AVO Offset Scaling in HRS-9

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The Purpose of AVO Offset Scaling

- Correct the systematic offset-dependent amplitude distortion in the gathers.

- Data conditioning
The General Concept of AVO Offset Scaling

• Determine the standard AVO response for the non-hydrocarbon-bearing, wet rock to derive a background set of parameters for scaling.

• Try to avoid including potential reservoirs, areas of strong structure (e.g. faulting), complex lithology or salt features.

• Understand how the rocks normally react to offset when they are brine-filled.
Two steps in AVO Offset Scaling

1. AVO Offset Scaling Analysis

To define the offset scaling value of the test windows.

2. AVO Offset Scaling Apply

To apply that scaling value to the zone of interest. The program will develop scaling parameters to rescale the actual data to match the test window.
The flow chart of AVO Offset Scaling in HRS

1. Theoretical Pre-stack Synthetic Gather
   - Trend Analysis for Offset Response
     - Offset Response Equation
       - Analysis
         - Fit? (Yes/No)
         - Change Parameters
   - Fit?

2. Actual Pre-stack Gather Data for Non-pay Lithology
   - Statistical Averaging
     - Average Pre-stack Gather from Actual Data
     - Offset Response Equation
       - Determine the scaling correction to make Actual match Theoretical
         - Scaling Parameters
           - Rescaling
             - Rescaled Test Volume
               - Fit? (Yes/No)

3. Actual Pre-stack Gather Data for the window of interest
   - Scaling Parameters
     - Rescaled Seismic Volume
Main Procedures

I. Using **AVO Offset Scaling Analysis**, calculate the mean global Intercept and Gradient for all gathers in a non-pay zone. Avoid anomalies such as steep dips and salt zones. Pick this zone close and stratigraphically equivalent to the zone you want to scale.

II. Using **AVO Offset Scaling Analysis**, calculate the mean Intercept and Gradient for the synthetic gathers that represent non-pay rock.

III. Run **AVO Offset Scaling Apply**, using the input from the gathers and using synthetic gather parameters as the output parameters. This calculates offset-dependent scalars to match the mean trend of the real gathers to the mean trend of the synthetic gathers. The scalars would not vary from gather-to-gather, and are only offset-dependent.

IV. If the ranges of offsets in the synthetic and real gathers do not match, select to automatically adjust the parameters for the maximum offset in the real gathers. Do this because the parameters for both analysis and application are set with respect to an X axis that has been normalized to the maximum offset (or angle) in the seismic volume.
Two ways to do AVO Offset Scaling Analysis

A. Two Volumes Trend Matching Analysis

Compare two volumes (an original seismic volume and a reference model volume, usually synthetic) to select a scaling that will adjust the trend from the seismic data to match the other volume.

- Compute the amplitude versus offset trend from the synthetic data over a certain zone to get a modeled background trend.
- Compute the amplitude versus offset trend from the real data over that zone to get an observed trend.
- For each trace, find the coefficient that converts the observed trend to the synthetic modeled trend.

B. Single Volume Trace-by-Trace Analysis

Define a scaling value for a single volume to correct for processing artifacts, particular on the far offsets.

- Compute the amplitude versus offset trend from the volume over a zone that represents a background trend.
- For each trace, find the coefficient that scales the data to line up the RMS amplitudes with the background trend.

Check the scaling by applying the scaling coefficients to a single section or arbitrary line before applying it to the full data set.
The Synthetic Volume

1. Create a pure brine synthetic volume.
Two Volumes Trend Matching Analysis

1. Select Process > AVO Analysis > AVO Offset Scaling Analysis to bring up the AVO Offset Scaling Analysis dialog.
2. Set up the parameters for the analysis.

You can set up Zones and Azimuth.

We set this to avoid the Potential Reservoir Zone.
3. Set up the **Model Parameters**.
The Offset Scaling Curves

4. Click **OK** on the **Scaling Analysis** dialog to show the **Offset Scaling Curves**.
5. Select the QC tab to show the Before and After offset scaling results.
6. Click the **AVO Analysis Apply** button to apply the scaling to the selected gathers.
The Seismic Sections

The seismic sections of the original gathers and scaled gathers.
Single Volume Trace-by-Trace Matching Analysis

7. Select Single Volume Trace-by-Trace Analysis to do AVO Offset Scaling Analysis.
The Volume Parameters

8. Set up the parameters for the volume.

You can choose the Order of fit. In this case, we use the First Order of fit.
The Scaling Analysis Dialog and the Volume Trend Curves

9. Click **OK** on the **Scaling Analysis** dialog to show the **Volume Trend Curves**.
10. Select the **Application QC** tab for the result before and after First Order of Fit offset scaling.

In this case, we used the first Order of Fit. You can try High Orders of Fit.
11. Click the **AVO Analysis Apply** button to apply scaling on the gathers.
The Resulting Seismic Sections

The seismic sections of the original gathers and the scaled gathers
The Offset Scaling Curves using the Second Order of Fit.
The Offset Scaling Curves

The **Offset Scaling Curves** using the **Third Order of Fit**.
How trend matching and trace-by-trace scaling works:

We scale the volume so its trend (the straight green line above) better matches the trend (the straight red line above) of a reference volume (usually a synthetic volume).

We correct for processing artifacts, especially for far offsets, by scaling each trace so the RMS amplitudes match the background trend.