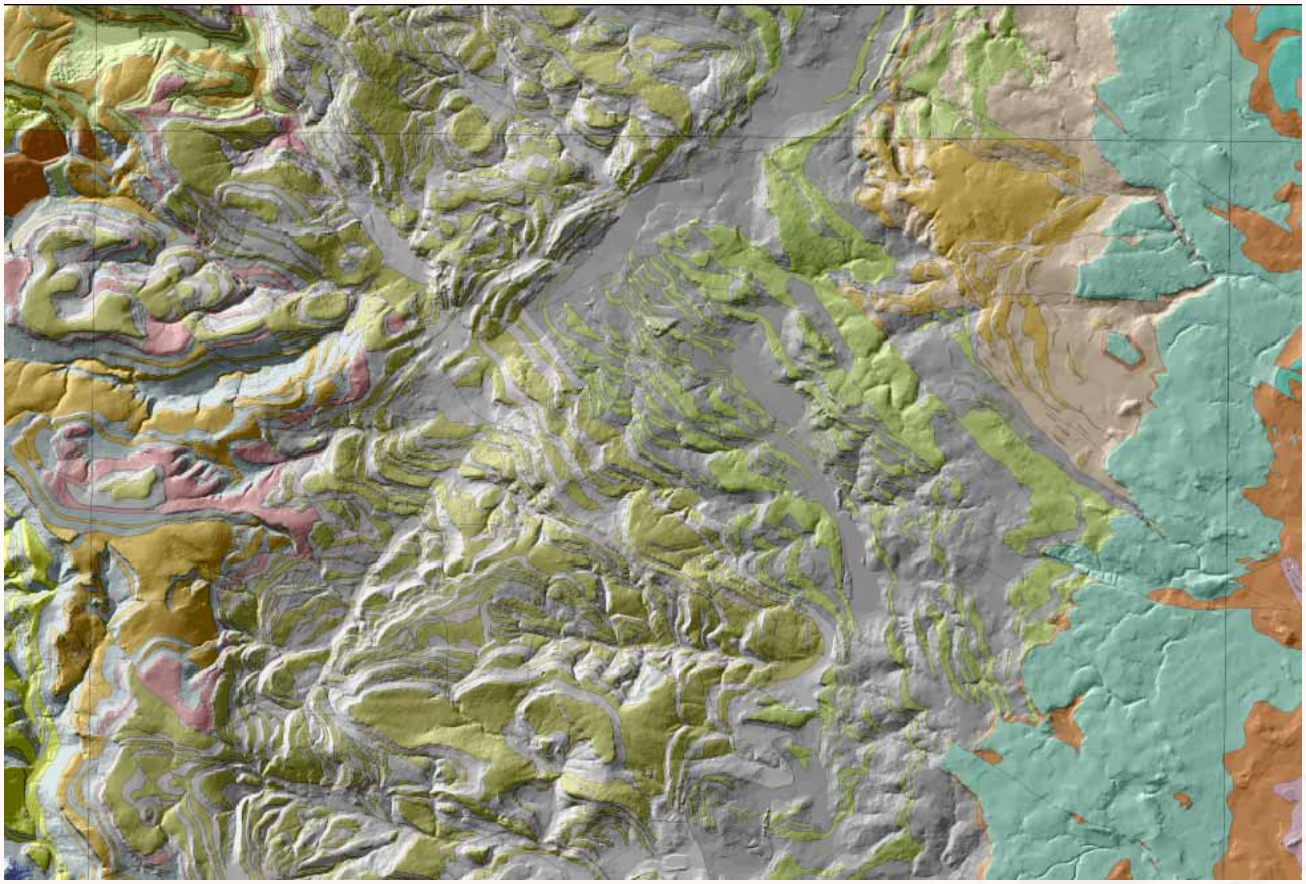
Sheffield 1:50K Solid Geology draped on shaded relief DTM derived from O.S. 5m contours. Visualised using ERDAS Imagine



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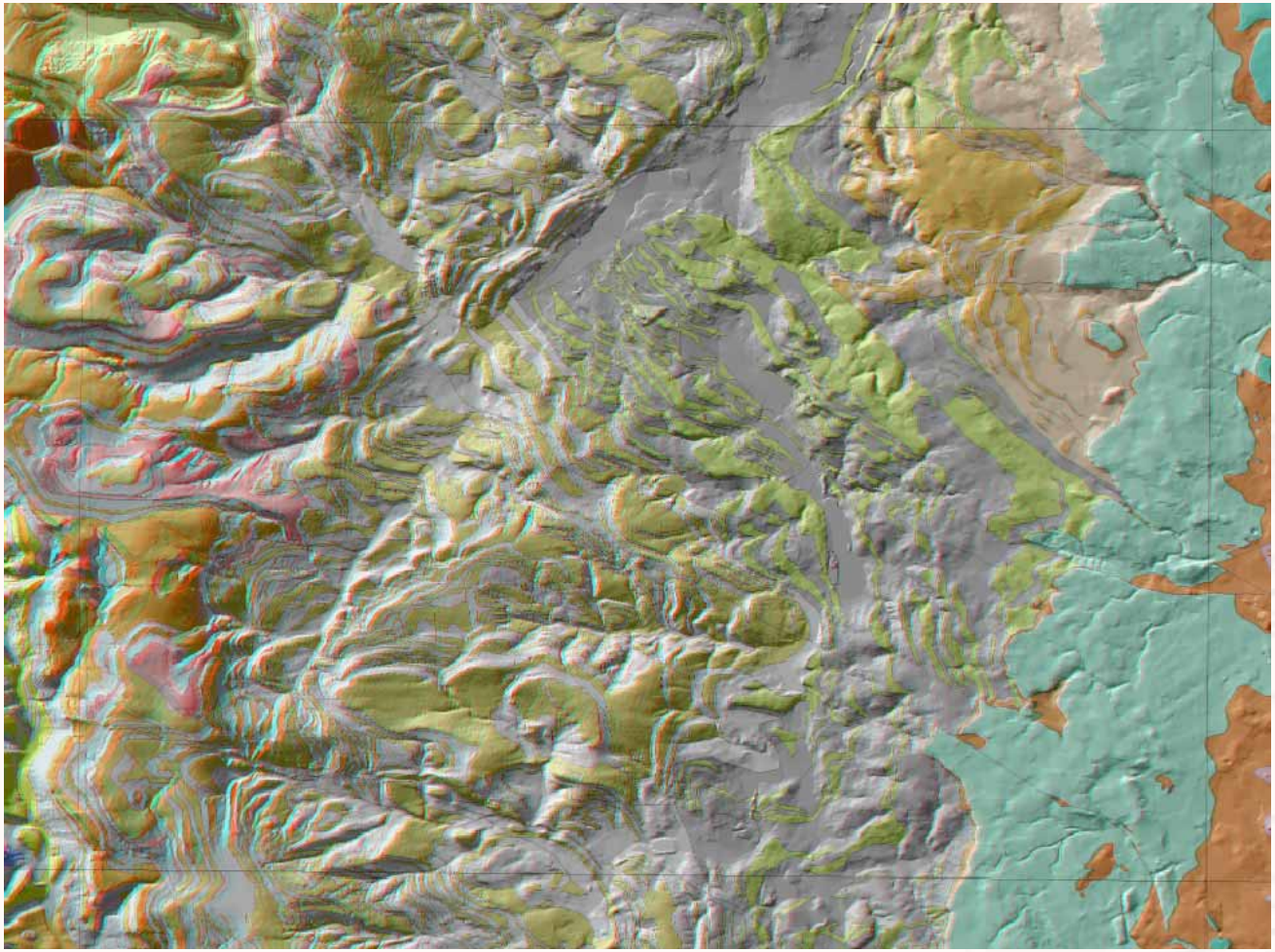
Sheffield 1:50k solid geology map combined with shaded relief anaglyph produced in ERDAS Imagine



