Integrating geospatial technology and traditional skills-based learning

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Outline

- Who am I?
- Geospatial technology in research
- Who are we teaching?
- What do we teach?
- Methods
  - traditional
  - integration
- A Case Example

Who am I?

2006: MGeol degree (Geology)

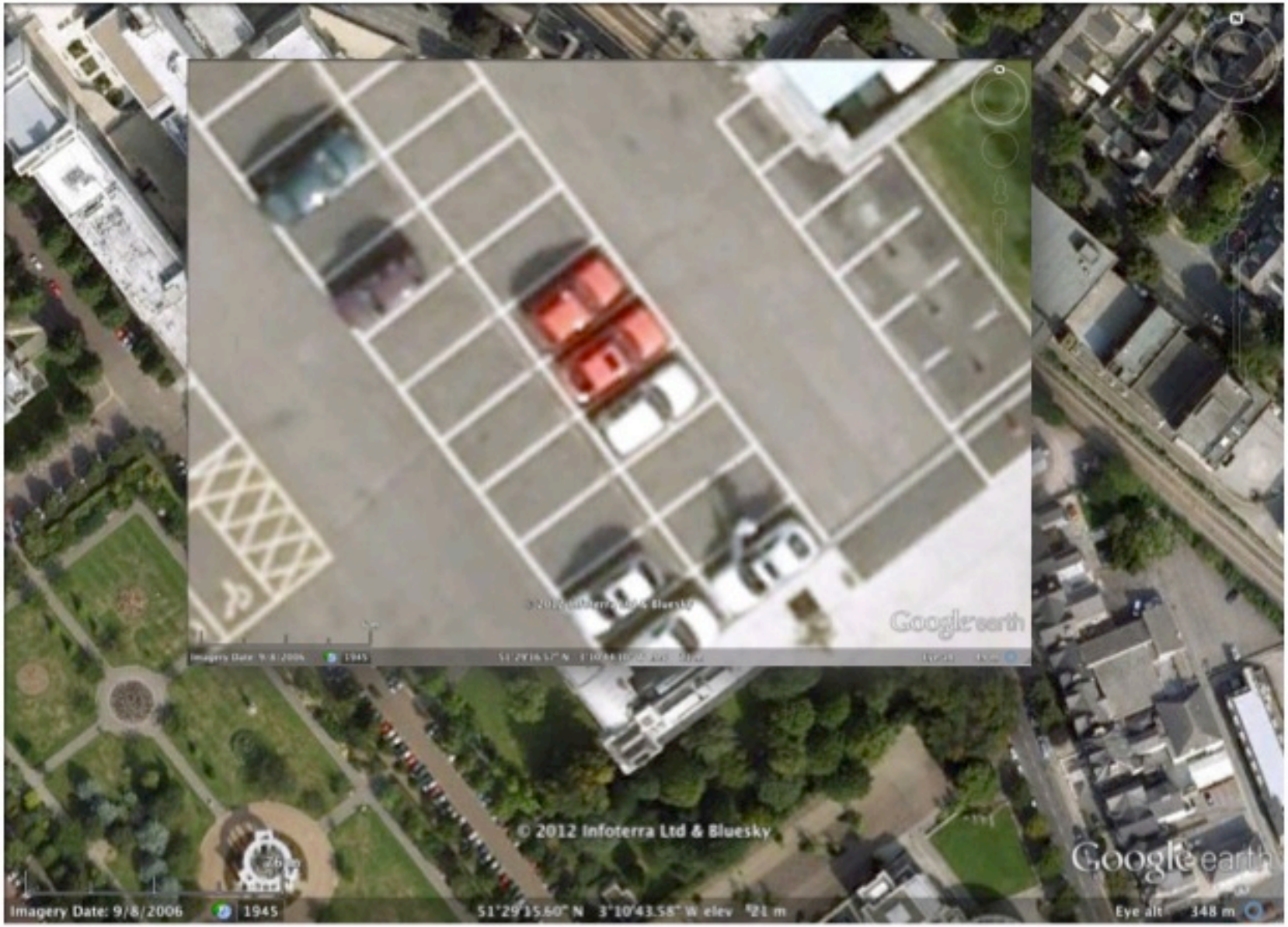
2010: PhD Structural Geology

2011: Lecturer in Structural Geology

- Training
  - "traditional" methods
  - geospatial technology added later

The Geospatial Revolution

Free Satellite Data: Sub-Metre Resolution

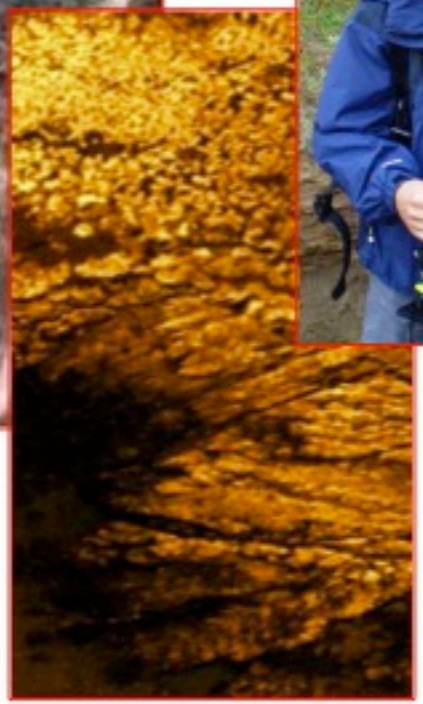


Free Satellite Data: Sub-Metre Resolution…

Outcrop Acquisition

mapping ('2D') ⟷ **survey ('3D')**

Ikonos, QuickBird



Airborne Lidar

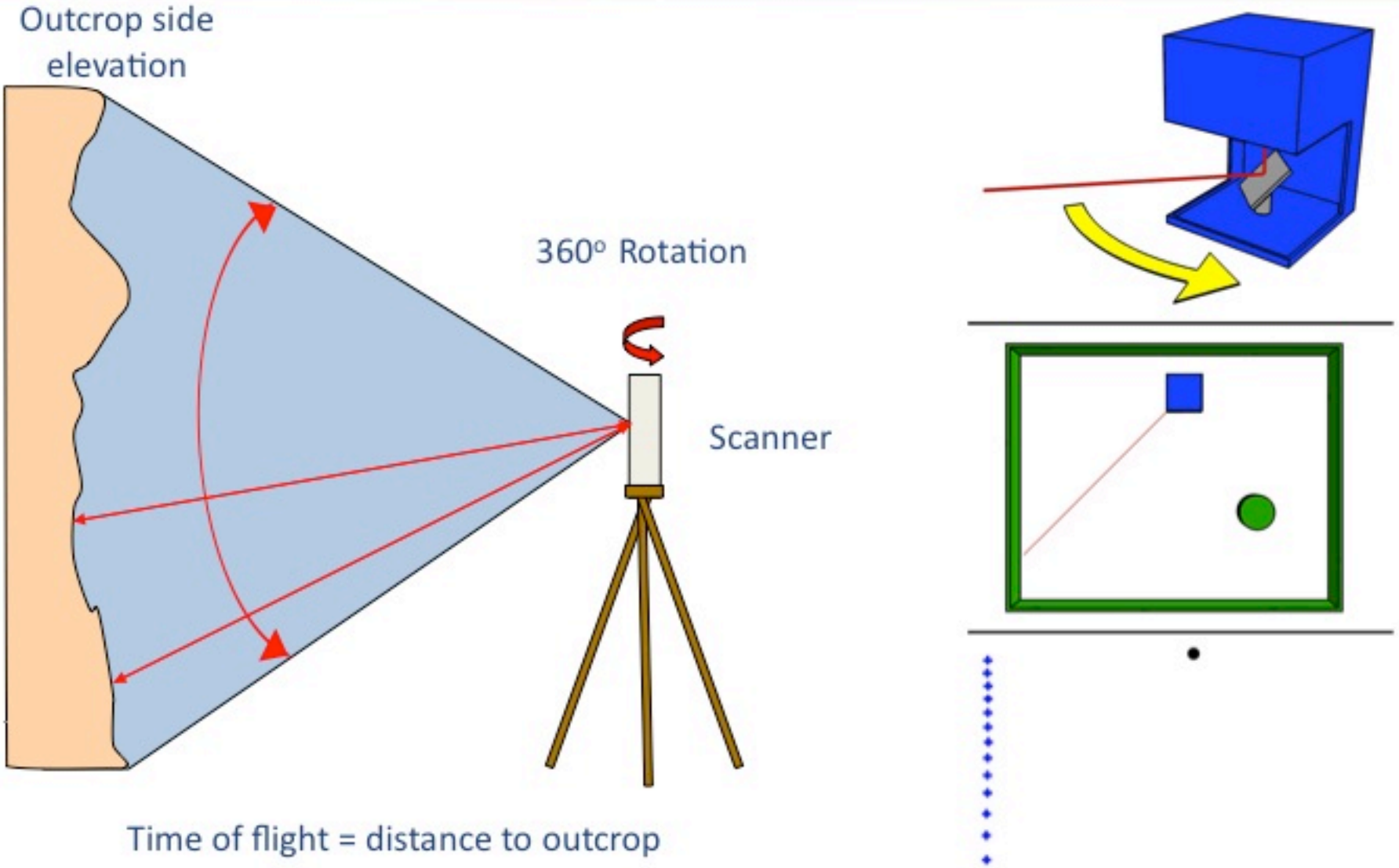
Digital tablet mapping

dGPS (RTK)

Laser range-finding

TLS (ground-based Lidar)

