

Sequence Attribute Analysis

Sequence Attribute Analysis, SAA, computes windowed trace attributes using horizons as the window boundaries. Often trace and horizon data are imported from interpretation systems.

Theory

SAA computes a series of seismic data attributes within time windows that are controlled by the interpreted horizons or simple constant time gates. These seismic attributes are then written back to the original interpretation software package and treated as any other time horizon file. They can be displayed as time horizons on seismic sections, mistie corrected, gridded, contoured and mapped. When seen in map view, subtle statistical patterns previously undetected often become obvious.

The ProMAX® processing system interfaces with the SeisWorks® 2D and 3D seismic interpretation packages.

The following is a list of the seismic attribute computations:

Amplitude statistics

- RMS amplitude
- average absolute amplitude
- largest peak amplitude
- average peak amplitude
- largest trough amplitude
- average trough amplitude
- tuning amplitude
- maximum absolute amplitude
- total absolute amplitude
- total amplitude
- average energy
- total energy

Complex trace statistics

- average reflection strength
- average instantaneous frequency
- average instantaneous phase
- slope of the reflection strength
- slope of the instantaneous frequency

Spectral statistics

- peak spectral frequency
- spectral slope from peak to maximum frequency
- maximum frequency for spectral estimates

Frequency Statistics

- frequency between zero-crossings
- effective bandwidth
- arc length

Correlation Statistics

- covariance coefficient to next CDP
- correlation window time shift to next CDP
- true event dip (ms/ft or ms/m)
- event dip within horizons (ms/ft or ms/m)
- distance interval between traces
- maximum trace-to-trace time shift
- average signal-to-noise ratio
- correlation length
- correlation components
- principle component option
- K-L signal complexity
- number of traces in analysis window

Sequence Statistics

- energy half-time
- slope at Energy Half-time
- ratio of positive to negative samples
- percent greater than threshold
- percent less than threshold
- threshold
- number of peaks
- number of troughs
- reflection heterogeneity

The following is a discussion about several of these attributes:

RMS or Average Absolute Amplitude

RMS amplitude provides a scaled estimate of the trace envelope. Like energy half-time and arc length, it is computed in a specified time window. RMS is calculated with the following equation:

$$x_{RMS} \equiv \sqrt{\frac{1}{N} \sum_{i=1}^N x_i^2}$$

Amplitude maps using the peak or trough amplitude of a single reflector have been in use for several years. Sequence Attribute Analysis takes this technology one step further by computing an amplitude value representative of an entire seismic data interval. In certain Tertiary basins, deltaic sequences grade from high RMS amplitudes in their sand-rich, shoreward facies to lower amplitudes in their shale-rich pro-delta or abyssal plain facies. These changes in sand-shale ratio are readily detected in map view.

Also, intervals containing gas saturated sands often exhibit anomalously large RMS amplitudes.