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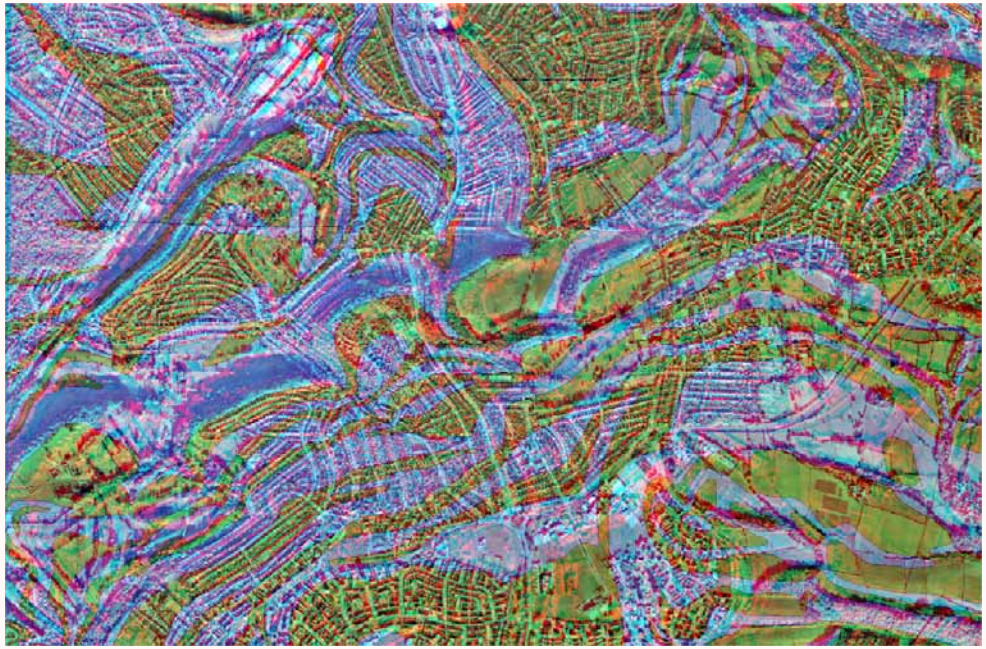
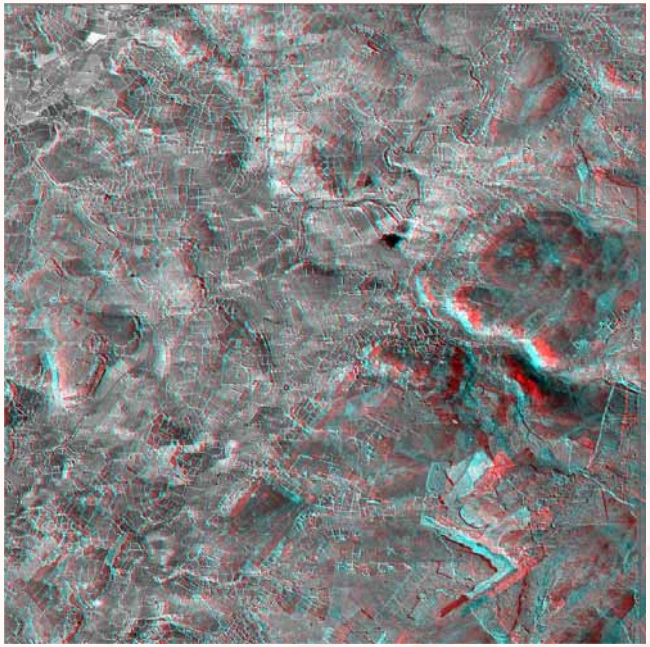
Three dimensional viewing

- Low cost three dimensional viewing possible using anaglyph techniques
- NEXTMap data can be combined with other vector and raster datasets and visualised in 3D using red-blue glasses



Sheffield NEXTMap DSM, Orthophotos, DiGMap linework



Central Wales NEXTMap DSM and ORI

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Geological Map Revision International

