INTRODUCTION TO SEISMIC DATA II: THE BASICS OF SEISMIC INTERPRETATION

**Objective:** This lab is the second in a three part series intended to introduce you to seismic data and complement your understanding of geophysical concepts from lecture. The previous lab focused on *seismic surveys*, which are an important tool in geophysical exploration and prospecting.

Now that you have an understanding of how a seismic survey is oriented in space – e.g., inlines, crossline, z-axis (time/depth) – it is possible to explore the geometries of rocks and fluids in the subsurface.

The purpose of this lab is to characterize the geology within a 3D seismic volume. You will use OpendTect, an open source software package, to view and interpret large-scale structural geology features within the subsurface volume.

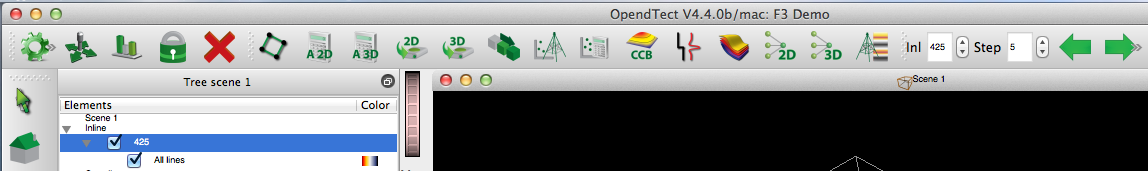
**Part I: STRUCTURAL GEOLOGY OF THE F3 SEISMIC BLOCK**

The seismic survey you will work with for this exercise is the same survey used in the first lab, the F3 Block volume from the North Sea. Recall that this is an area of interbedded sandstones and shales, which are interpreted to be the result of fluvio-deltaic processes operating over the last 25 Ma.

\_\_\_\_ On your computer, launch OpendTect. Do not select additional plug-ins when prompted. Once the application is open, choose Survey > Select/Setup from the top toolbar. Select the F3\_Demo Survey from the window and click OK. The seismic survey is now loaded for you to view in the main window.

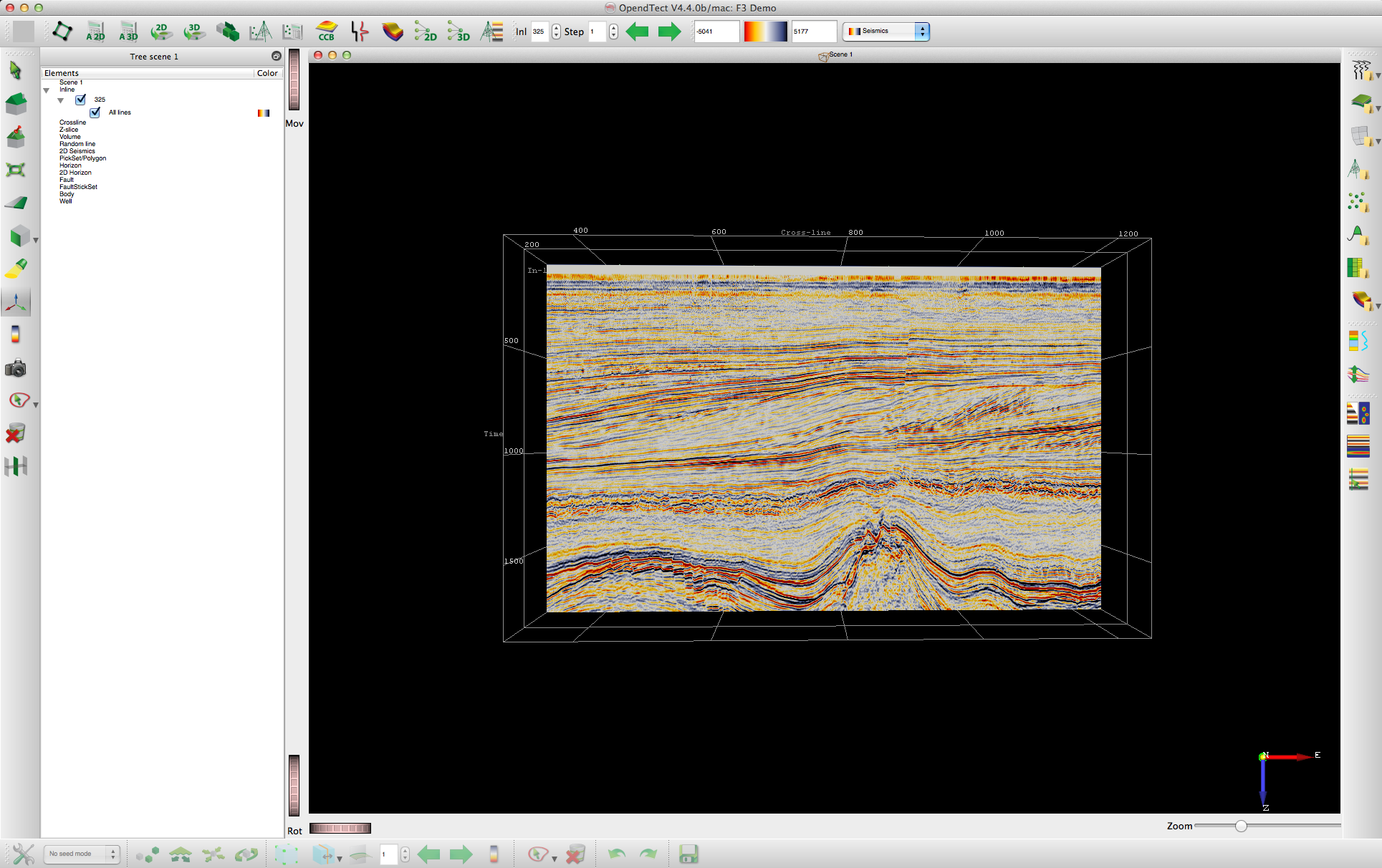
\_\_\_\_ Bring up an inline and load the attribute *All Lines.* (Refer to the previous lab if you need to review the steps to bring up inlines or load data.)

