Printing Instructions:

- one document, 5 pages, letter size, B&W
- TWO figures, total of 2 pages, letter size, B&W

Introduction:

- The lecture sets up the exercise
- text below

Solution:

- send in a request

Exercise : Tying a Well to a Seismic Line

This ‘exercise' is more of a demo in which the instructor walks through the material with the students. The students do not need to read the exercise write-up - better to watch the screen and follow the discussion.

Figure 1 shows some blocked logs for "Well A." Review the different columns:

1	First column is a two-way time scale. We can get an *approximate* two-way travel time scale by using depth:velocity pairs from the sonic log.
2	Second column is a blocked version of interval velocity as derived from the sonic log.
3	Third column is for density. Well A did not have a density log, so a default value of 2.0 was assigned. The lack of a density log will be one factor that limits the accuracy of the synthetic trace compared to the real seismic trace.
4	The fourth column is impedance, velocity times density. Since we have no density log, the impedance is simply a rescaling of the blocked density log.

5	Column 5 shows the values of the reflection coefficients (RCs) at those depths where impedance changes. Increases in impedance are ‘spikes’ to the right of zero. Decreases in impedance are ‘spikes’ to the left of zero. The length of the ‘spike’ is proportional to the magnitude of the reflection coefficient (i.e., a large RC results in a "long" spike.)
6	Column 6 shows the response of negative reflection coefficients. Note that the pulse starts at zero at the depth of the negative RCs and extends about 0.065 seconds below the RCs. We have used a minimum phase pulse.
7	Column 7 shows the wavelets for the positive reflection coefficients.
8	Column 8 is the composite or synthetic trace. All of the individual wavelets associated with each RC is summed horizontally to get the composite. This simple seismic model should produce a trace that approximates the real seismic trace closest to the well.

- Four stratigraphic tops are indicated on Figure 1.
- As you talk about some of these horizons, point to the appropriate part of Figure 1 on the screen.

- Start with the deepest horizon, the top of the Buda.
- Is the top of the Buda marked by an increase or decrease in impedance? (Increase)
- Point out the wavelet associated with this top (hint: the RC is a relatively large positive value as the lithology changes from shale to limestone.
- Point out how this wavelet is represented on the composite trace.

- We are using a minimum phase pulse, so we want to mark zero crossings.
- For a positive RC it would be a -/+ zero crossing and it will be about ¼ of a wavelength below the top picked in the well (about 0.03 sec on Figure 1
- Mark on the composite where you would map the Buda top on the seismic trace.

- Next examine the top of the Eagleford shale with the students.
- Is it a positive RC or a negative RC? (Negative)

- Point out its wavelet.
- Show the students the +/- zero crossing about ¼ of a wavelength below the top picked in the well where we would map the top of the Eagleford on the seismic trace.

- Next consider with the students the top of the Woodbine sand.
- Is it a positive RC or a negative RC? (Positive)
- Point out its wavelet.
- With the students, determine where on the composite you would map the Woodbine top on the seismic trace.

Ask the students:

- Did you notice that the second half of the Eagleford wavelet almost aligns with the first half of the Woodbine wavelet?
- When summed together these two half-cycles will interfere CONSTRUCTIVELY. We call this tuning.
- The peak associated with the top of the Woodbine has a greater magnitude than if it was isolated.
- What would happen to the peak if the Eagleford shale interval thickened to twice what it is in this well?

Once we have marked the composite on Figure 1, the next step is to scale the synthetic trace to match the time scale of the seismic line and position it on the line at the appropriate location. Then we can mark the horizons on the seismic (based on our analysis of the synthetic) and proceed with mapping.

Figure 2 shows the synthetic spliced into the seismic line. Now we can transfer the markings of tops from Figure 1 to the synthetic trace on Figure 2. Use different colors for the three horizons. We can also mark the top of the Austin Chalk on the seismic.

At the well, the Eagleford is marked in the top part of a trough and the Woodbine is marked in the lower part of the same trough. KEEP YOUR PENCIL POINTS SHARP!

- What happens to the Eagleford and the Woodbine horizons as they are mapped to the south (right)?

This is a KEY exercise – possibly the most important for young seismic interpreters to grasp. Understanding how different 'acoustic' units are

represented on the seismic data and how their expression changes laterally as units thicken/thin or change properties is essential for properly mapping stratigraphy on seismic data.