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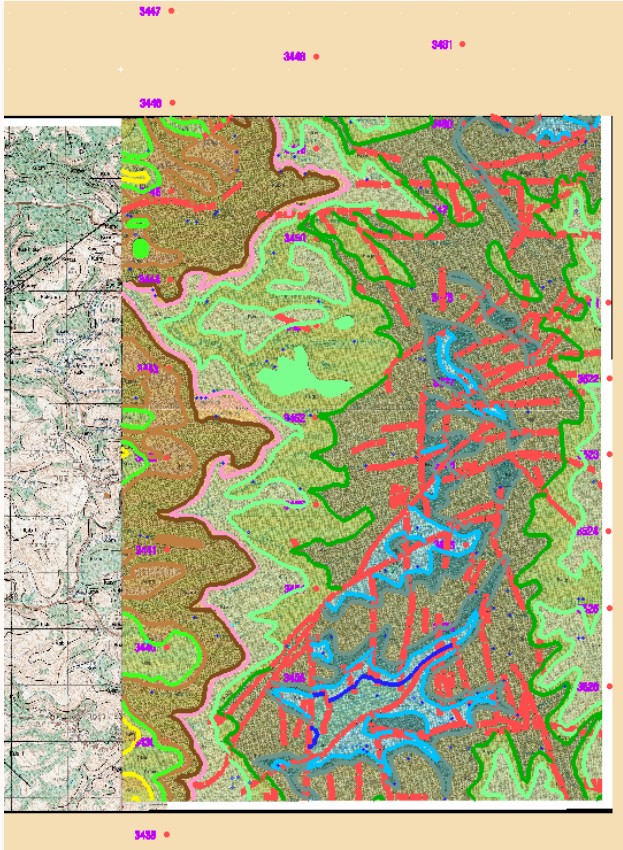
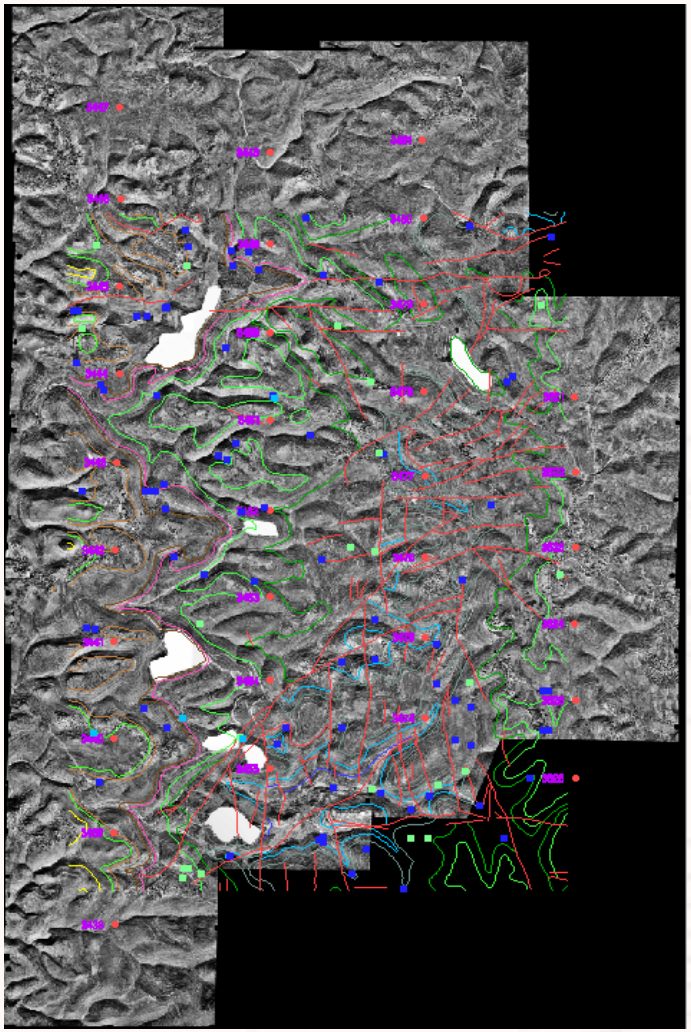
Palestine: Ramallah. Hydrogeology & karst interpretation digitised 1:50k geology overlain on orthophoto mosaic





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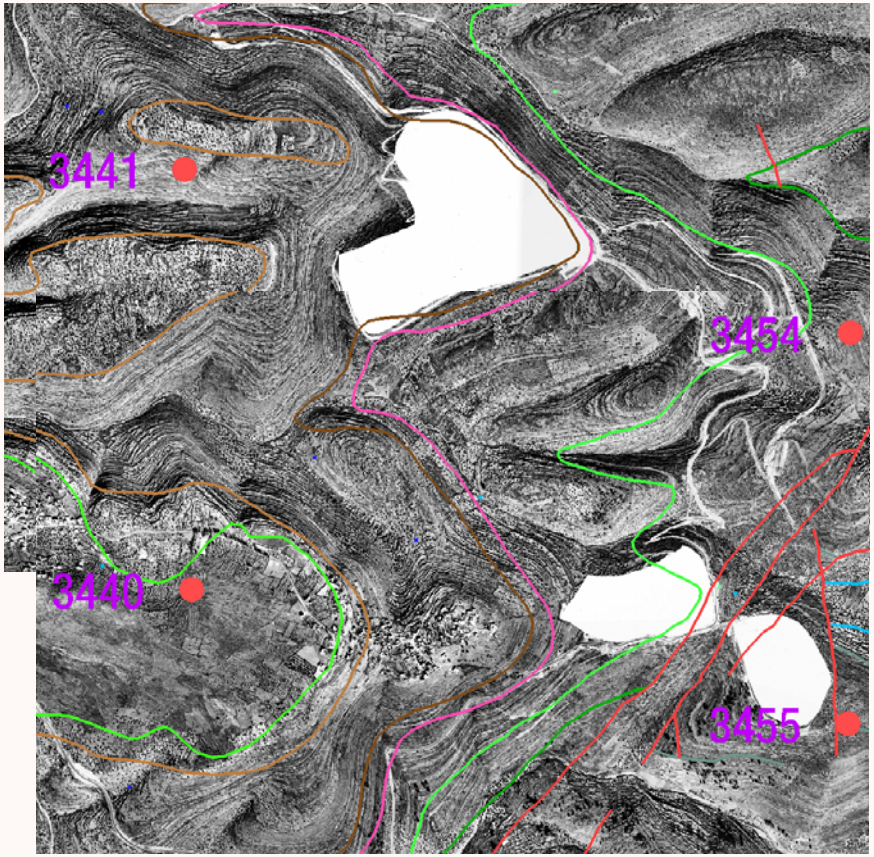
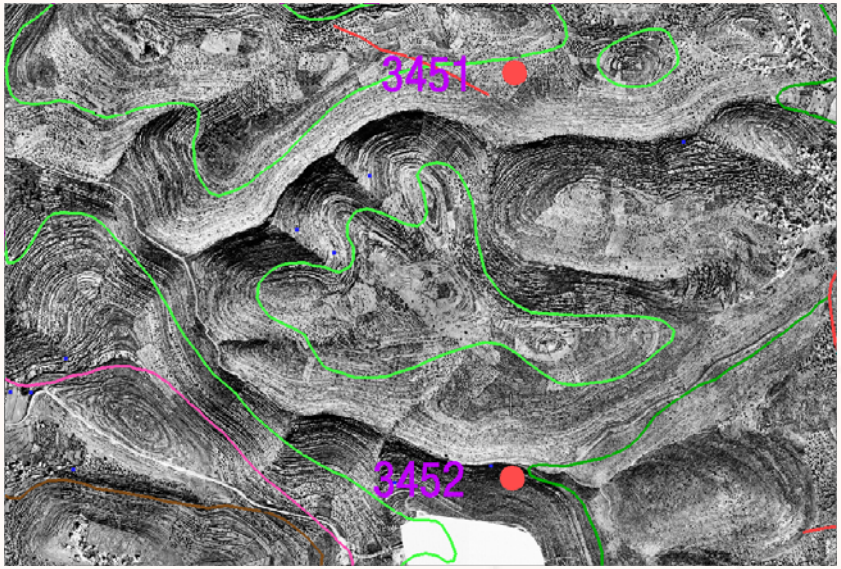
Palestine: Ramallah. digitised 1:50k geology overlain on orthophoto mosaic shows many errors – potential to correct geological boundaries