\_\_\_\_ For this lab, you will use the top toolbar to navigate precisely through inlines and crosslines. First, be sure the inline is selected (highlighted) in the Tree Scene on the left of the screen. Then, define a line number in the box shown below and click enter. To move through the data in intervals, e.g., to look at every 10th inline, use the step tool with the green arrows.



\_\_\_\_ Use these tools to navigate to Inline 325. Your screen should look like the one below.

\_\_\_\_ Use your mouse to zoom in and out, noting the two circled areas below, labeled A and B.



A

B

***Q1. What kinds of structural features are shown in the circled regions? Are these features characteristic of regional extension or compression?***

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***Q2. Trace the uppermost extent of the feature circled B in Inline 325. Does this feature appear to reach the surface of the F3 Seismic Volume? Why or why not?***

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***Q3. Trace the lowermost extent of the feature circled B in Inline 325. Where does this feature terminate? What type of structure is located at the base of the B feature?*** *(Note: Think back to what geologic features are present in this seismic volume. You may want to refer to the F3 Seismic Block information page on the OpendTect website.)*

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***Q4. What is the relative timing of features A and B compared to each other? In other words, which feature(s) are older? In the space below, write a short essay explaining your logic.***

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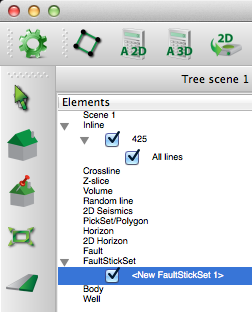
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**Part II: SEISMIC INTERPRETATION OF FAULT PLANES**

One of the advantages of working with seismic data is the ability to visualize complex geometries in a three-dimensional space. In this section, you will trace the 3D extent of fault planes within the F3 seismic volume.

\_\_\_\_ Navigate to Inline 325 and be sure that the attribute *All*

*Lines* is displayed.

\_\_\_\_ In the Tree Scene on the left, click on *FaultStickSet*

and select NEW. This will add a new series of fault sticks

named < *NewFaultStickSet 1>*.