Exercise 7: Tying a Well to a Seismic Line

Objective	In this 'interactive' exercise, we will look at a blocked sonic log from a well. Several formation tops are given. As a group we will go through the process of relating these formation tops to a synthetic (modeled) seismic trace.

Materials	• A detailed synthetic display for the Papermills #1 well • A seismic line with the synthetic trace spliced in

Part 1: Understanding the Synthetic Trace

Introduction	Figure 1 is a detailed synthetic plot for the Southland Paper Mills #1 well. We use this type of display to understand a synthetic (modeled) seismic trace and associate stratigraphic tops picked in the well to the seismic data.

Step	Action
1	Note the first column in Figure 1; it is a two-way time scale. The time scale is computed from the sonic log which has depth in the well and interval velocity. Given depth:velocity pairs, it is easy to get an approximate two-way travel time scale. Note the last column in Figure 1 is a depth scale in feet. Figure 1 is linear in time, but not linear in depth. Why?
2	Note the next two columns in Figure 1. The second column is a blocked version of interval velocity, derived from the sonic log. The third column is for density. Since a density log was not run in this well, a constant value of 2.0 was assigned. The lack of a density log will be one factor that limits the accuracy of the synthetic trace compared to the real seismic trace.

3	The fourth column is impedance, velocity times density. Since density does not vary with depth, the impedance log is simply a rescaled velocity log.
4	Column 5 shows the values of the reflection coefficients (RCs) at depths where impedance changes. Increases in impedance are 'spikes' to the right of zero. Decreases in impedance are 'spikes' to the left of zero. The length of the 'spike' is proportional to the magnitude of the reflection coefficient.
5	Look at the next two columns. Column 6 shows the response of negative reflection coefficients. Note that the pulse starts at zero at the depth of the negative RCs and extends about 0.065 seconds below the RCs. Is this a zero phase or minimum phase pulse? What is the frequency of this pulse? Column 7 shows the wavelets for the positive reflection coefficients.
6	Column 8 is the composite, synthetic trace. All of the individual wavelets associated with each RC is summed to get the composite. Given all the assumptions and limitations of this simple seismic model, this trace should approximate the seismic trace closest to the well.

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Part 2: Tying the Stratigraphic Tops

Step	Action
7	Four stratigraphic tops are indicated on Figure 1. Let's start with the deepest horizon, the top of the Buda. Is the top of the Buda marked by an increase or decrease in impedance? Find the wavelet associated with this top (hint: the RC is relatively large as the lithology changes from shale to limestone. Then find how this wavelet is represented on the composite trace. The pulse is minimum phase, and so we mark zero crossings. For a positive RC it would be a -/+ zero crossing and it will be ¼ wavelength below the top in the well (about 0.03 sec on Figure 1. Mark on the composite where you would map the Buda top on the seismic trace.
8	Next we will examine the top of the Eagleford shale. Is it a + RC or a – RC? Find its wavelet. Mark on the composite where you would map the Eagleford top on the seismic trace.
9	Finally consider the top of the Woodbine sand. Is it a + RC or a – RC? Find its wavelet. Mark on the composite where you would map the Woodbine top on the seismic trace. Did you notice that the second half of the Eagleford wavelet almost aligns with the first half of the Woodbine wavelet? When summed together these two half-cycles will interfere CONSTRUCTIVELY. We call this tuning. The peak associated with the top of the Woodbine has a greater magnitude than if it was isolated. What would happen to the peak if the Eagleford shale interval thickened to twice what it is in this well?

