

Section Analysis

The **Section Analysis** tool in Move2017 allows quantification of the length, area and thickness of stratigraphic horizons in 2D. The results provide first-order constraints on the structural evolution of a region and help identify areas of interpretational uncertainty.

The tool automatically restores line length by removing fault offsets and the effects of folding. The results are plotted in stratigraphic order above the original section interpretation (Figure 1). In this Move feature, a workflow for implementing line length analysis and interpreting the results is outlined.

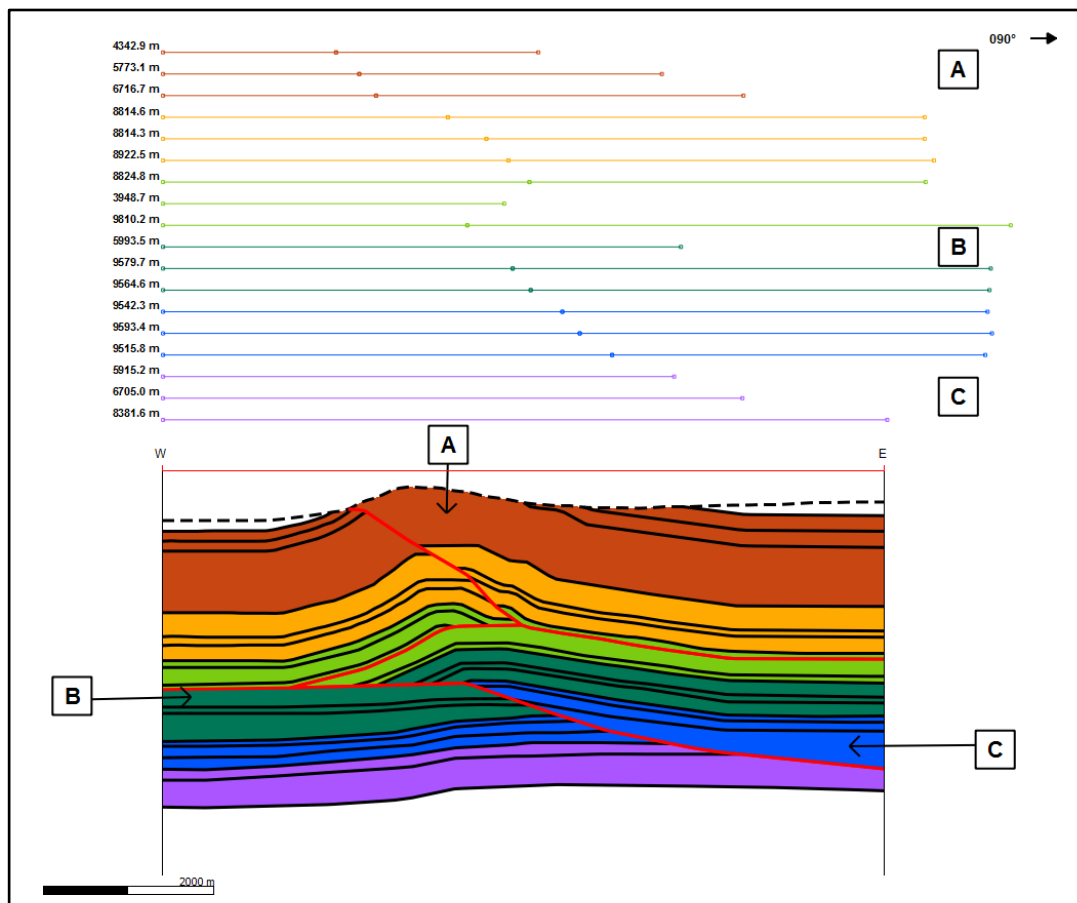
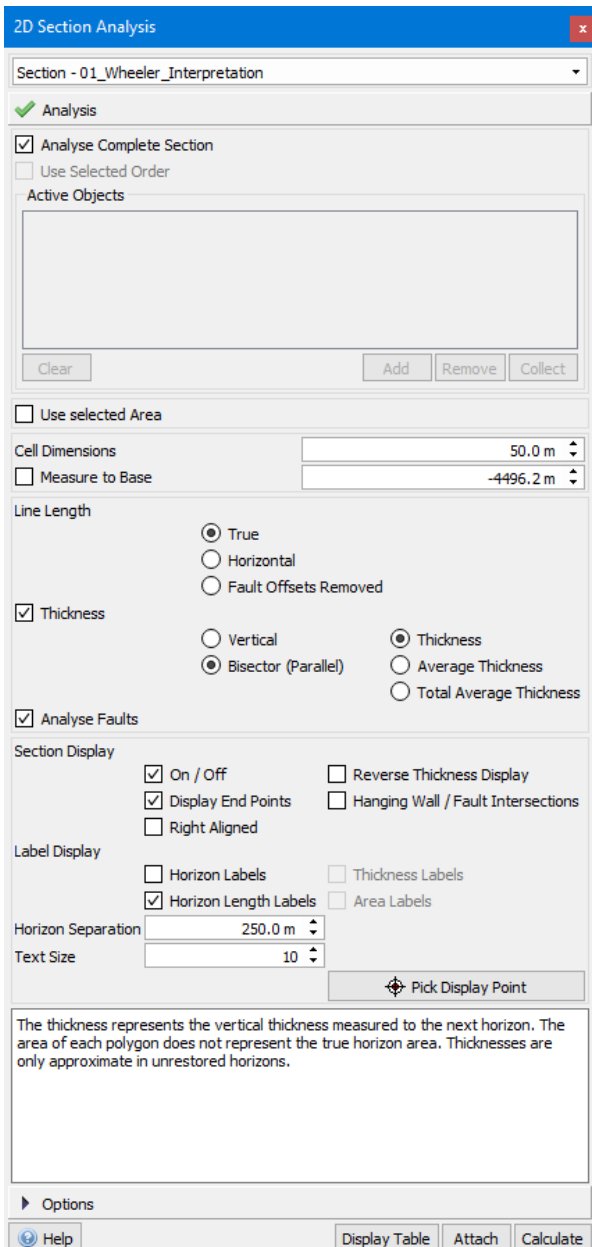