\_\_\_\_ Fault sticks are a method for picking fault planes. In

this case, let’s begin by picking the fault plane that you

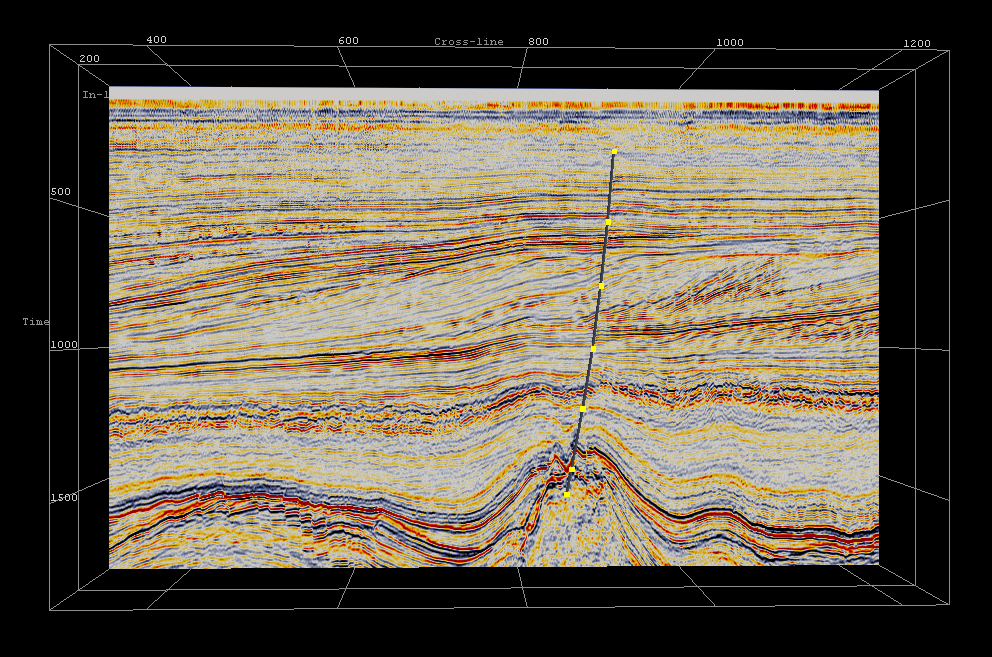
identified as the **B feature** in the previous lab section.

\_\_\_\_ With the *<NewFaultStickSet 1>* highlighted in the Tree

Scene, use your mouse to select a few points along the

B fault.

Once you have selected a few points along the fault, your screen should look like the one on the following page.



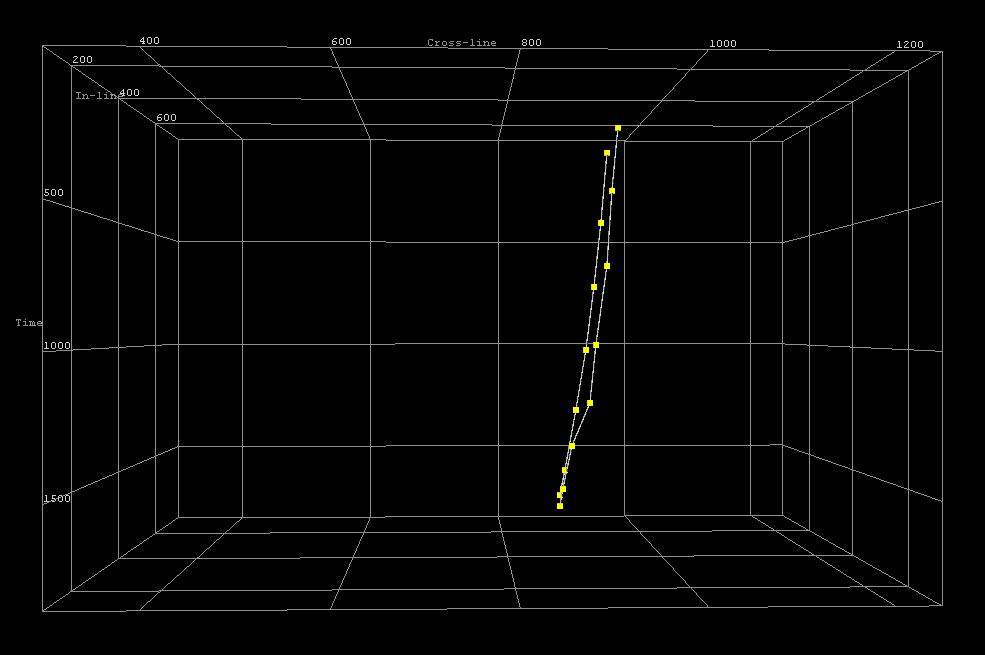
*This is the essence of seismic interpretation. You have just interpreted a fault plane from seismic data!*