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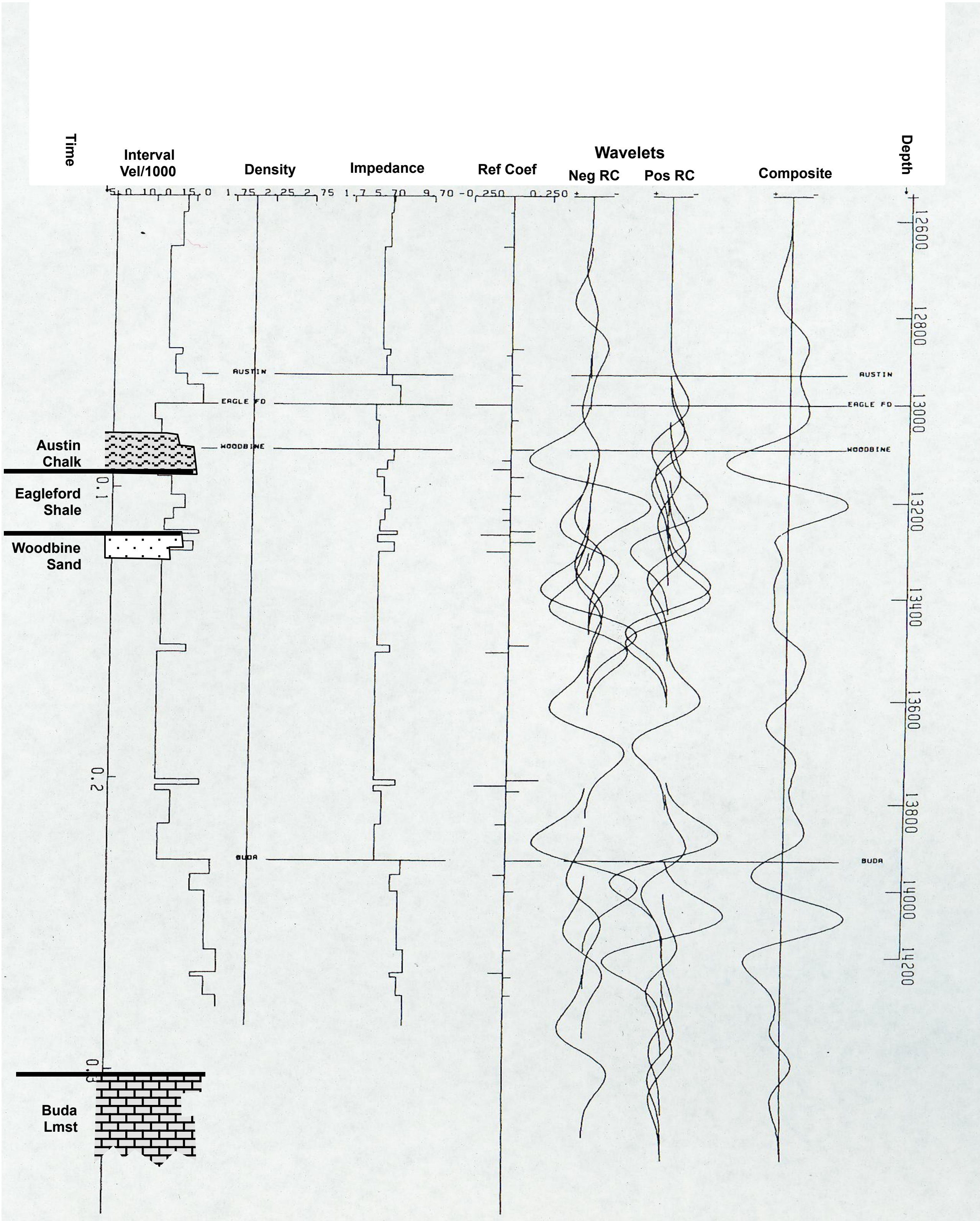
Exercise 7: Tying a Well to a Seismic Line, Continued

Part 3: Marking the Seismic Line

Introduction to Part 3	Once we have marked the composite on Figure 1, the next step is to scale the synthetic trace to match the time scale of the seismic line and position it on the line at the appropriate location. Then we can mark the horizons on the seismic and proceed with mapping.