Figure 1. Interpreted section from the Wheeler Ridge anticline in California (Muller and Suppe, 1997). Results of Section Analysis calculation are displayed above the interpretation. Three areas of interest identified on the interpretation and their corresponding Section Analysis results.

Using Section Analysis

A cross-section through the Wheeler Ridge anticline in California is used here to highlight how Section Analysis can help identify issues in an interpretation. Figure 1 shows the present-day geometry of the fold and section analysis results. Following an outline of the Section Analysis workflow, there is a discussion relating to the three key areas of line length variance that were identified from the study.

Section Analysis is accessed from the 2D Kinematic tools on the Modules tab in Move. The user can choose to **Analyse Complete Section** (Figure 2), auto-restoring all the horizons in the 2D section, or analyse the line length of individual horizons.



2D Section Analysis

Section - 01_Wheeler_Interpretation

✓ Analysis

Analyse Complete Section

Use Selected Order

Active Objects

Clear Add Remove Collect

Use selected Area

Cell Dimensions 50.0 m

Measure to Base -4496.2 m

Line Length

True

Horizontal

Fault Offsets Removed

Thickness

Vertical Thickness

Bisector (Parallel) Average Thickness

Total Average Thickness

Analyse Faults

Section Display

On / Off Reverse Thickness Display

Display End Points Hanging Wall / Fault Intersections

Right Aligned

Label Display

Horizon Labels Thickness Labels

Horizon Length Labels Area Labels

Horizon Separation 250.0 m

Text Size 10

Pick Display Point

The thickness represents the vertical thickness measured to the next horizon. The area of each polygon does not represent the true horizon area. Thicknesses are only approximate in unrestored horizons.

Options

Help Display Table Attach Calculate

Figure 2. Section Analysis toolbox set up prior to calculation. Settings are for visualizing length and bisector thickness during analysis. Horizon Labels will not be displayed.

Analysis is implemented by clicking **Calculate** at the bottom the of the toolbox. Whilst the results are automatically plotted above the section, the position can be adjusted by selecting **Pick Display Point** and clicking on a point in the view. Thickness and Area labels may be visualized when displaying an average thickness. By default, unfolded horizons are aligned to the left of the section; this can be changed using the **Right Aligned** option.