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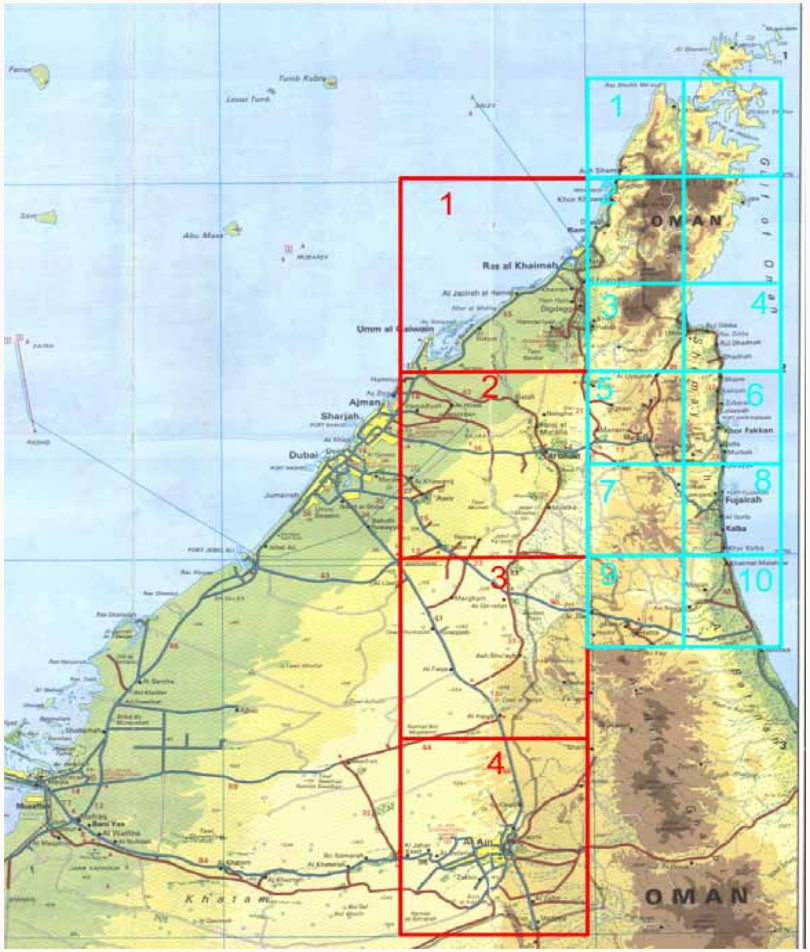
The U.A.E. project



- 10 Million Dollar contract over 4 years.
- 10 x 1:50k and 4 x 1:100k geological maps.
- Airborne geophysical and radiometric surveys.
- Seismic surveys.
- Geochronology.
- Economic geology.
- Hazard mapping.
- Palaeontology.

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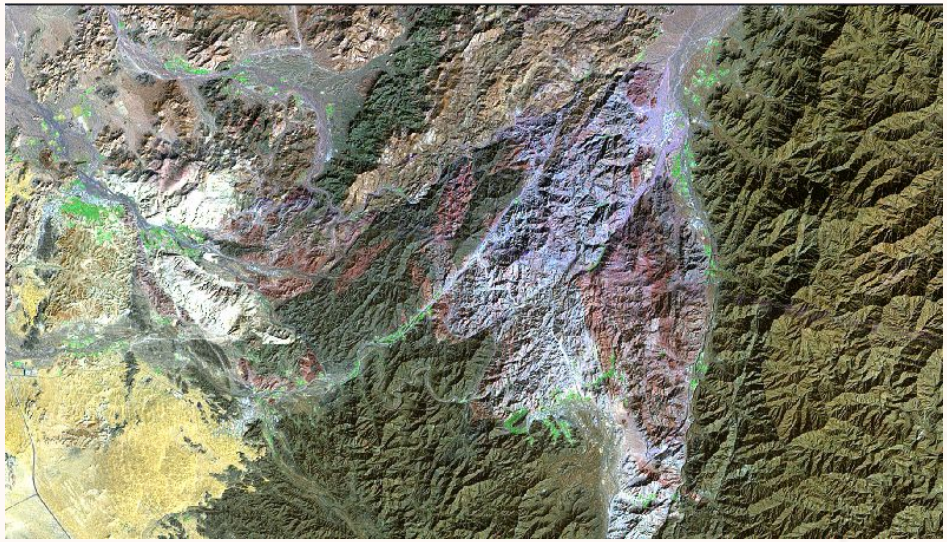
Imagery Datasets & Products

- Landsat 7 ETM+ (4 scenes: 27/11/2000, 11/2/2002)
- NIMA 10m B&W orthorectified Spot imagery (1992) downloaded from the web
- 970 stereoscopic colour aerial photos at 1:25k (1975)



- Example 1:25k sheet of Landsat bands 741 in RGB of N. Masafi with 1km grid lines removed

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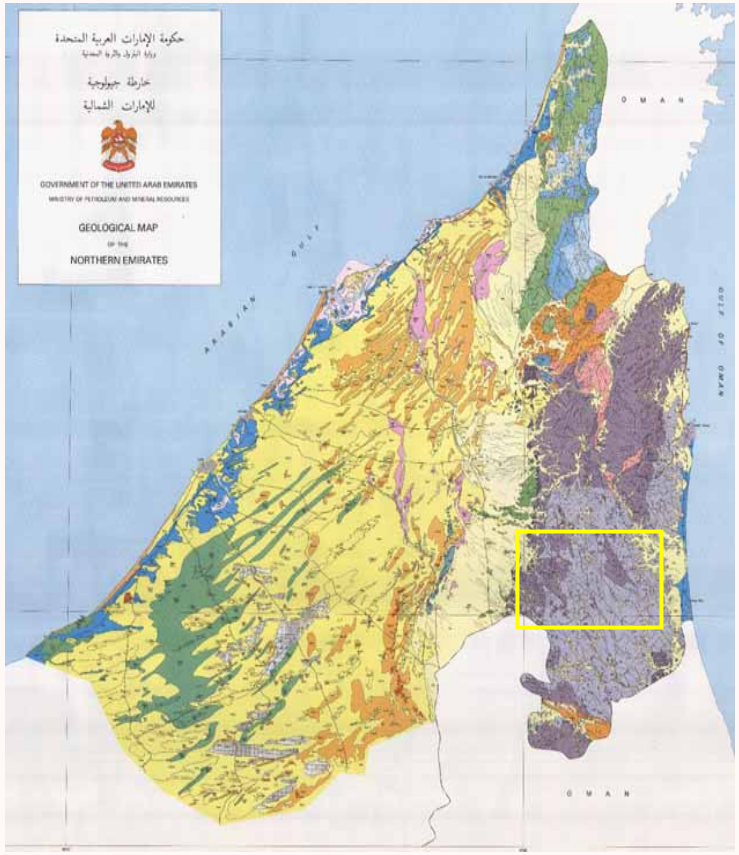
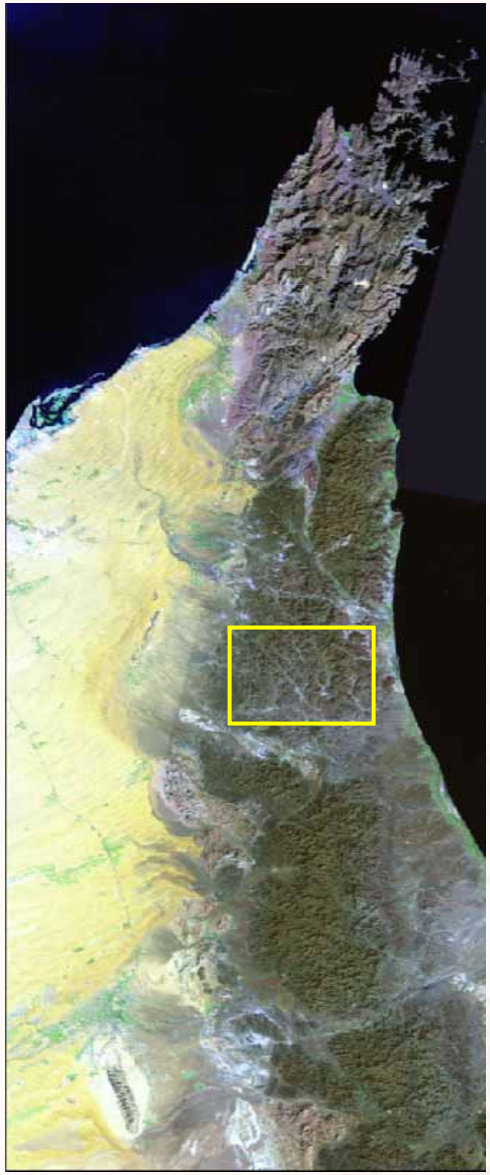
Geology of northern UAE