Lidar – Laser Scanning

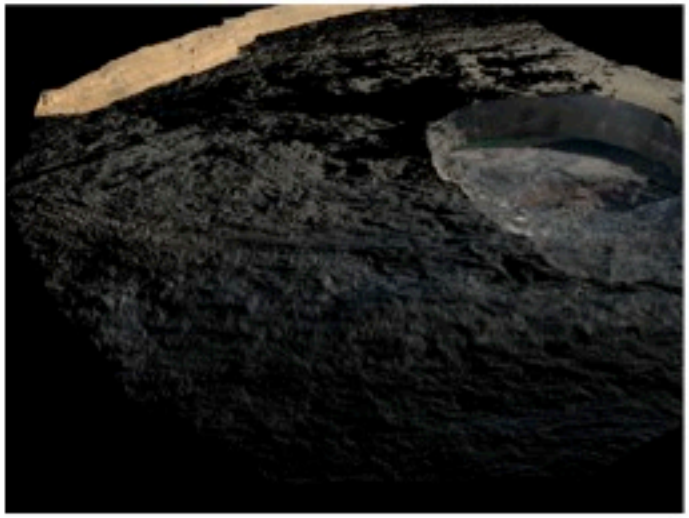


courtesy of: Geospatial research Ltd

source: *Wikipedia*

Virtual Outcrop Models

- Dabbahu fissure, Ethiopia
- Erte Ale volcano
- For BBC/Discovery channel 'Hottest place on Earth' series



courtesy of: Geospatial research Ltd

Virtual Copies vs. Geospatial Analysis

- highly realistic copy of the outcrop
- ideal for virtual field-trips etc.

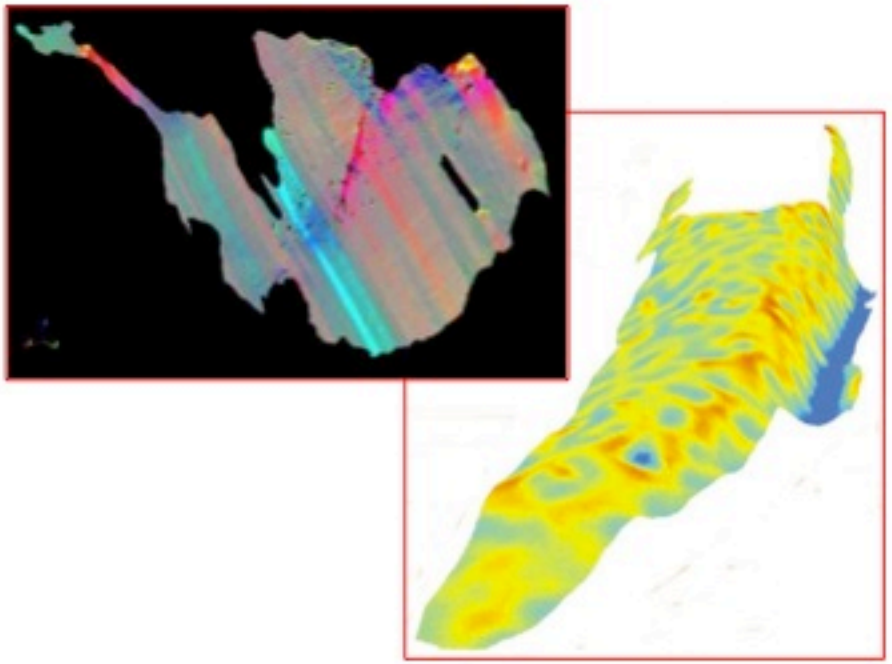
Key issues:

- point meshing, mesh optimisation, hole filling, and draped images
- good quality colour
- smooth visualisation (hard & software)

- georeferencing and precision are key
- quantitative analysis of 3D geometry

Key issues:

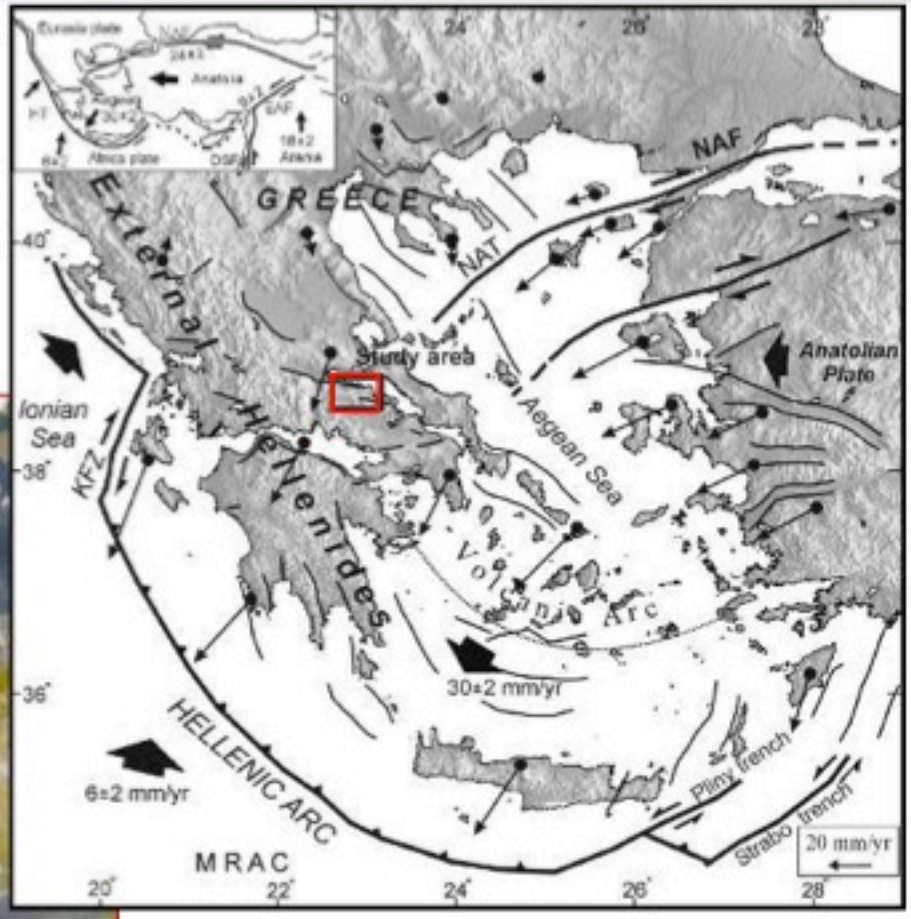
- must remove extraneous points (vegetation, people, dust etc)
- full outcrop coverage less important
- interpolation, extrapolation & new methods of spatial analysis are needed