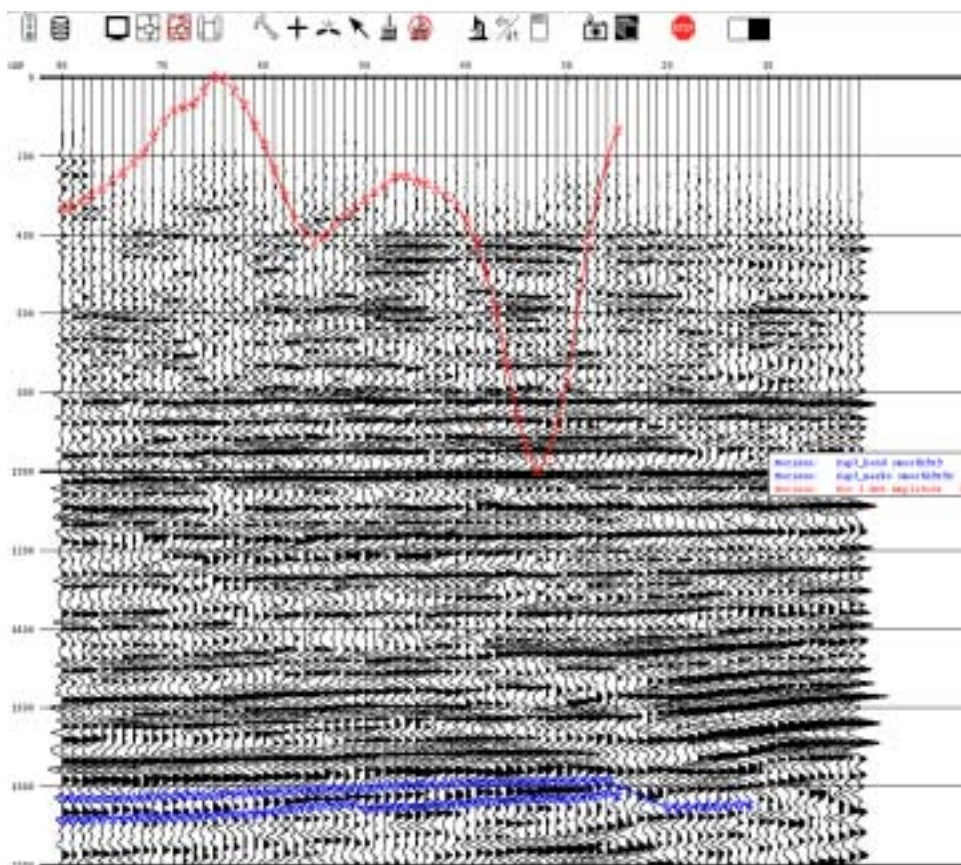


Figure 1: Seismic line with RMS Amplitude. Displayed in the ProMAX® processing system. Top and Base of producing sandstone interval are interpreted horizons imported from the SeisWorks® 3D interpretation software. This producing gas zone coincides with a dramatic increase in RMS Amplitude pointing downward over center of gas field.

In Figure 1, RMS amplitudes (in red) are computed for the interval containing a gas-prone sandstone between the horizons. Larger time values correspond to larger RMS amplitudes, with a positive amplitude anomaly pointing downward. RMS amplitudes are relatively low to the left of the gas field, rise dramatically over the center of the field, and then decrease to the right.

Average Instantaneous Frequency

For each seismic trace that is read in, an instantaneous frequency trace is computed and a mean for all instantaneous frequency values within the seismic sequence is output. In some situations, gas saturated sands attenuate

higher seismic frequencies causing anomalously low average instantaneous frequencies coincident with anomalously high RMS amplitudes or bright spots.