Landsat 741 R-G-B

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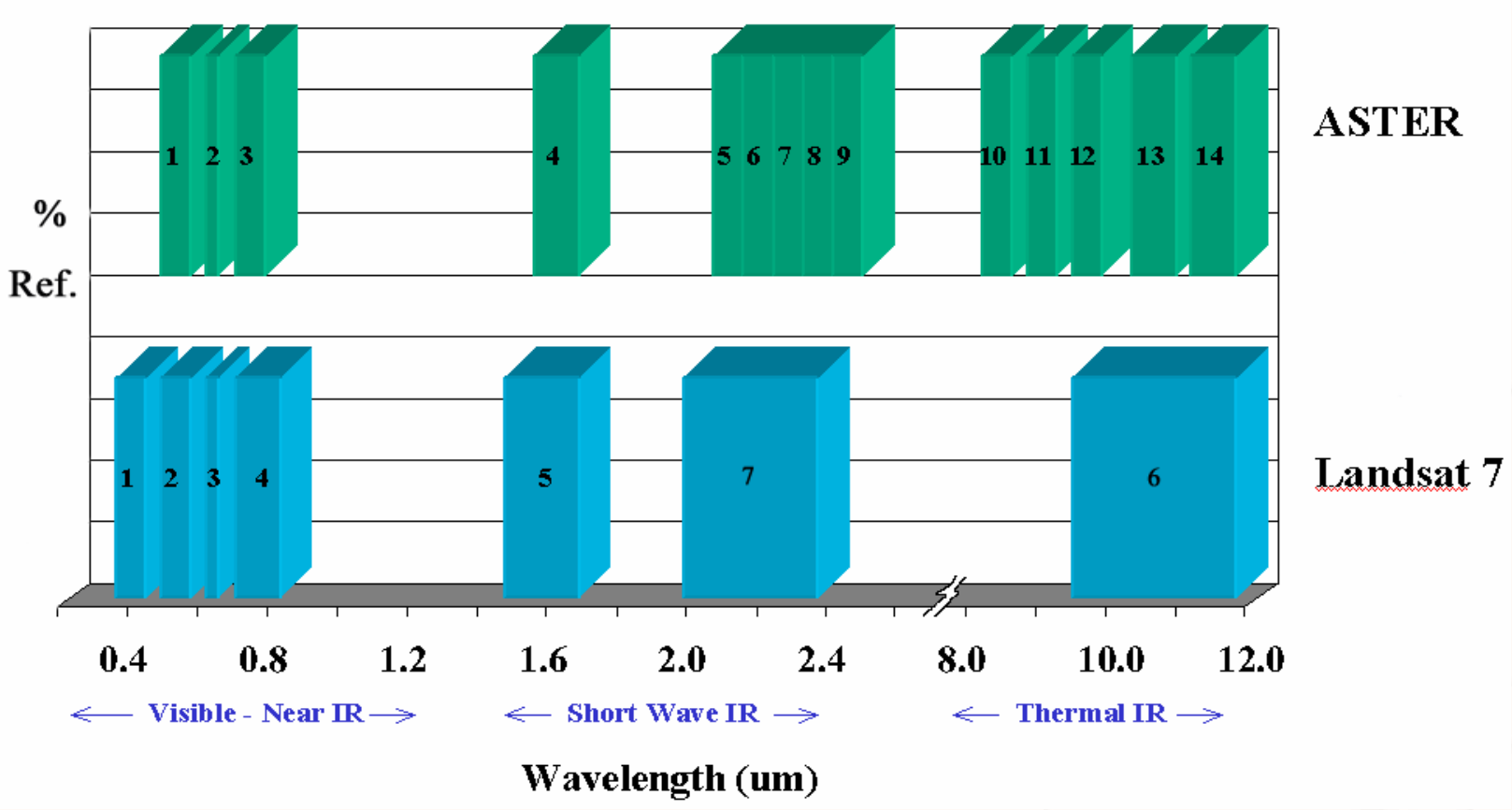
COMPARISON OF ASTER AND LANDSAT BANDS