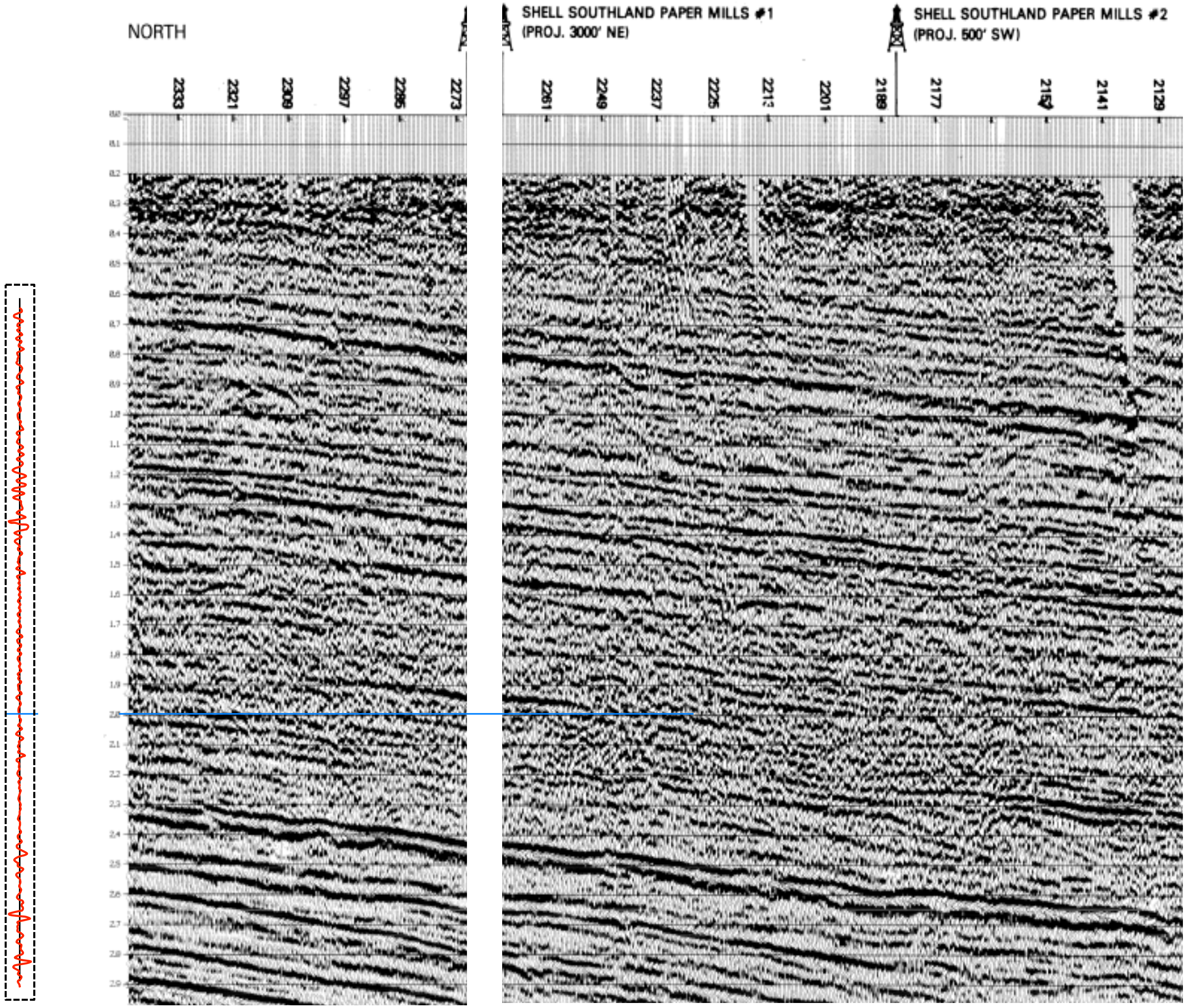
Step	Action
10	Figure 2 shows the synthetic at the same scale as the seismic line. There is a gap in the seismic line where the well is located. Use scissors to cut out the synthetic trace (cut just inside the dotted lines. Then put the synthetic in the gap on the seismic line. The blue lines are at 2.0 seconds two-way time. Do the peaks and troughs line up between the real and modeled seismic? Try moving the synthetic up a little. Can you get a reasonable alignment of peaks and troughs near the bottom of the well (synthetic trace)? Now we can transfer the markings of tops from Figure 1 to the synthetic trace on Figure 2. Use different colors for the three horizons. We can also mark the top of the Austin Chalk on the seismic. At the well, the Eagleford is marked in the top part of a trough and the Woodbine is marked in the lower part of the same trough. Hope you have sharp pencil points! What happens to these two horizons as they are mapped to the south (right)?

NOTE	This is a KEY exercise – possibly the most important for young seismic interpreters to grasp. Understanding how different 'acoustic' units are represented on the seismic data and how their expression changes laterally as units thicken/thin or change properties is essential for properly mapping stratigraphy on seismic data.



Time
Interval Vel/1000
Density
Impedance
Ref Coef
Wavelets
Neg RC
Pos RC
Composite
Depth
Austin Chalk
Eagleford Shale
Woodbine Sand
Buda Lmst
AUSTIN
EAGLE FD
WOODBINE
BUDA
12600
12800
13000
13200
13400
13600
13800
14000
14200

Figure 1


NORTH
SHELL SOUTHLAND PAPER MILLS #1
(PROJ. 3000' NE)
SHELL SOUTHLAND PAPER MILLS #2
(PROJ. 500' SW)
2333
2321
2309
2297
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2273
2261
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2201
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