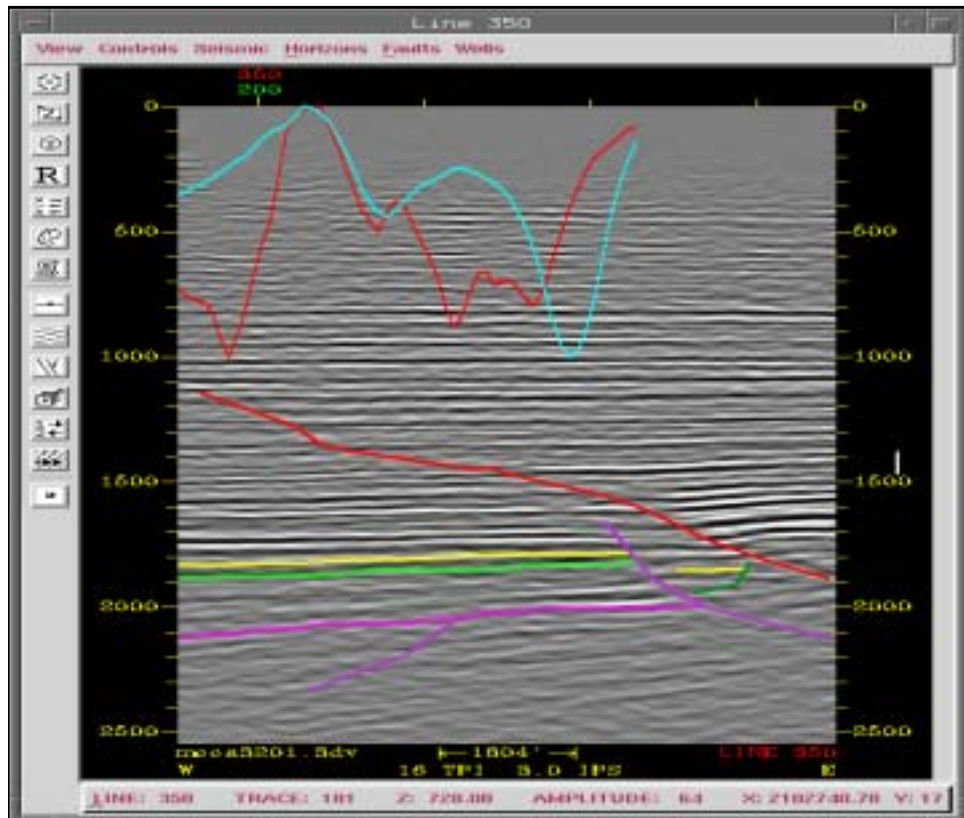


Figure 2: Seismic Line with RMS Amplitude and Average Instantaneous Frequency Attributes. Displayed within Seisworks 3D Package.

In Figure 2, Average Instantaneous Frequencies computed for the same sandstone interval are relatively high to the left of the field, and decrease across the field until reaching a low at the fault intersection. In map view, attribute anomalies become even more meaningful.

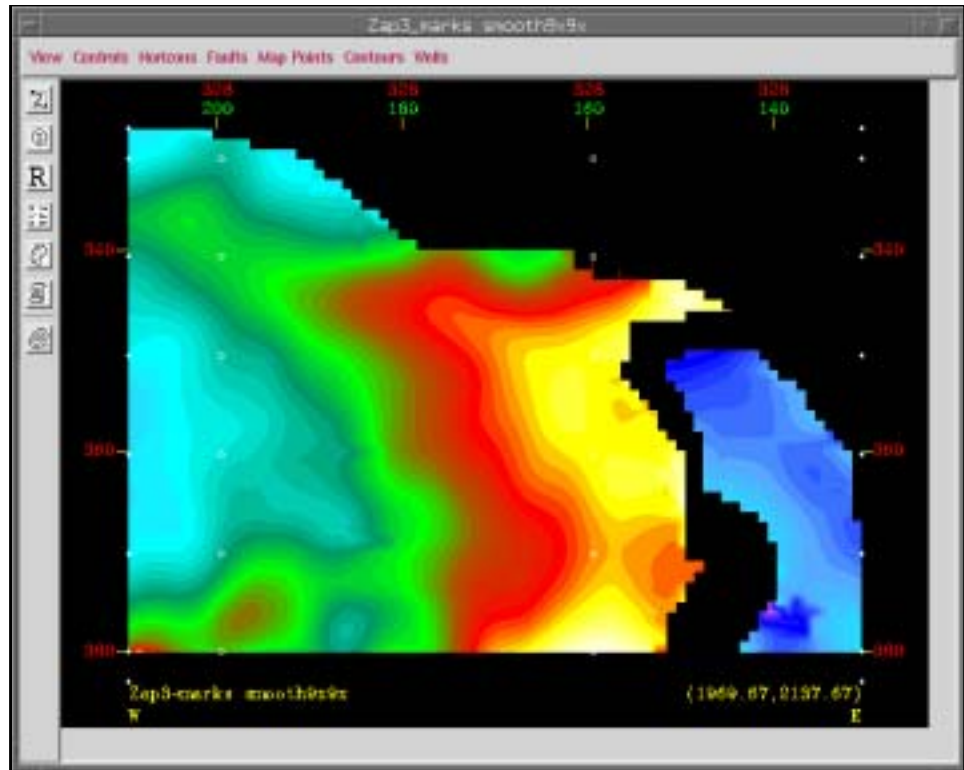


Figure 3: Time Structure Map, Top of Productive Sandstone Interval. Gridded and Contoured within SeisWorks® 3D Package.