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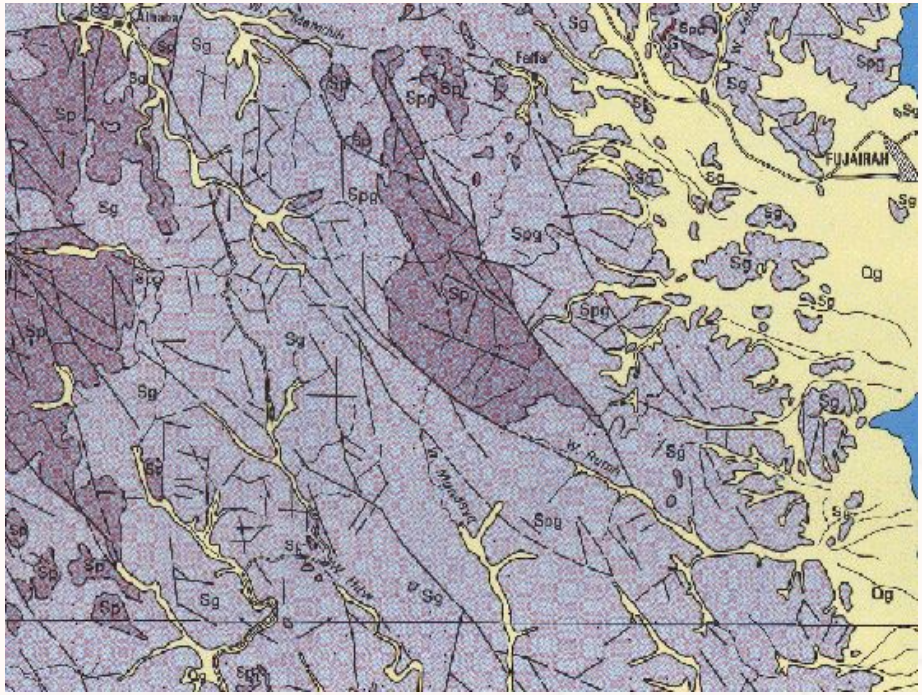
Test Area: ultrabasics and basics ASTER VNIR compared with geology

ASTER vnir 321 in R-G-B



Geology extract from 1:250k

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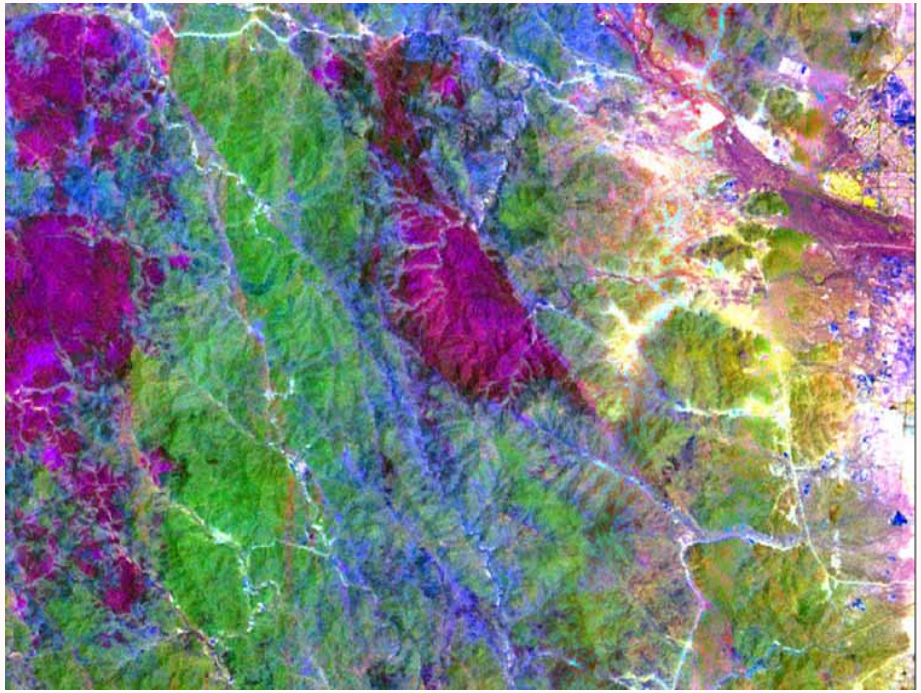
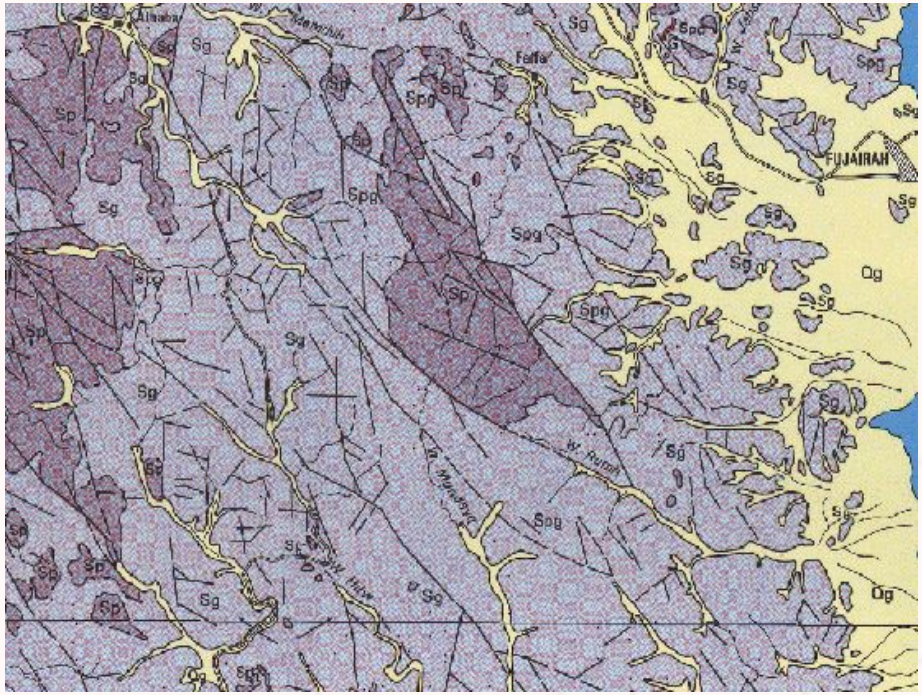
Test Area: ultrabasics and basics
ASTER SWIR dc's compared with geology