courtesy of: Geospatial research Ltd

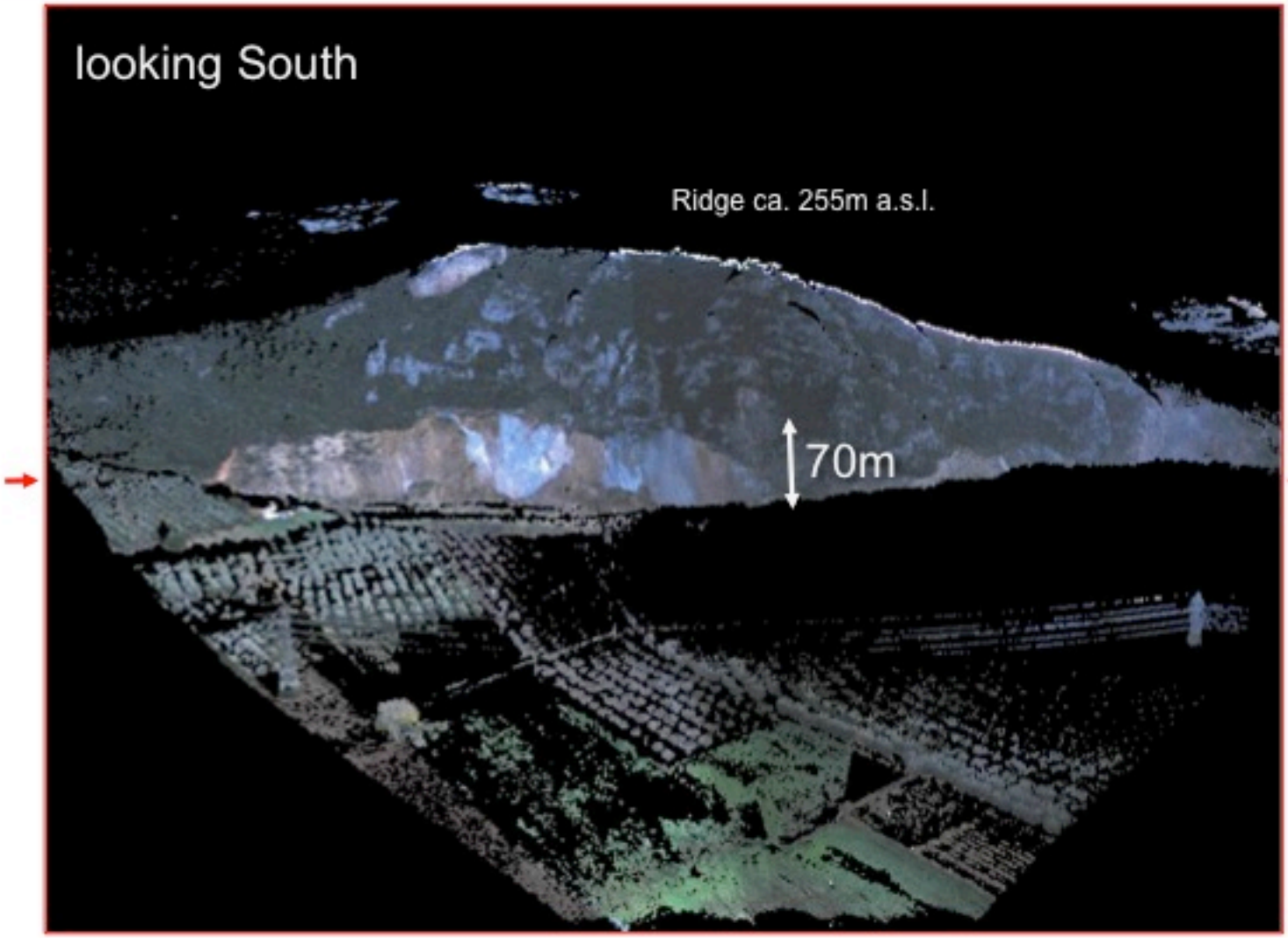
Gulf of Evia, Greece

NASA



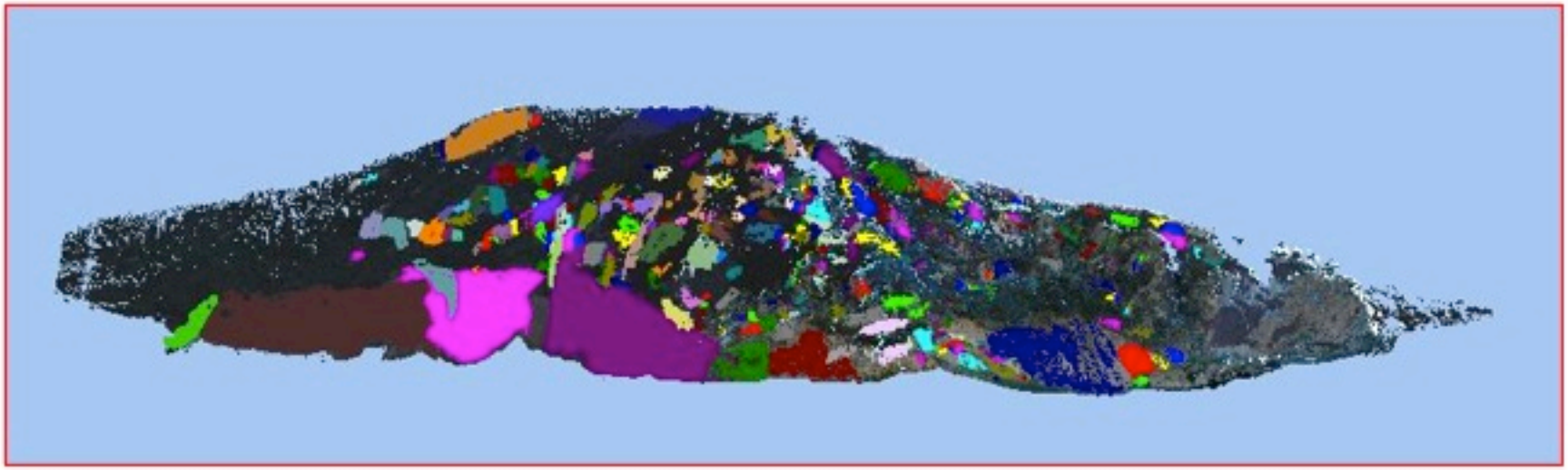
Kokkalas et al., 2006, 2007

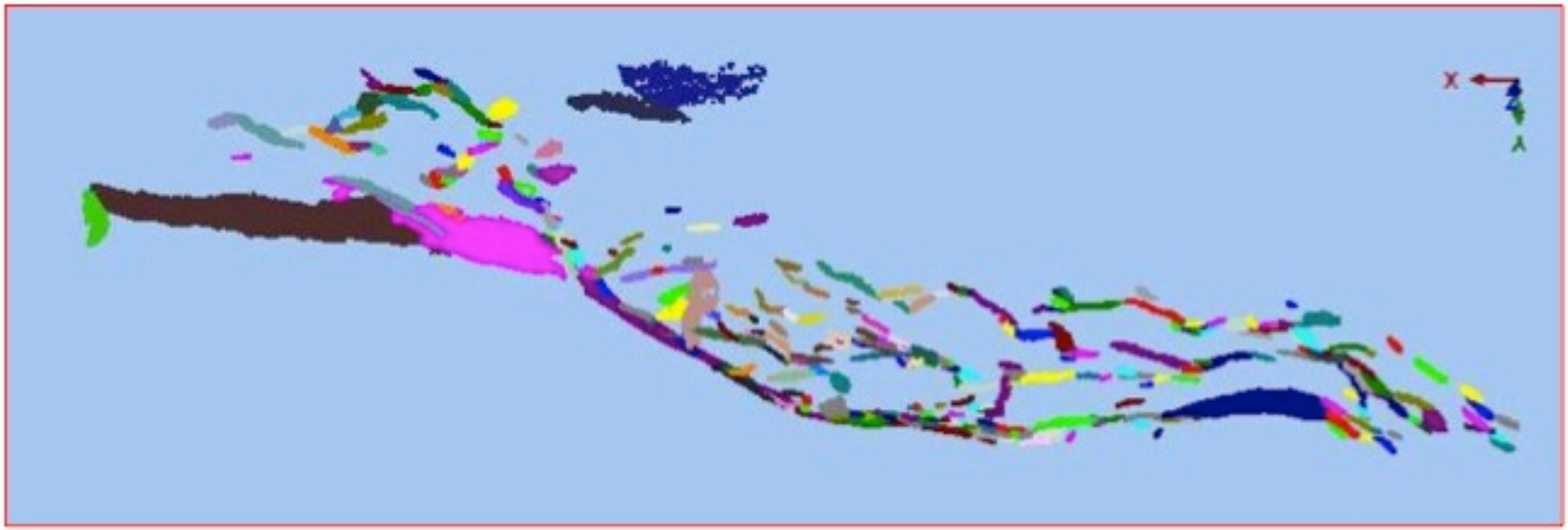
Arkitsa Fault, Overview



courtesy of: Geospatial research Ltd

Fault Segmentation



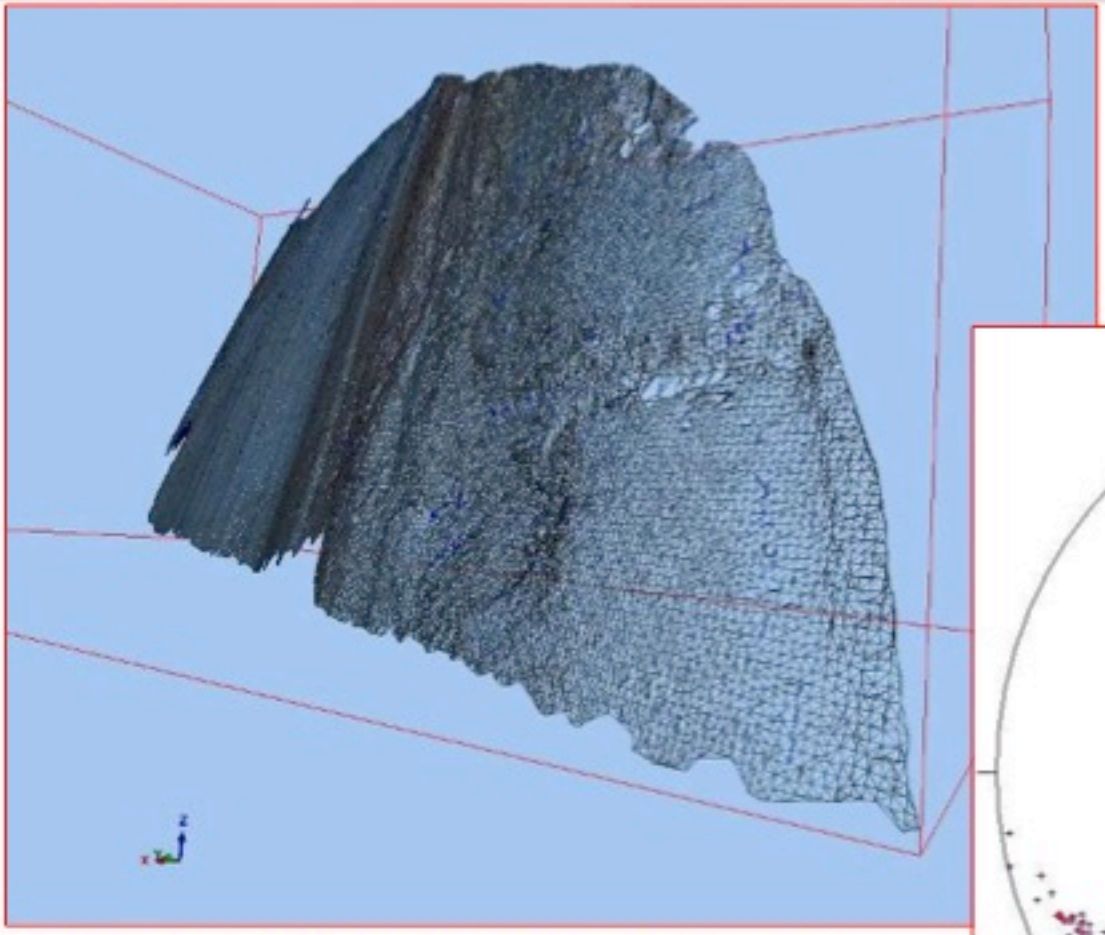


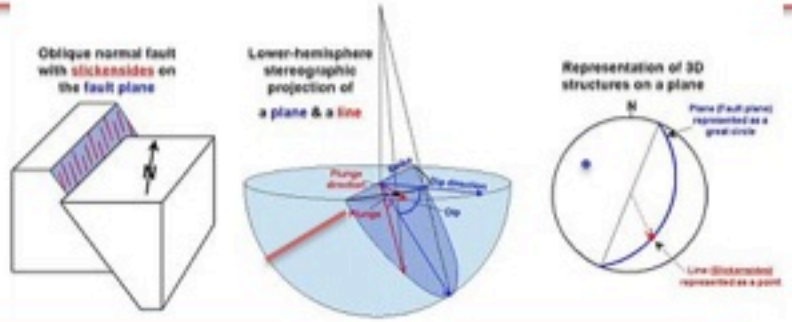
courtesy of: Geospatial research Ltd

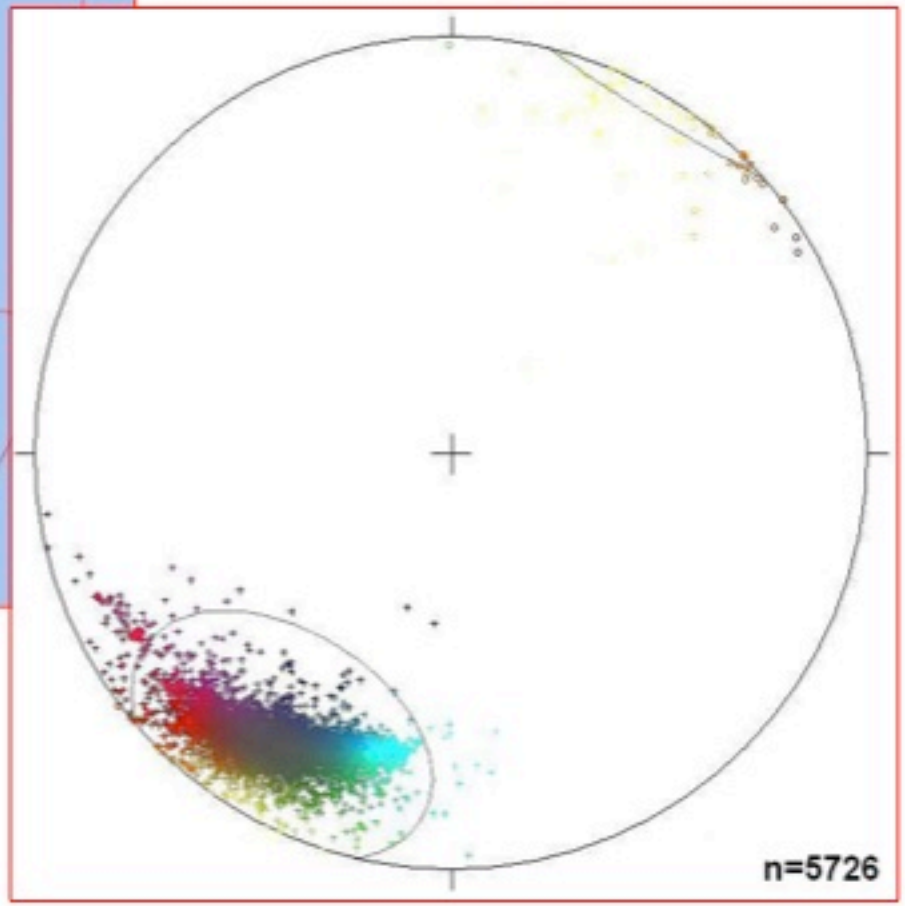
Arkitsa Fault, Medium Res.

courtesy of: Geospatial research Ltd