Figure 3 contains a time structure map contoured on the top of the productive sandstone interval. The structure consists of an upward dipping sand interval intersected by a fault.

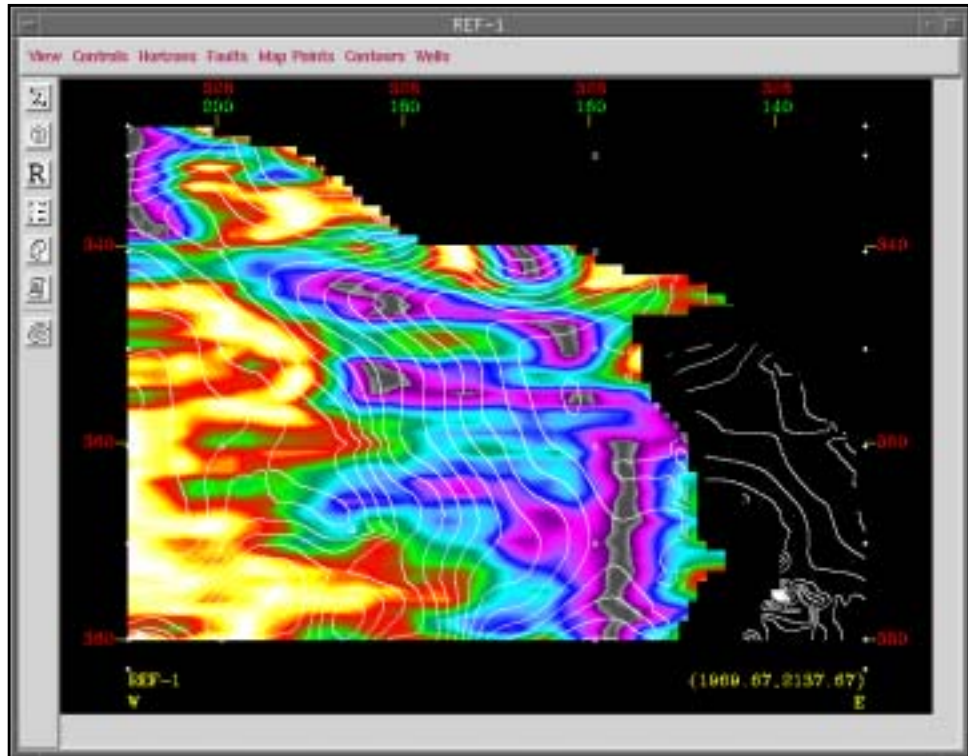


Figure 4: RMS Amplitude Attribute (in color) with Time Structure, Top of Productive Sandstone Interval (white contours). Gridded and Contoured within SeisWorks® 3D Package

Figure 4 is an RMS Amplitude attribute map of the same area with time structure contours overlain in white. The correspondence between anomalously high amplitudes shown in blue and purple and the structurally high portions of the sand interval.