ASTER swir dc351 in R-G-B



Geology extract from 1:250k

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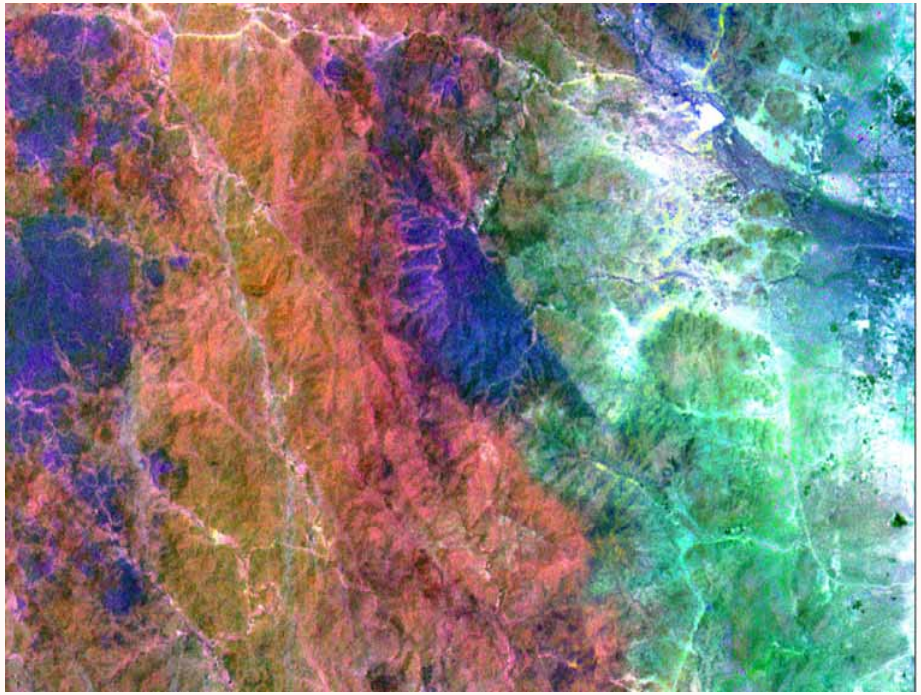
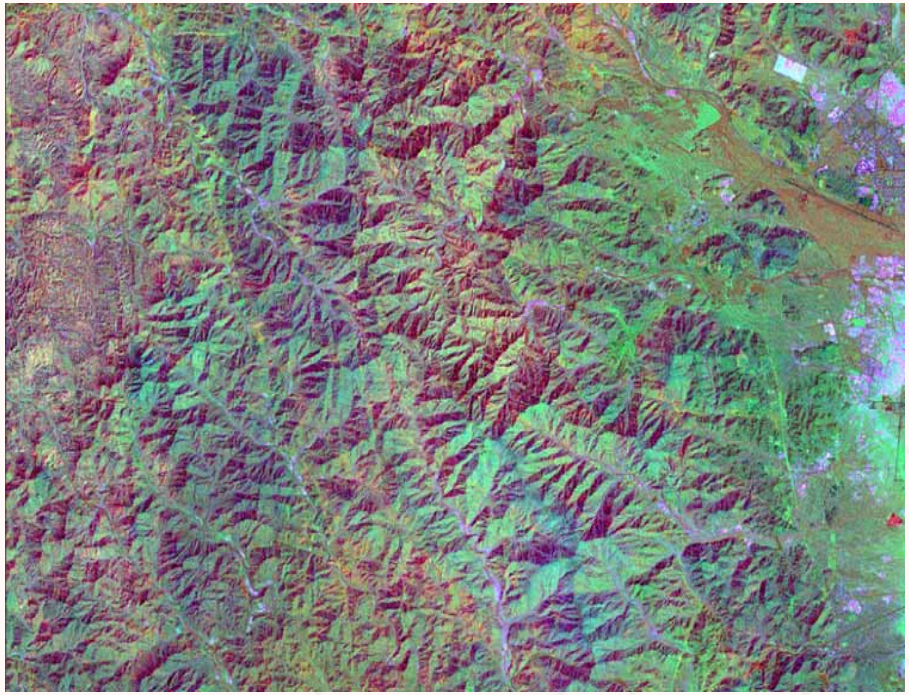
Test Area: ultrabasics and basics
ASTER SWIR dc's compared with Landsat ratios



ASTER SWIR dc643 in R-G-B



Landsat ratio composite
r57-r51-r43 in R-G-B

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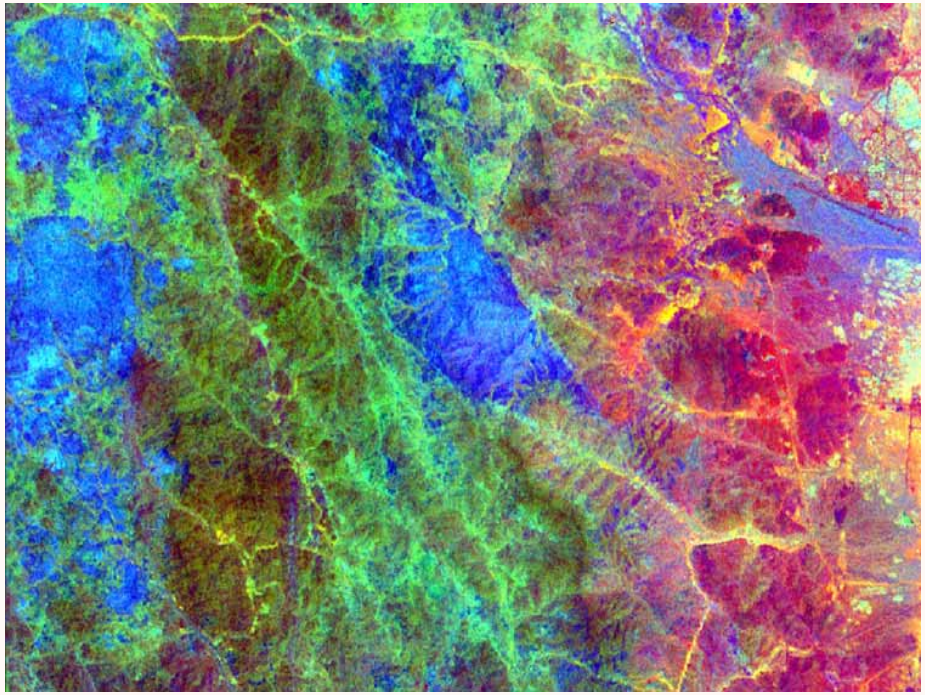
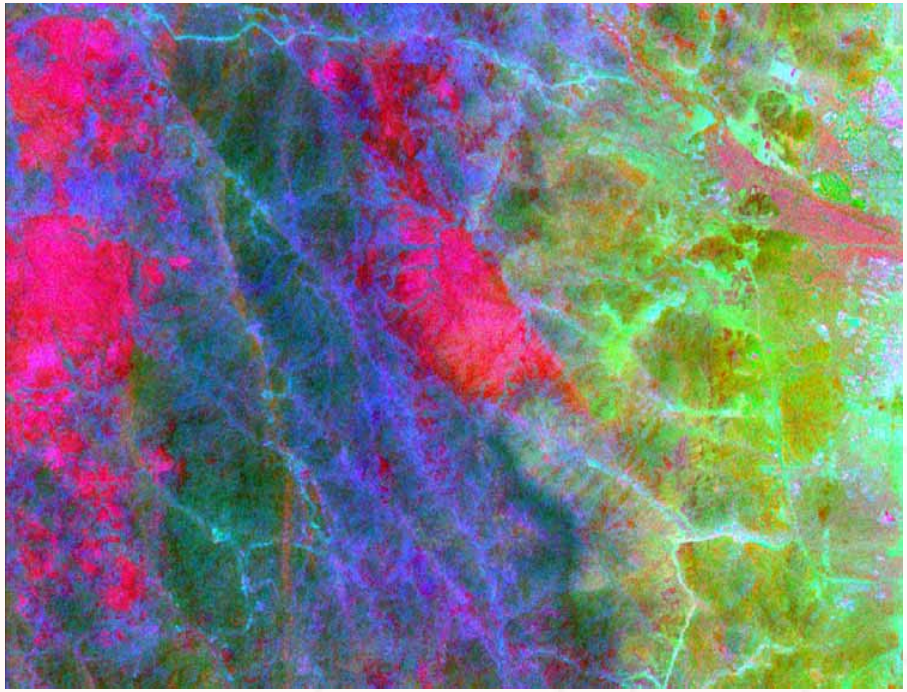
Test Area: ultrabasics and basics
ASTER SWIR ratio composite bands