Quantitative Spatial analysis



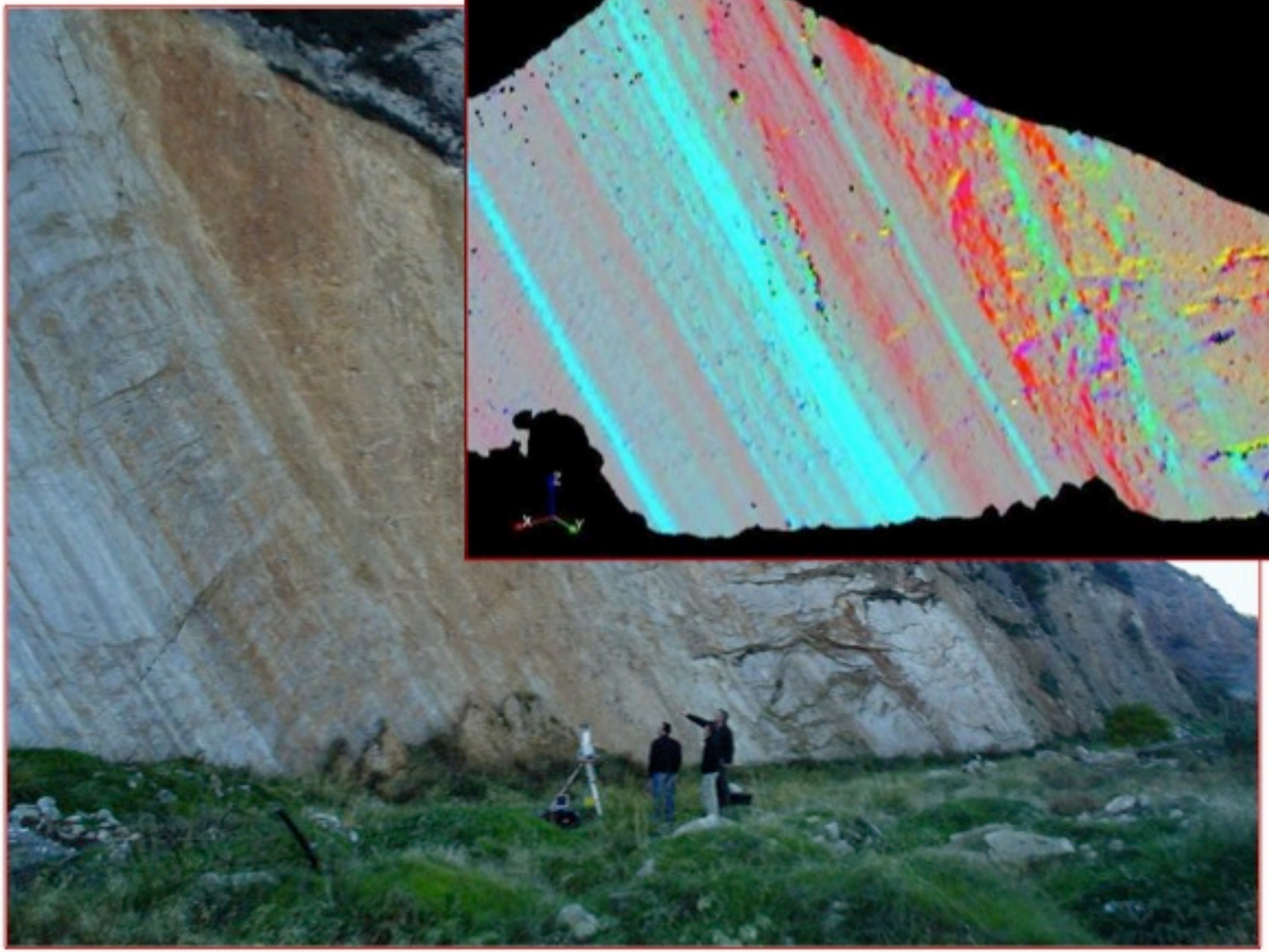




Kokkalas et al. 2007, Jones et al. 2007

c.f. fault roughness: Renard et al. 2006, Sagy et al. 2006

Spatial Variation in Orientation



Research-led Teaching

Who are we teaching?

- Increase in spatial cognitive skills - a result of TV from early age, computer games internet etc?
- but decrease in more abstract reasoning skills – perhaps attributed to decrease in reading books
- Against background of increasing IQ due to improved education and other environmental factors