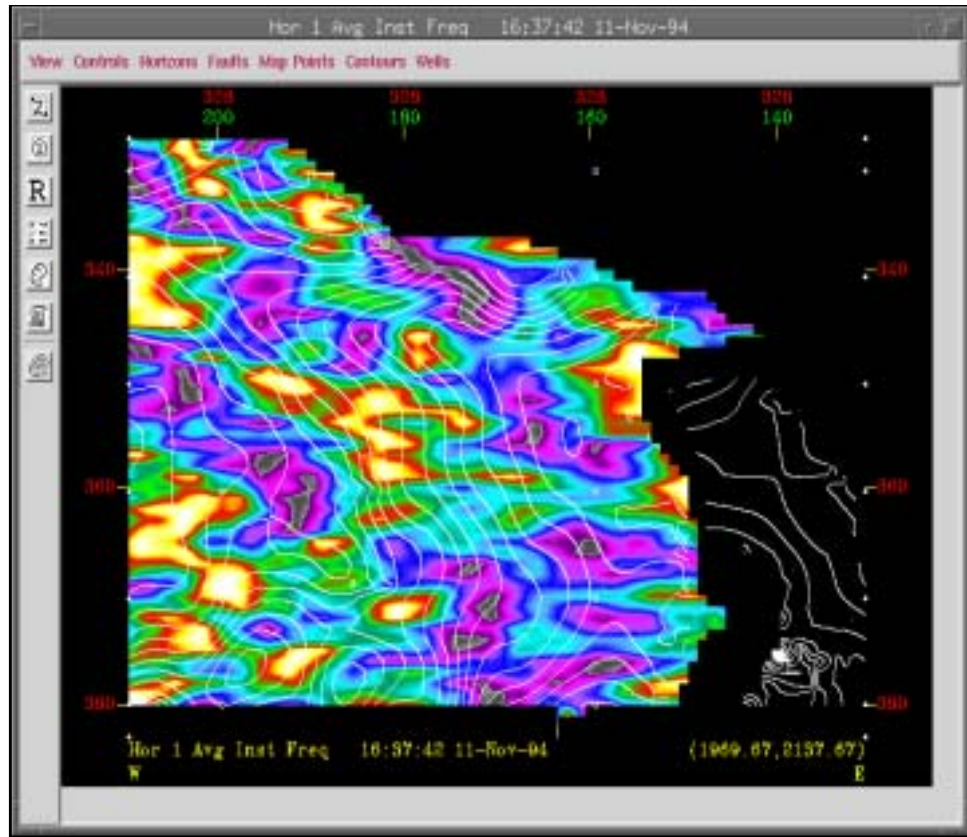


Figure 5: Average Instantaneous Frequency Attribute (in color) with Time Structure, Top of Productive Sandstone Interval (white contours). Gridded and Contoured within SeisWorks® 3D Package.

In Figure 5, the Average Instantaneous Frequency attribute is overlain with the time structure contours. There is a correspondence between structural highs and anomalously low average instantaneous frequencies shown in purple.