Analysing length

The results display the line length of eighteen individual horizons. The length of the longest horizon measured ~10 km and the shortest horizon ~4 km. This difference highlights that there are potential issues with the interpretation and can be summarised as three key areas (highlighted on Figure 1).

A – Surface erosion (dashed line).

B – Horizons 08 and 09 not interpreted in footwall fault block.

C – Horizon 16, Horizon 17 or Horizon 18 not interpreted in hanging wall fault block.

Some of these simple interpretation issues, such as missing horizons or eroded material, can be resolved using the **Horizons from Template** tool in Move.

Analysing thickness

Horizon thickness variations can be calculated in four ways:

- **Thickness (Vertical)** – The thickness for each line object will be displayed, this thickness is calculated vertically from each point on the line.
- **Thickness (Bisector)** – The thickness is calculated using the bisector from each point on the line.
- **Average Thickness** – The average of the thicknesses across each line, this will be based on the vertical or bisector thickness was calculated.
- **Total Average Thickness** – The height of the displayed polygon will equal the average thickness of all lines of that horizon.

Figure 3 shows the thickness variations across Wheeler Ridge interpretation using a bisector thickness calculation. Whilst previous work proposed that most sedimentation was pre-tectonic (Muller and Suppe, 1997), thickness analysis indicates across thinning on deeper horizons (teal and blue, Figure 3). The origin of thinning could be investigated with a 2D geometric restoration.