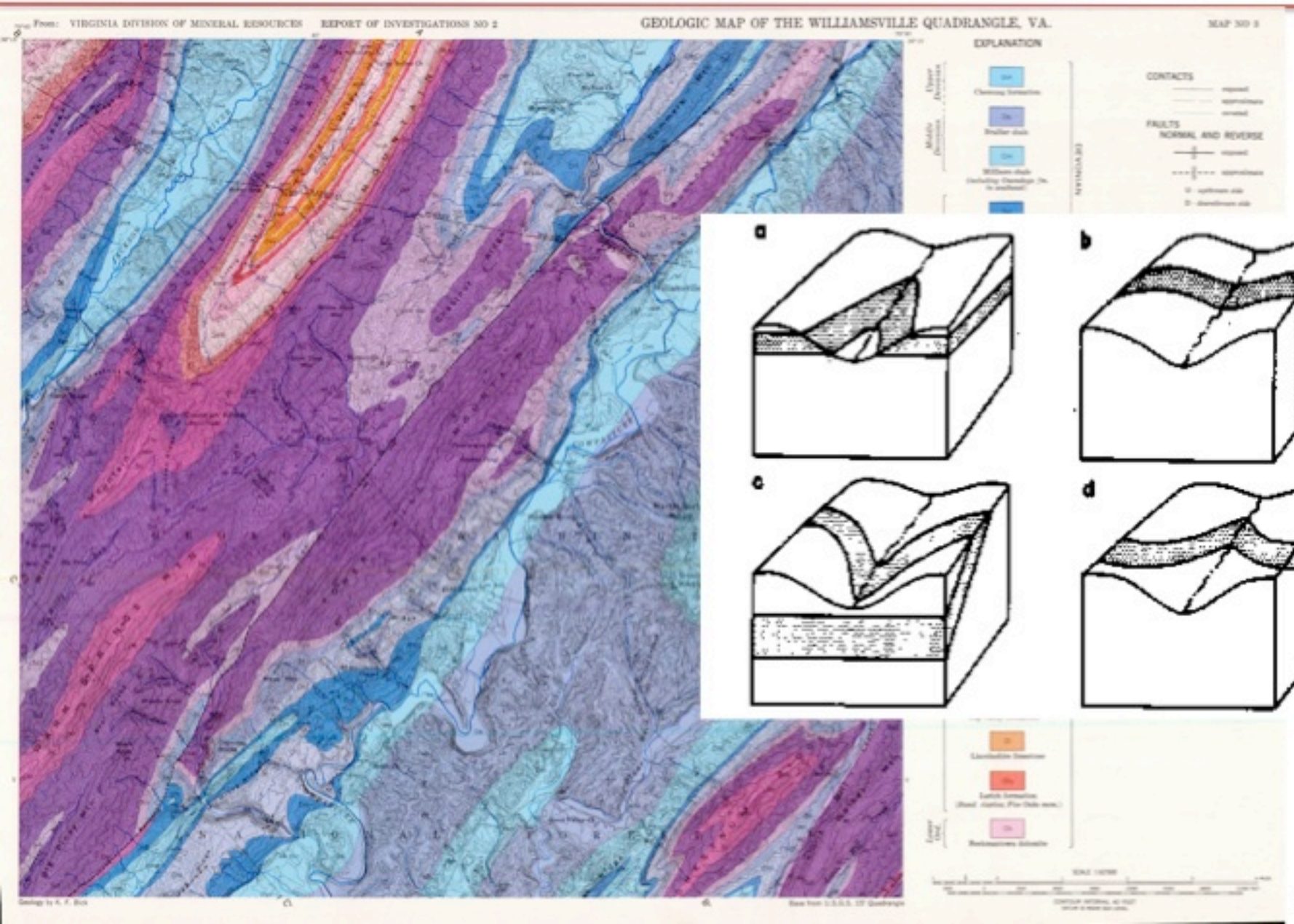
"TV-babysitter" image from: http://itthing.com

Greenfield, 2009 (Science)

What do we teach students?

- critical evaluation of the validity of data
- methods, and scientific concepts
- build scientific, technical, quantitative, and communication skills.
- how to address real-world problems…

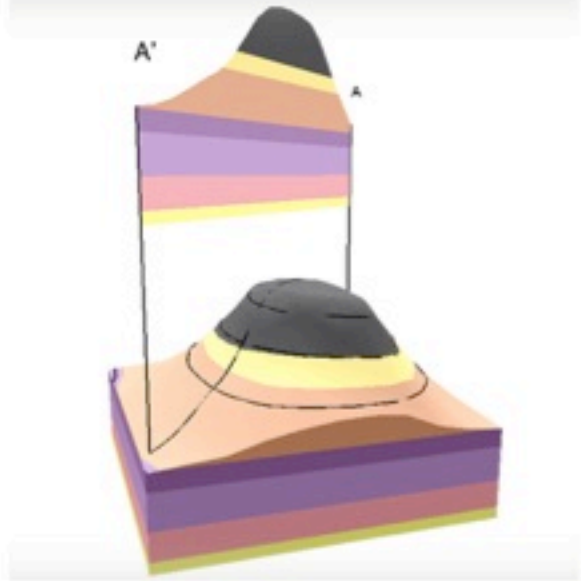
2D Visualization: Maps



USGS

Visual aids: 3D blocks

http://visible-geology.appspot.com/

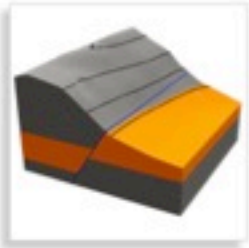


Geologic Beds

In Visible Geology you can add any number of layers with you choice of thickness and color. After adding the beds, tilt the layers by inputting the strike and dip or visually to learn this geologic notation. Explore the outcrop pattern on different topographies to experientially learn the 'Rule of V's'.

Geologic Folds

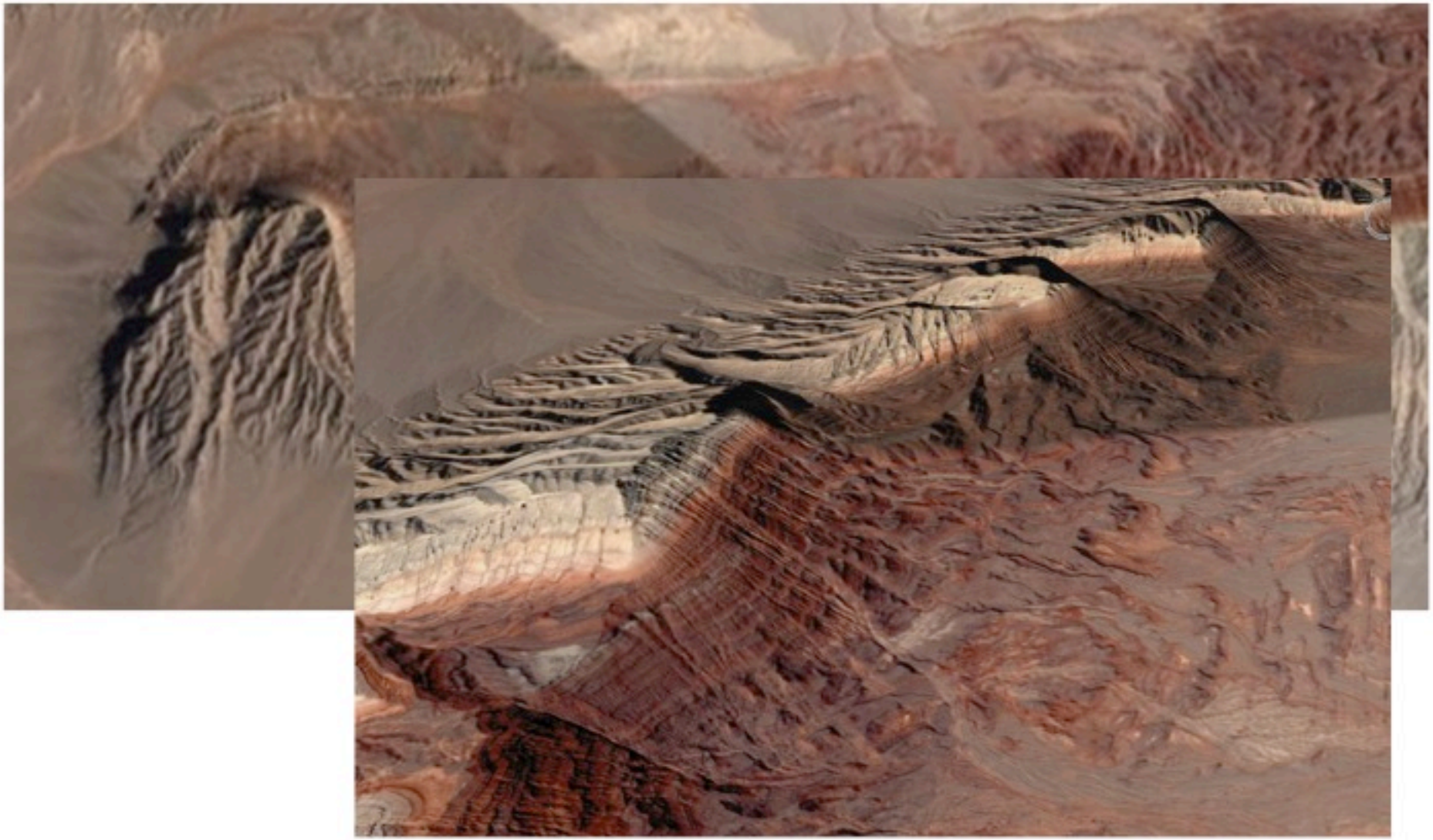
Fold any existing geologic history by visually choosing the wavelength, amplitude, and shape of a geologic fold. Create complex folding events by adding multiple folds at differing orientations.



Faults

Create any type of planar geologic fault, as well as fault-bend-folds and blind-thrust faults. Choose the orientation visually and pick the direction and magnitude of the slip vector on the fault plane.

