Using Kingdom Suite for
3D Horizon/Fault Interpretation
Parts 3 & 4 - Horizon Interpretation and Correlation

Wilson (2010)
A footnote to last week’s exercise

**Double Vision?**

- Last week when you were digitizing your faults you might have noticed that you often ended up with a double line. One of those lines is the straight-line fit of the fault surface through the fault surface points you digitized. The other curvy line is a spline-fit of all the points - the 3D totality of points - you digitized along the fault surface.

In this exercise, it will probably work best if we just turn off the spline fit surface. To do this click **Faults** on the menu bar across the top and from the drop down menu click on **Fault Management** (see below). In the **Fault Management** window, click on the second tab over - the **Display** tab.

![Fault Management window: Set display type to Fault Lines](image)

Under **Display Type**, click on **Fault Lines**. This displays the linear-fit surface through the digitized fault points. Remedies to the oddly shaped spline-fit surface go beyond the scope of this workshop. We should be able to do a fairly good job using the linear interpolation of fault points through the data cube.
STEP - 28. Once you are satisfied with your fault interpretation you can **begin picking horizons**.

29. As mentioned earlier, we will be interpreting the "Green" 1.3 second reflector through the 3D data base. The display below (Figure 18) **Display line 80**. If you are not working with the Golden data set then pick an “appropriate” reflection event for digitization.

![Figure 18: The Green Horizon has been carried across Line 80.](image)

30. **Horizons are created** in much the same way as faults. Anywhere on the seismic line, right click and select **Horizon Management**. Select the **Create** tab and then enter **Green** for the horizon name and then select a color (**Green**). Hit OK. The **Green** horizon is now active.

31. **Display the horizon** in map view by double clicking on the icon next to the GREEN Horizon. Since no picks have been made, no horizon is visible.
32. **Horizon Picking**: Right click on a seismic line and select *Picking Parameters*. Make sure that *Stop at Displayed Fault Surface Intersections* is enabled. This feature, when enabled, works with the Autopick-2D Hunt mode. Picking will stop when the reflection terminates or when the horizon encounters a fault surface.

33. Display the Horizon Toolbar by left clicking on **View**, **Toolbars**, and **Horizon bar**. Note that the active horizon is highlighted in the toolbar. Hot keys are available, **M** = manual picking, **F** = Fill mode, **H** = 2d Hunt, **E** = Erase, **P** = Peak, and **T** = Trough. Hot keys are not available for zero crossings.

34. Note the shape of the cursor and the status bar. The cursor is now represented by a ‘+’ with an E, M, F, or H next to it. Change the picking mode to either F or H, and change the phase to peak. Pick the event as far as you can. Jump the fault if desired. Note that the map display is updated immediately after picking.
35. Once the horizon has been picked across the inlines do the crosslines. Place the cursor on any cross line within any inline seismic display, then right click and display the crossline at that point. A small tick mark is visible where the two lines intersect. The tick mark color will be the same as that of the horizon you are picking. You may also see a vertical red line. This red line is a line overlay and can be disabled by left clicking on View and selecting Line Overlays. A check mark indicates 'on'. If you chose the 2D Hunt mode, left click once on the tick mark and the entire horizon between fault segments is completed.

Increment through your data using the arrow keys and continue picking this horizon. Remember that the skip increment that occurs with each touch of the arrow key can be adjusted using the Line, Seismic Line Skip Increment selections. Then set the increment to the number of lines desired (5 for example). Now is also a good time to check for the consistency of your picks as you make your way through the crosslines. You should end up with picked grid of lines for the GREEN horizon (Figure 19).
That finishes today’s lab. We will come back next week and begin picking the fault polygons and complete the horizon interpretation.

Figure 19: Horizon picks are shown on the grid of inlines and crosslines. Travel times are color coded. Fault intersections (Main in Red and Antithetic in Green) are correlated through the area.

36. **Draw fault polygons around the fault gaps** by right clicking on the map and then click on *Edit Fault Polygon* and then *Enable Editing*. Then right click the map once again, click on *Edit Fault Polygon* and then select *Digitize*. The following window will appear. Just click OK and accept the new polygon set.
You may find it useful to zoom in on the faults to observe the gaps as shown in Figure 20.

Begin left clicking a series of points, which define the fault gaps. Double click on the final point. The fault polygon is drawn to outline the gap (Figure 20).

Figure 20: Fault gaps in horizon GREEN appear in a close-up view of the basemap.

