OR/14/026 Modelled faults

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Hulbert A G, Terrington R L. 2014. Metadata report for the East Midlands region of the Pennine Basin 1:250 000 resolution geological model. *British Geological Survey Internal Report*, OR/14/026.

All of the faults used in the construction of the model were sourced from the East Midlands Basin Subsurface Memoir (Pharoah et al., 2011[1]). These were digitised per surface as ESRI polyline shapefiles as part of the Regional UK Lithoframe programme. As the model was regional in nature, an initial filtering of the faults was applied to ensure that only those that had significant throw/displacement (generally >100 m) were used for the surface construction.

One method of filtering was to select faults that had a length of greater than 10 000 m (a value arrived at by experimentation), as it is recognised that the greater the length of the fault (in 2D space) the greater the throw/displacement (Young-Seog and Sanderson, 2005[2]). By selecting faults over 10 000 m, many of the faults with throws of greater than 100 m are used in the modelling phase.

For shorter faults, finding those that had significant displacement and were worthy of inclusion in the model was a case of manual inspection. This was achieved by taking all of the faults that had a length shorter than 10 000 m, and examining the contour values across and within a buffered distance (usually either 250 or 500 m) in order to estimate the change in elevation across the fault. From the results of this, faults that were less than 10 000 m in length but were found to have a throw greater than 100 m were selected for use in the project.

The total distribution of faults modelled can be seen in Figure 6.

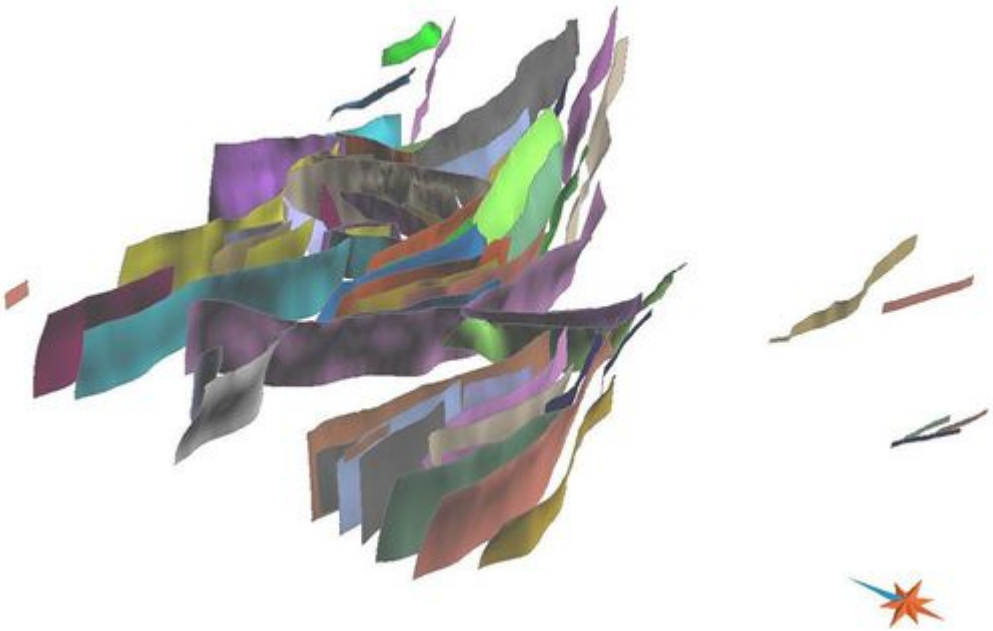

Figure 6 Distribution of the modelled faults for the East Midlands Model.

Two types of faults were produced using the Structural Modelling Workflow in GOCAD®. Some of the faults were produced using the fault sticks method (whereby fault cuts at individual surfaces were combined to produce a fault surface) and the rest used the Fault Centre Line method (a single

fault line at a particular level, with a fault dip and direction applied). For both types of faults generated, fault contacts were modelled where individual faults were crossed or truncated by other faults in the model

Fault sticks

1. Each surface was calculated using the digitised contours to give a raw unfaulted surface.
2. The fault traces generated were draped onto their respective surface.
3. Faults were grouped by their fault location — meaning each draped fault trace that corresponded with an individual fault was extracted to a new fault curve object — further filtering could be undertaken at this point, as not all draped fault cuts were necessarily required to produce an aesthetically pleasing fault object (Figure 6).
4. The grouped fault traces were allocated a *Fault Stick* data type in GOCAD® and put through the Structural Modelling Workflow for generating a fault surface. Manual editing of the fault surface was sometimes necessary to smooth out any spikes or anomalous data.

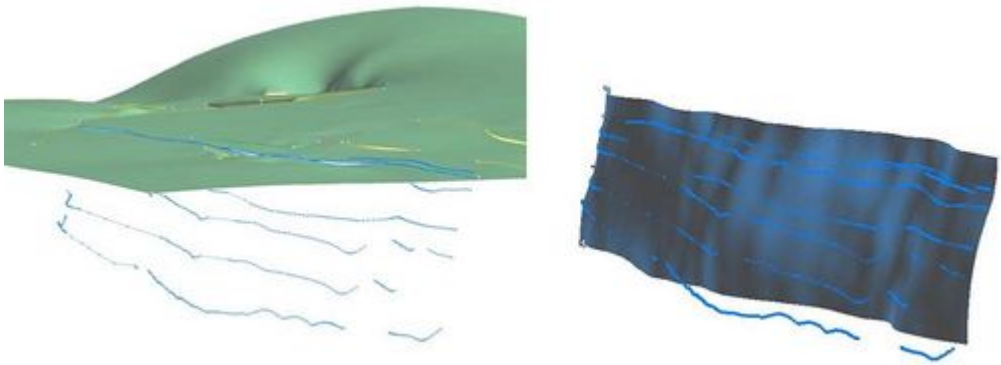

Figure 7 Example from the Northumberland-Solway Model showing the construction of a fault surface (the Closehouse-Lunedale fault) from fault sticks (right image in blue) and the interaction of the fault with the Permo-Trias surface prior to faulting (in green) from Terrington *et al* (2013)[3].

Fault center lines

If the fault trace only occurred on a single surface, or the fault heave over several surfaces was insignificant, the *fault centre line* data type was used in GOCAD® Structural Modelling workflow. The *fault centre line* allows the user to specify the elevations of the top and the base of the fault and the dip angle. The fault generated is a simple extrusion of the fault centre line. This fault type is often used where faults displace the outcrop (or subcrop).

Fault contact modelling

After fault construction, fault intersections need to be modelled and constraints built. This is normally done within the modelling workflow using the 'Fault Contact Modelling' dialogue. This works well with relatively simple fault networks. For more complex networks or where individual faults may not always have the same vertical extents, manual construction of fault contacts and constraints produces a better model. To do this, we use the 'cut by surfaces' method with the 'build constraints' option selected. This fills the fault contact table in the same way that the workflow method does. The fault network for the East Midlands model was done in this way.

References

1. ↑ PHAROAH, T C, VINCENT, C J, BENTHAM, M S, HULBERT, A G, WATERS, C N, and SMITH, N J P. 2011. The structure and evolution of the East Midlands region of the Pennine Basin. Subsurface Memoir edition. *British Geological Survey*, 143.
2. ↑ YOUNG-SEOG, K, and SANDERSON, D J. 2005. The relationship between displacement and length of faults: a review. *Earth Sciecne Reviews*, Vol. 68, 317–334.
3. ↑ TERRINGTON, R L, and THORPE, S. 2013. Metadata report for the Northumberland and Solway Basin 1:250 000 geological model. *British Geological Survey*, OR/13/049 (British Geological Survey).

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