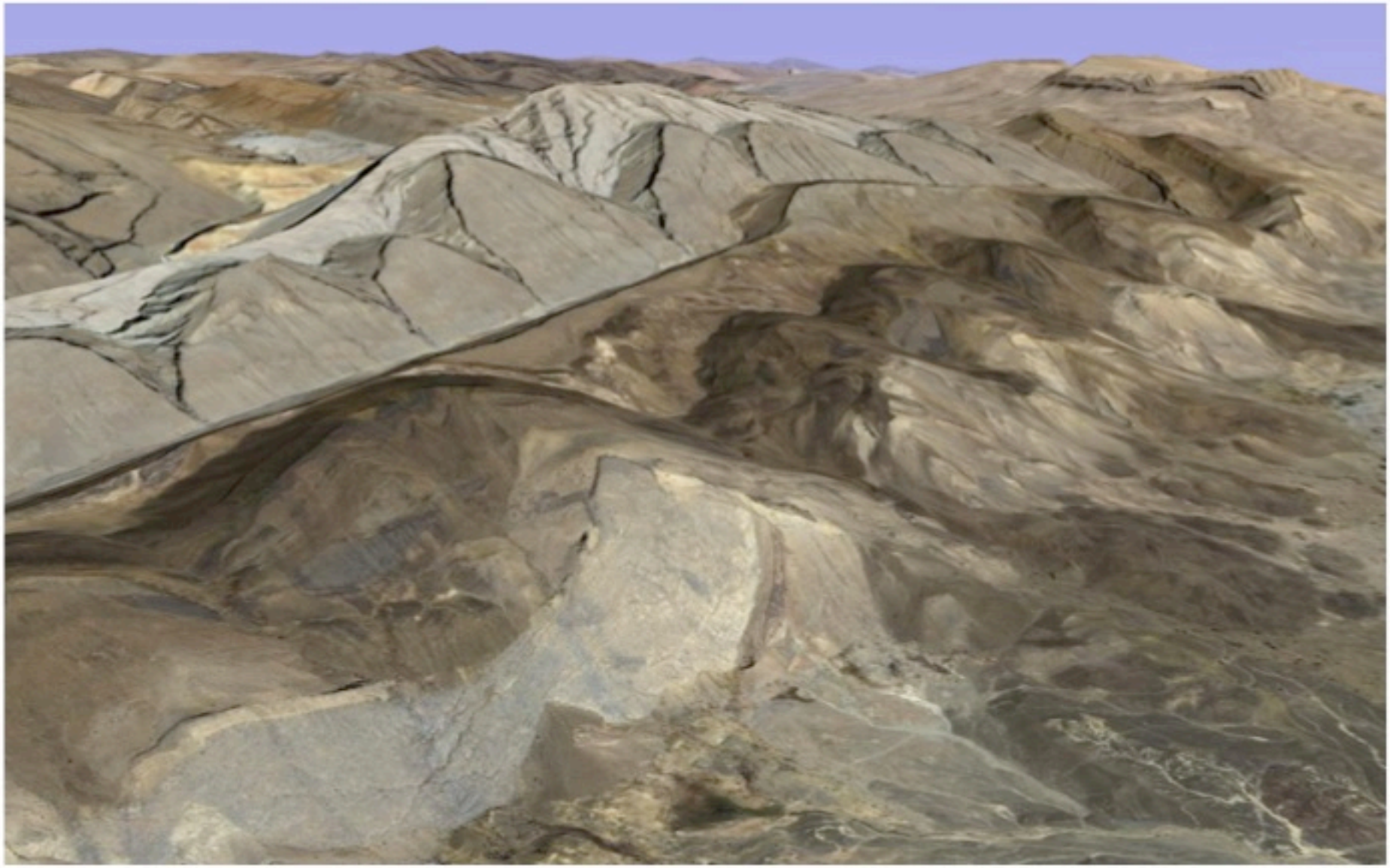
Visual aids: GoogleEarth



East of Yazd, Iran

Barbara Tewksbury: http://serc.carleton.edu/NAGTWorkshops/structure/approach.html

Visual aids: GoogleEarth



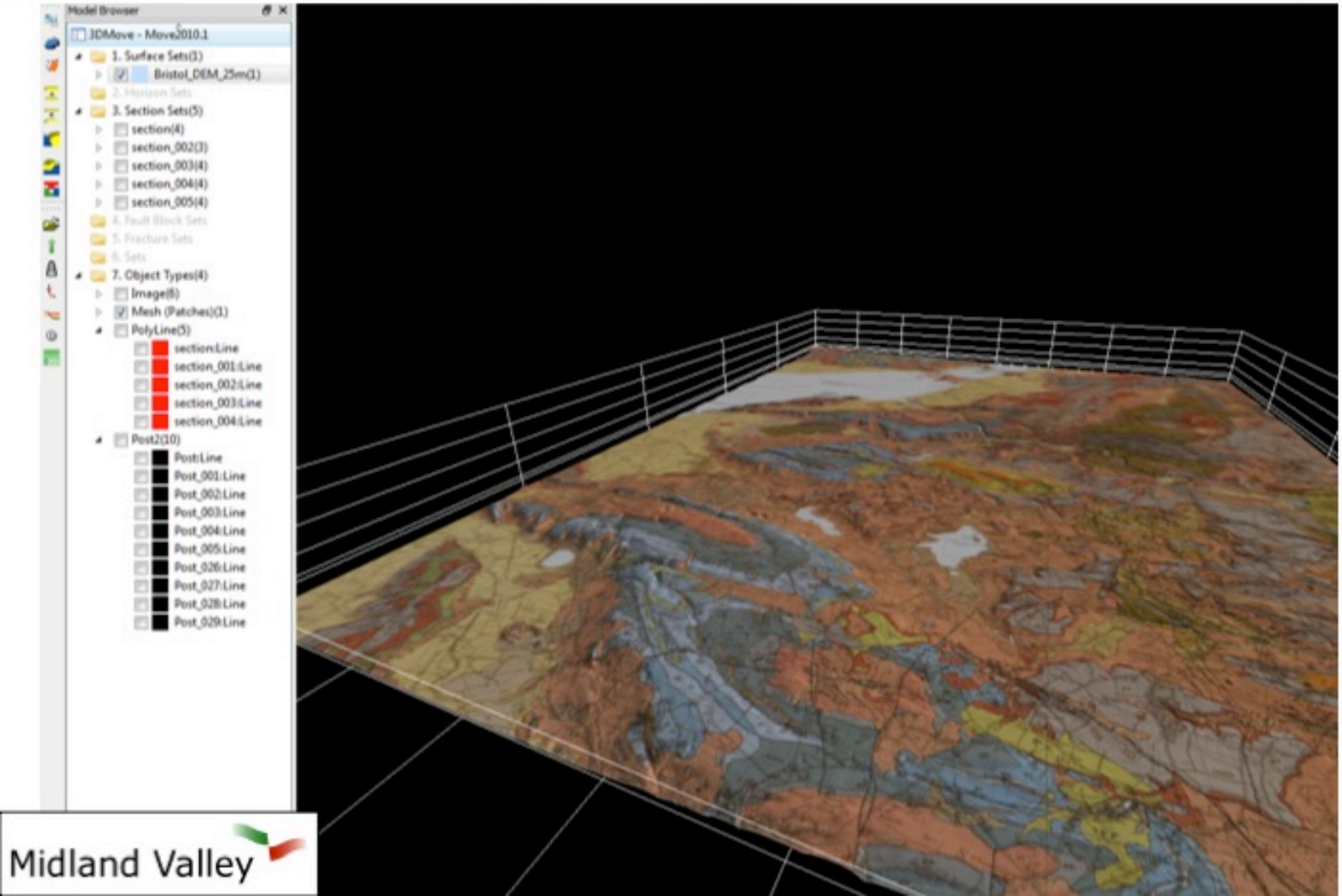
Barbara Tewksbury: http://serc.carleton.edu/NAGTWorkshops/structure/approach.html

An Integration Approach

1. Traditional map skills (Year 1 module + 4 weeks)
   a) Paper-based mapping
   b) Sketch maps and sections
   c) Accurate cross-sections

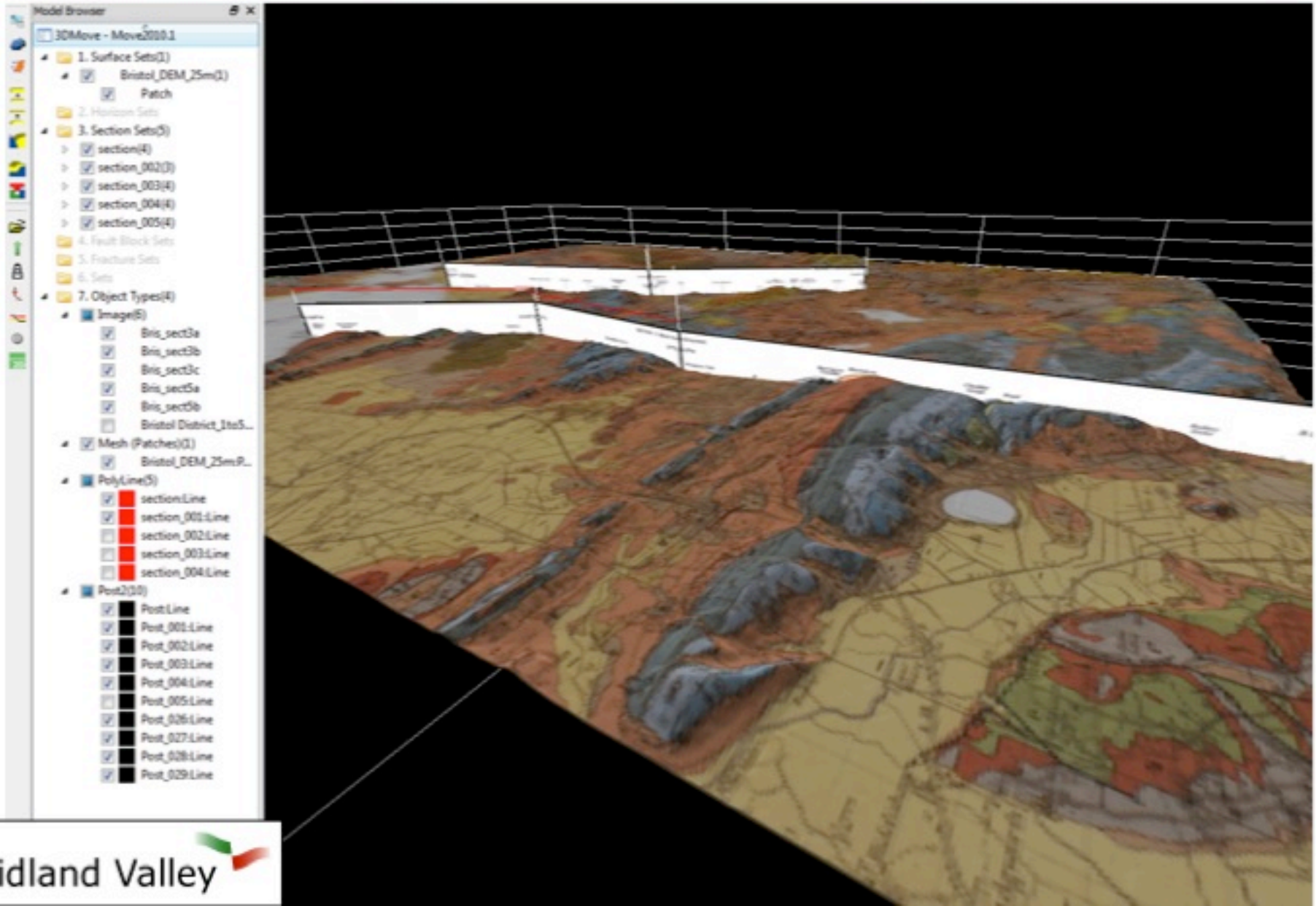
2. Computer-based map skills (4 weeks + independent project)
   a) How to construct maps (*MVE Move 2D/3D*)
   b) Importing data sets (maps, DEMs, cross-sections, well data)
   c) Cross-section analysis