It may help to zoom in and draw polygons around visible segments in a close-up view. Use the slide bars to reposition your viewing area farther along the fault. Continue digitizing the polygon. When the rubber band is returned to the adjoining point on the opposing side of the fault, double click on that point. One continuous polygon will appear. Your fault polygons will look similar to those shown in Figure 21 below.
After double clicking to tie off the end of the fault polygon, your display will look similar to that shown below.

The black area represents the fault gap.

Figure 21: Close-up view of fault polygons drawn around the fault gaps.
Assign Fault Polygon to Fault
Note: This menu option is available when a horizon or grid is displayed in an active Base Map

From the KINGDOM main window menu bar, click on Faults>Edit Fault Polygons>Enable Editing, then click on Digitize to begin creating fault polygons. After a fault polygon has been digitized, double-click to select the fault polygon and open the Assign Fault Polygon to Fault dialog box.

The Assign Fault Polygon to Fault dialog box simply associates the selected fault polygon with a fault from the current working set.

The Assign Fault Polygon to Fault dialog box contains the following elements:

Fault Name - a list of faults in the working set to which you can assign the current fault polygon.

Once your fault polygons have been associated with a horizon, you uncheck the Unassigned faults in your faults list and your newly assigned faults should be displayed.
In the Figure above Right click and select Fault Polygon Management

In the Fault Polygon Management window Under Draw Fault Polygon Fill Color, check the “Fill Color Based on Associated Fault Surface.”
In the Figure below you should see your fault polygons displayed in the color assigned to the fault intersecting that horizon.

As you go from Horizon to Horizon, create a new Fault Polygon Set such as the C38 Flt Polygons, The DtoE Flt Polygons, etc.
Double click and assign. A repetitive process.
Alternatively, use **Auto Create Fault Polygons**. This option is useful whenever the fault surface is easily picked and smooth. Go to the menu bar and select **Faults, Auto Create Fault Polygons**. You can display fault polygons in several ways: outline only, solid fill or solid fill with an outline. To change the display, right click on the map, select **Fault Management** then select the **Fault Polygons** tab. Make your selection and hit OK.

37. With this grid, the **horizon is now ready for the autopicker**.

38. Left click on **Horizons** on the Command line and select **Polygon Hunt**. Using the left mouse button, draw a polygon around one of the fault blocks. Double click to end. Autopicking begins immediately after double clicking. Continue this process using a series of polygons. Not recommended is one giant polygon. Instead, create a series of smaller polygons.

Note that you can bring up a seismic line and go to regions of the data where the **Polygon Hunt** operations are having trouble. You can manually interpret the data in these regions directly on the seismic lines. When you do this, the active seismic line will show up as a red line. If you want to bring up a line nearby you need only left click on the red line overlay and drag it to the location where you need an interpretation.
Your completed horizon interpretation will look something like the one shown below (Figure 22).

![Two-way travel time map to top of the GREEN reflector generated from interpretation and automatic computer tracking between picks.](image)

Figure 22: Two-way travel time map to top of the GREEN reflector generated from interpretation and automatic computer tracking between picks.

39. **If you don't like how 3D Hunt worked** in particular area, left click on **Horizons** and select **Polygon 3D Erase**. Draw a polygon around the area of interest similar to 3D Hunt. You will be given the option to **erase hunted picks, seed picks** or **both hunted and seed picks**. Select hunted picks only. Hit Yes and the polygonal area is wiped clean with only the seed picks remaining. Repick a tighter grid if necessary and rerun 3D Hunt.
40. Once the map is completed, display the amplitudes. Go to the Project Tree and left click on the '+' sign next to the GREEN horizon line. This opens the horizon showing you the additional surfaces available (Figure 23). Drag the amplitudes from the Project Tree to the map window.

Figure 23: View of Project Tree window, Clicking the + sign at left on an individual horizon opens a drop down list of other data available for that horizon. In this case displays of amplitude and time are listed.

Dragging the amplitudes from the Project Tree list to the base map will cause reflection event amplitude to be displayed. Horizon travel times are shown in Figure 22. Horizon amplitudes are shown below (Figure 24).
41. Generate a **time-structure contour map** by selecting **Map** and **Select Contour Overlay**. Select the horizon and data type (Time) (Figure 25). Click on OK.

Figure 24: Horizon amplitudes for GREEN Seed.

Figure 25: Contour overlay horizon selection menu. Note the Parameters button.
After you click OK, the **Contour Parameters** will automatically appear. You can also change the contour parameters by clicking on the **Set Contour Parameters** icon to see what the effect is. You can check the effect of various parameter selections by leaving the contour parameters window active and selecting **Apply**. Your result may appear similar to that shown below (Figure 26).

![Figure 26: Contour Overlay on GREEN.](image)

Figure 26: Contour Overlay on GREEN.