ASTER swir ratio composite
r89-r45-r68 in R-G-B



ASTER swir ratio composite
r78-r89-r45 in R-G-B

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New Products in development

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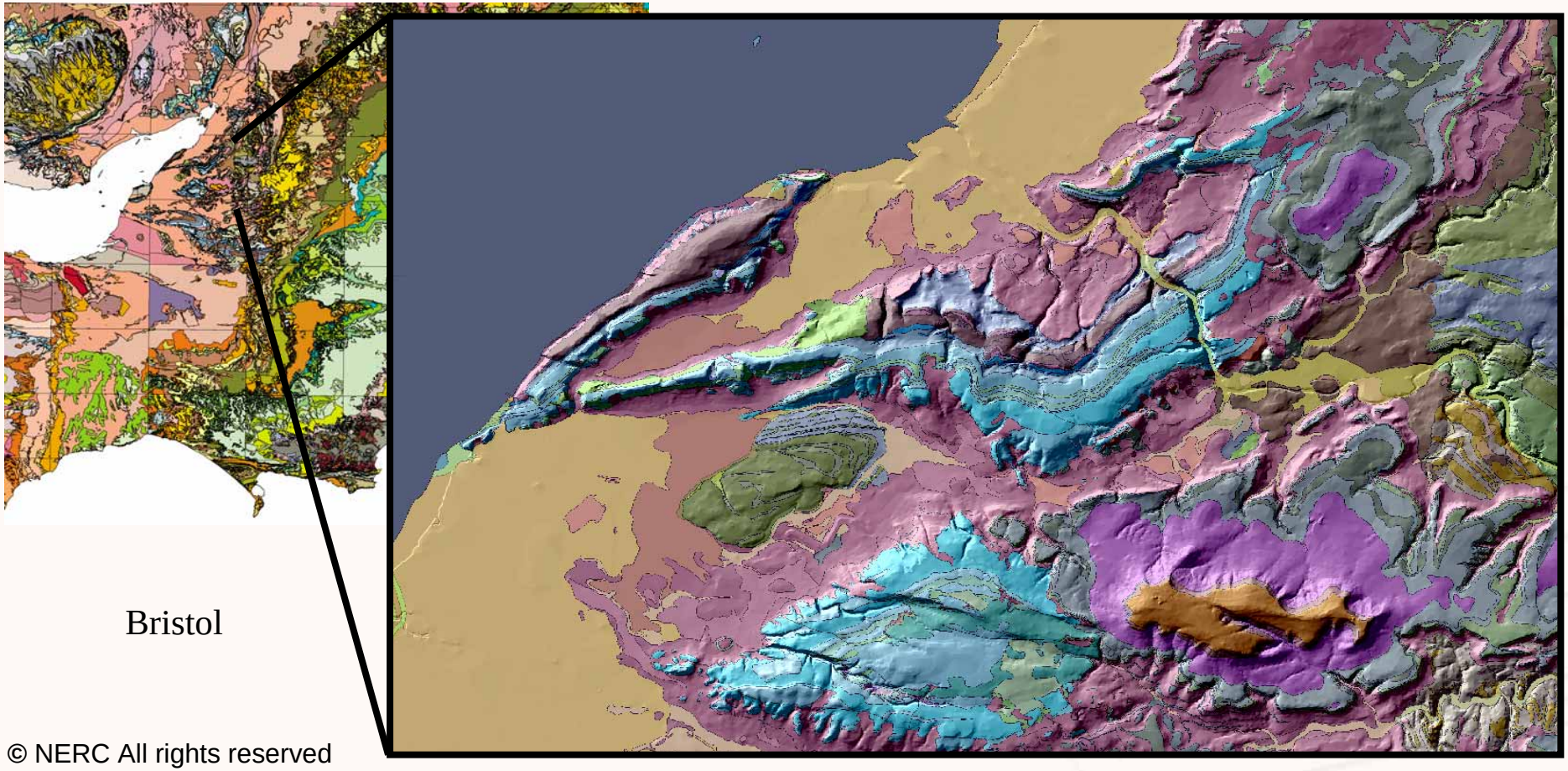
Public understanding of science – a new method for presenting the geological map



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SYNTHETIC STEREOSCOPIC IMAGERY OF AFGHANISTAN

Synthetic stereopair tiles (200km x 200km) created using orthorectified Landsat 7-4-2 mosaics (c.2000) & 90m SRTM DEMs

Have completed tiles for UTM zones 41N, 42N, WGS 84 datum

A variety of software used: Envi, ERDAS Imagine, ArcToolbox, ImageStation

Can view in 3D from scales of 1:1,500,000 to 1:50,000

Synthetic stereoscopic images could be created for orthorectified ASTER and hyperspectral images

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Conclusions – Main Mapping Benefits

- **Ease of transfer of geological interpretation onto printed 1:10k orthophoto field-slips +/- 5m O.S. contours or raster basemaps. (No more eye-balling, photocopy scale reduction, or use of Plan Variograph).**

- **Geological mapping speeded up. Accurate ImageStation stereo interpretation reduces time in field locating features. Reduced costs through greater efficiency.**

- **Greater functionality allows digital enhancement of images, contrast enhancements and hot-spot removal.**

- **Best for mapping some Quaternary features: river alluvium & terraces, head deposits, clay-with-flint, landslides, peat, drumlins, eskers, moraines, glacial channels. Moderately good for mapping sandstones in sandstone/shale sequences, or harder bands in limestone/shale or in the chalk.**

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Conclusions – Visualisation Benefits

- **2D-3D-4D visualisation possible. Multidate photogrammetric data such as DTMs and break-of-slope lines, can record landscape evolution through time. These may then be input for further computer modelling, such as coastal erosion or landslide development.**

- **Oblique perspective views give better appreciation of geomorphology and geology than flat orthophotos.**

- **Quality control of maps is greatly improved. By draping old/new 2D geological raster maps onto DTMs, can check for 3D consistency.**

- **Synthetic stereopairs using any terrain model and an orthophoto image +/- a translucent raster geological map is revolutionising how BGS works. We can now quickly produce a single stereomodel image for each 1:10k map-sheet.**

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