Integration: *Move 2D/3D exercise*



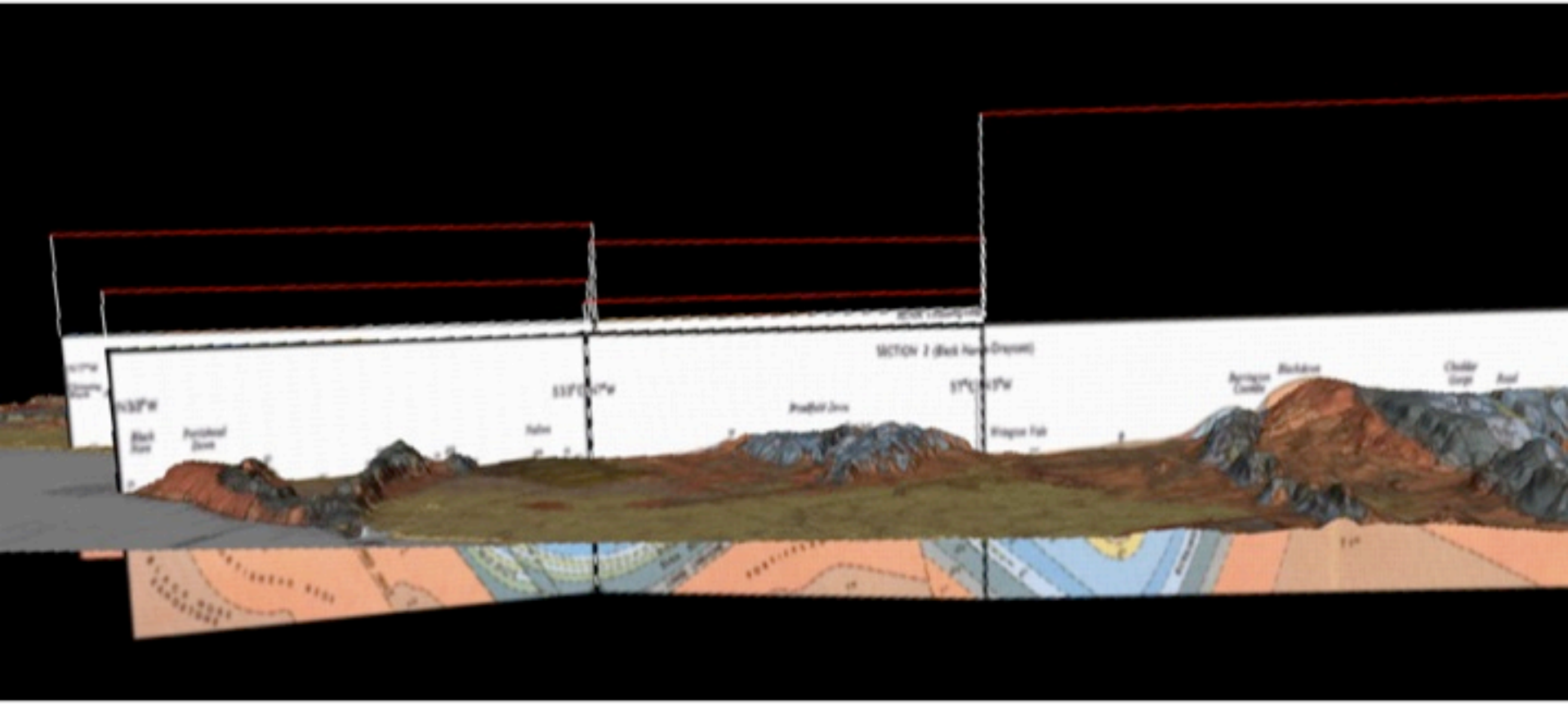
Midland Valley

Move 3D exercise



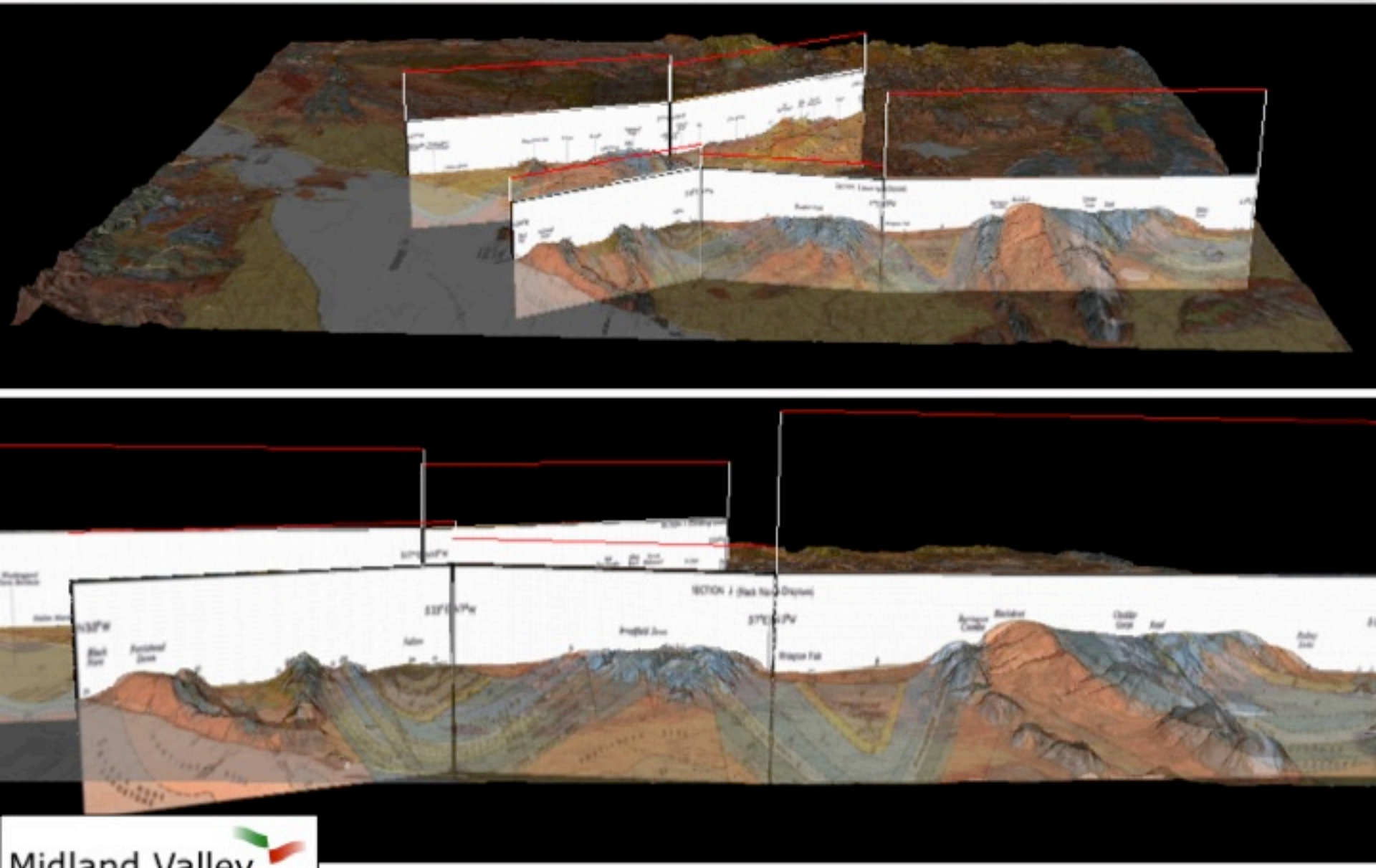
Midland Valley

Move 3D exercise



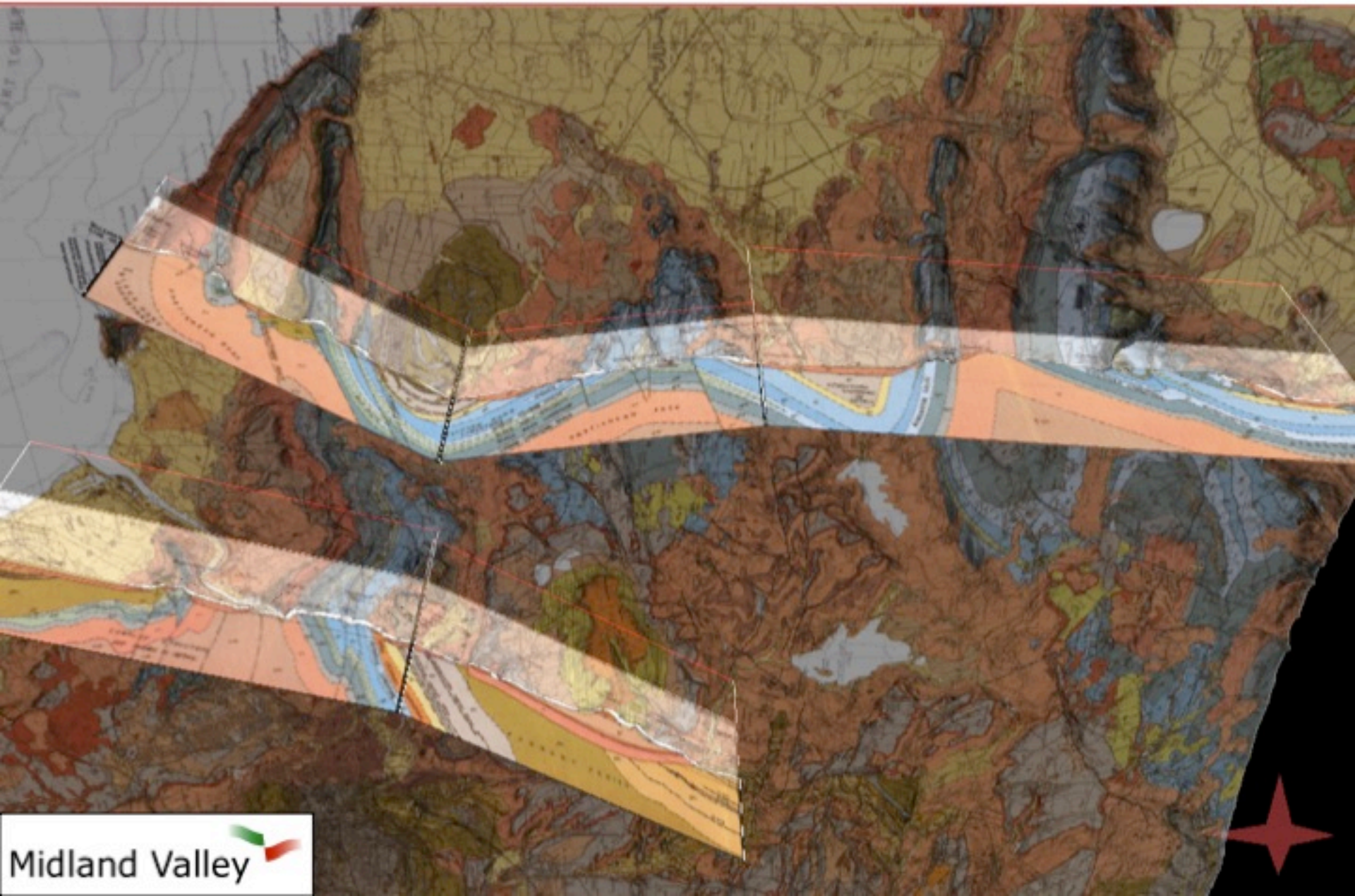
Midland Valley

Move 3D exercise



Midland Valley

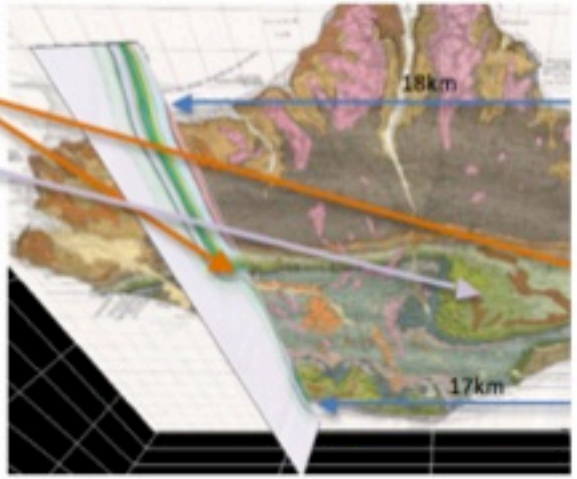
Move 3D exercise

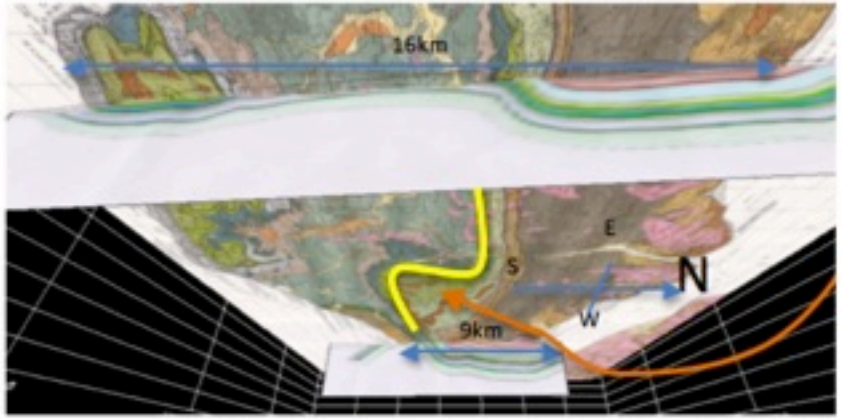


Move 2D/3D exercise: results

Isle of Wight – Assessed Practical

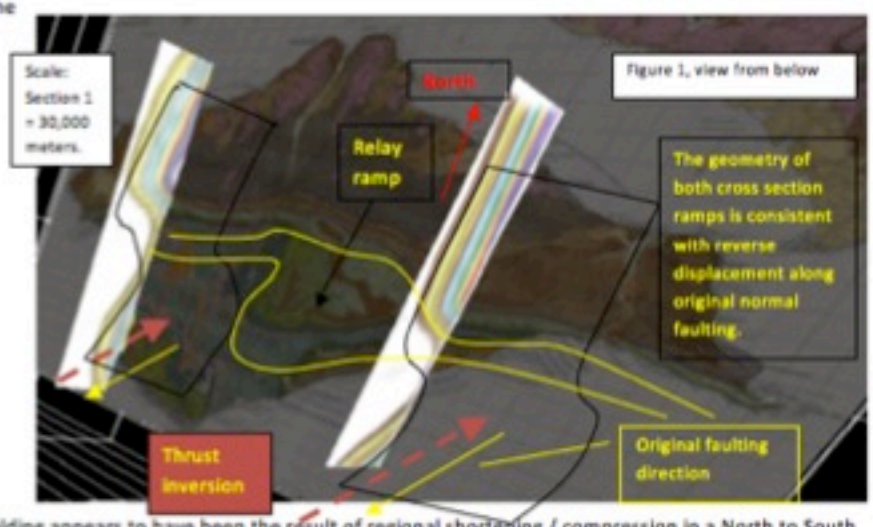
This view shows the folded beds and the area of low deformation in between the inferred inverted normal faults. It also shows the rest of the map for the interpretation of geology between the cross sections showing the geology at depth.



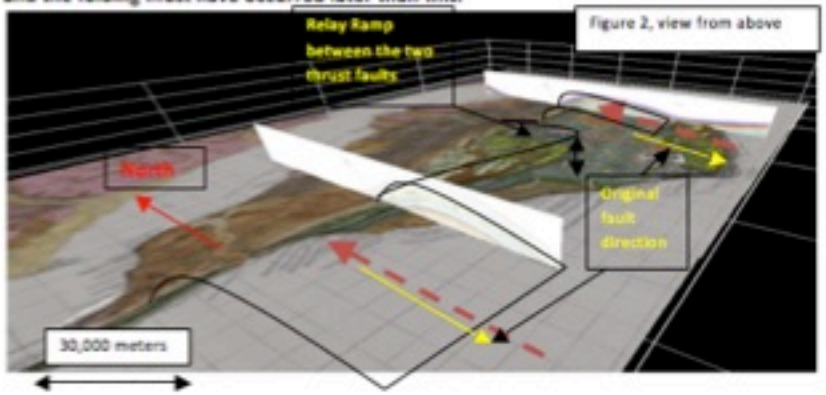


The Isle of Wight appears to have been extensively deformed by a regional tectonic event. From the images below it appears that the whole structure of the Isle is composed of an extensive set of fault related folding.

The



folding appears to have been the result of regional shortening / compression in a North to South direction along the fracture zones of previous normal fault structures. The steeply dipping strata of the folds contrast with the shallow geometry of the centre of the isle, here the two folds are separated by a relay ramp which was creating during the original faulting episode. The Isle of Wight is at the southern most point of England. The deformed units are of Cretaceous to Oligocene in age and the folding must have occurred later than this.



Final thoughts

- Geospatial technologies can provide a fantastic resource for teaching
  - 3D visualization makes complex problems more accessible
  - potential for 3D data recording and interrogation
  - new perspectives?

but…

- background knowledge is still required
- emphasis on quantitative scientific observation, and progression to logically formulated interpretation must be maintained

Acknowledgements

Funding for RRG Research at University of Durham


Software for use in non-commercial research