\_\_\_\_ Now you will continue interpreting the fault along multiple inlines. In the Tree Scene, select *Inline > 325* and be sure it is highlighted. Then, along the top toolbar, set the *Step* value as 10, and click the *LEFT arrow*.

\_\_\_\_ are now displaying data on Inline 315. You can no longer see your fault interpretation on Inline 325 because it is behind the current displayed line. You can use the green arrows to navigate back and forth along the inlines.

\_\_\_\_ In the Tree Scene, select the <*NewFaultStickSet 1*> and be sure it is highlighted. Then, use your mouse to interpret the fault on Inline 315. These points will be added to the NewFaultStickSet 1.

\_\_\_\_ Once you have added a fault stick on Inline 315, return to the Tree Scene and uncheck the box next to Inline 315. This simply turns the Inline off. Your screen should look similar to the one below.



*Every time you add a fault stick to the <NewFaultStickSet 1>, you are creating a 3D object.*

*In this case, the object in space is a three-dimensional fault plane.*

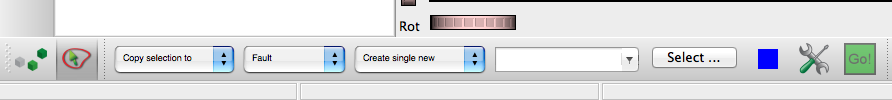
\_\_\_\_ Turn the display of Inline 315 back on in the Tree Scene. Carefully repeat steps 4 and 5 to pick fault sticks throughout the seismic volume by stepping the inline in increments of 10. Trace the fault through as many seismic lines as possible or until you can no longer identify the fault discontinuity.

***Q1. When you have completed picking fault sticks, right click on the <NewFaultStickSet1> and select Save. Please save your work as YourInitials\_FaultBStickSet.***

***What is your fault stick set saved as?*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_ Now that you have a series of fault sticks, it is possible to create a fault plane to cut the seismic volume data. Begin by turning OFF any Inline or Crossline displayed on the screen. You should be able to see all your fault sticks.

\_\_\_\_ In the Tree Scene, highlight your fault stick set. Then, on the bottom of the screen, select the Lasso Tool.



\_\_\_\_ Click and hold down your mouse button as you ‘lasso’ all of the fault sticks you picked for Fault B. The selected sticks and points should turn a different color once they have been lassoed.

\_\_\_\_ You will now use the menu along the bottom of the screen to create a new fault plane from the fault sticks you have selected. In the first dropdown menu, select *Copy Selection to*. In the second dropdown menu, select *Fault*. In the third dropdown menu, select *Create single new*. Finally, click ‘Select’ and enter a new name for your fault. When all of these items are set, click the green box labeled GO.

\_\_\_\_ Note that a blue fault plane appears, which merges fault stick points throughout the volume for Fault B.

***Q2. What is your fault saved as?*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Q3 EXTENDED ASSIGNMENT. Return to the area circles as A in the image on page 2. Using what you have learned, interpret a series of at least four fault planes (there are many).***

***Provide the names of your saved fault sticks and faults below.***

**Fault Stick Names Fault Names**

***Q4. How does the geometry of Fault B differ from Fault A?***

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***Q5. How deep might you expect the faults in area A extend beneath the seismic volume? In other words, if you had an additional block of seismic below the F3 volume, what might you expect to see?***

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*Congratulations! You have completed 3D fault interpretation.*

*The next lab in this series will focus on oil and gas exploration.*