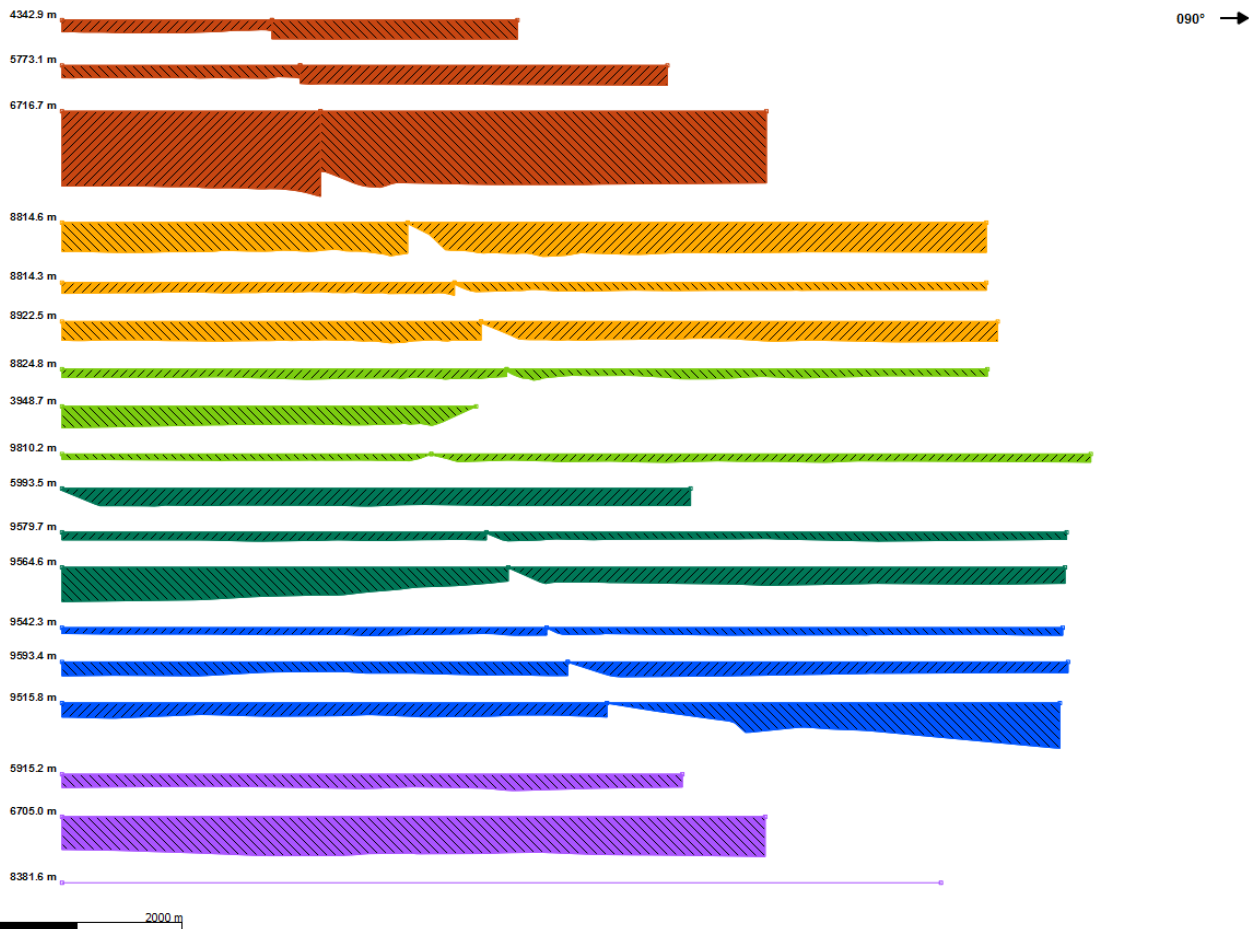


Figure 3. Thickness calculation performed on Wheeler Ridge interpretation. Thicknesses are calculated as Bisector thicknesses.

Additional analyses

New functionality added to Section Analysis for Move2017.1 allows calculation of sedimentation rates and across-fault displacement.

This data is accessed by clicking on **Display Table**. A table will open with more detailed analysis of the model. The information is split over three tabs:

- **Horizon Analysis** – Results on a per horizon basis in tabular form. The results include Thickness, Area, Length and Sediment Rate.
- **Line Measurement** – Results on a per line basis. The Name, Colour, Thickness, Area and Length for each object will be listed.
- **Displacement Analysis** – Displacement experienced by each horizon in tabular form and may also be plotted on a Fault Depth plot. The results are broken down into total values and values for each fault block.

Horizon analysis

The **Age plot** within the **Horizon Analysis** tab allows section analysis results to be plotted against horizon age.

Figure 4 shows the sedimentation rate for a rift system. The plot indicates that sedimentation rates were steady until 165 Ma, prior to a rapid increase in sedimentation lasting for ~ 20 Ma. Following this, sedimentation declined to the present-day rate. A smaller decrease occurred

between 170 – 165 Ma, this could potentially indicate restricted sedimentation or a change in sea level.

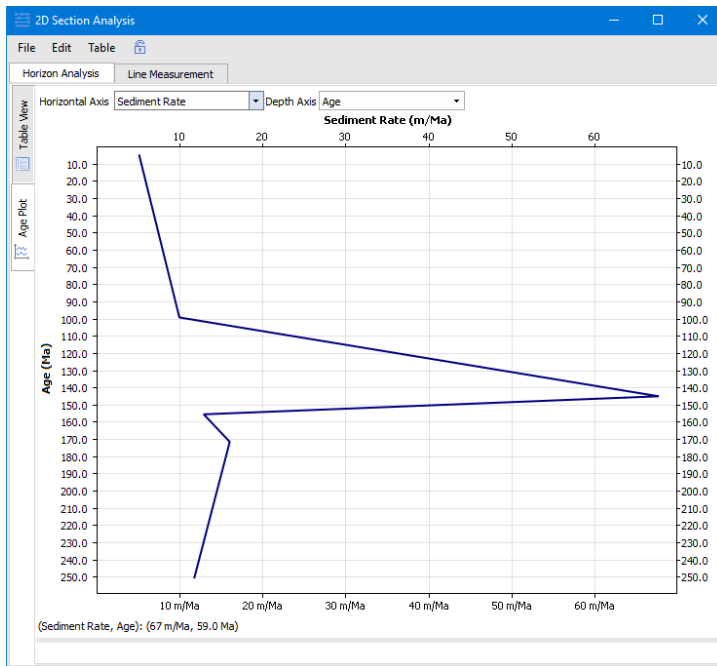


Figure 4. Table display from section analysis results. Figure 6B. Age Plot of Sedimentation Rate v Age

As has been shown, the Section Analysis tool in Move is very useful for quickly analysing the validity of an interpretation and determining where further work or attention may be required due to differences in line length or area.

References

Muller, K. and Suppe, J., 1997, Growth of Wheeler Ridge anticline, California: geomorphic evidence for fault-bend folding behavior during earthquakes. *Journal of Structural Geology*, **19**, p. 373-88.