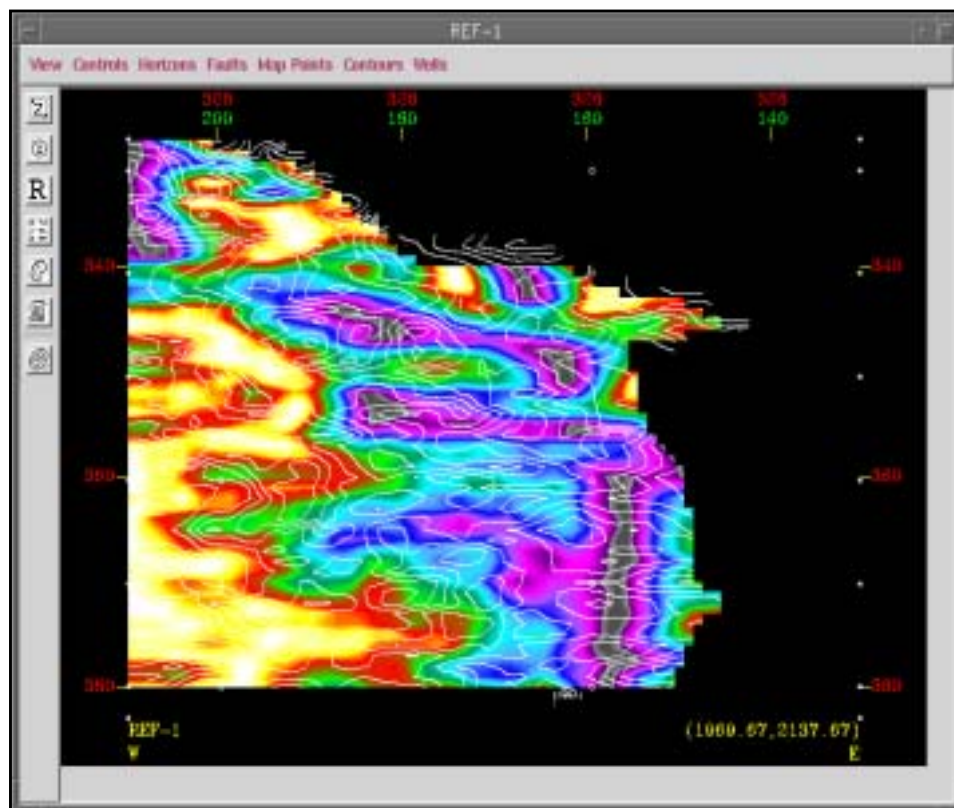


Figure 6: Average Instantaneous Frequency Attribute white contours with RMS Amplitude Attribute in color. Gridded and Contoured within SeisWorks® 3D package.

In Figure 6, the Average Instantaneous Frequency attribute, in color is overlain with the RMS amplitude, in white. Note the correlation between Average Instantaneous Frequency lows and RMS amplitude highs. The coincidence of these two anomaly types may indicate gas accumulations with more confidence than either anomaly taken by itself.

Energy Half-Time

Energy half-time is a relative measure of where the seismic energy is concentrated within a time window. It is the average time of the trace power relative to the center of the window expressed as a percentage of half the window length. In any given window, the average time t_a of the trace power is

$$t_a = \frac{\sum_{n=1}^N t_n x_n^2}{\sum_{n=1}^N x_n^2}$$

where x are the windowed trace samples. Letting t_c represent the time at the window center and t_l represent the total window length, energy half-time E_{ht} becomes

$$E_{ht} = 200\% \cdot \frac{t_a - t_c}{t_l},$$

Energy half-time ranges from -100% to +100%. It is independent of overall amplitude levels, but is strongly influenced by the window length, which should be relatively short to include only one dominant energy zone. At any given time, energy half-time quantifies the degree to which the energy in the analysis window is front-loaded (less than 0), rear-loaded (more than 0), or center-loaded (about 0). In practice, energy half-time resembles instantaneous amplitude change, and highlights changes in overall amplitude levels.

Changes in energy half-time spatially should be related to possible facies changes.

Covariance Coefficient to Next CDP

As an estimate of signal-to-noise ratio, this attribute map can be output to clear film and overlain on other maps as a means of indicating the relative seismic quality in a given area. Also, as with RMS amplitude, signal-to-noise ratios may decrease dramatically as one proceeds from the highly reflective, sand-rich facies of a delta to the less reflective, sand-poor facies of the pro-delta or abyssal plain.

Event dip within horizon

The dominant trace-to-trace dip within a seismic sequence is subtracted from the dip of the horizons bounding the sequence. This removes any event dip due to post-depositional tilting of the strata. This attribute might be very useful for mapping of prograding deltaic sequences. Parallel, non-divergent reflectors within the delta sequence would

exhibit zero dip, while the clinoforms of the delta slope facies may yield a mottled pattern of high and low dips in map view. Finally, on the abyssal plain, dips should return to a more uniform zero value. In map view, various delta lobes may appear as bands of low dip ringed at their slope margins by higher dips, which in turn grade seaward into more uniform zero dips corresponding to the abyssal plain facies. Note that to the extent possible, this attribute should be computed on dip lines only. Using a grid of orthogonal dip and strike lines would yield conflicting dip information at line ties, and would not give a usable map pattern.

Frequency Series

For each input trace, an estimate is made of the three most dominant frequency components of the power spectrum for a specified analysis window. These three frequency attributes, designated F1, F2, and F3, are output to separate horizon files and are arranged on output so that F1 is the lowest frequency, F2 is the intermediate frequency, and F3 is the highest frequency.

To derive these attributes, SAA does a spectral analysis of each trace using the maximum entropy method (Burg 1967). A sixth-order polynomial is used to model the power spectrum and identify its three peaks (or poles). The average of this approach is that it gives reliable estimates with limited data input; however, 40 ms of data is considered necessary for stable output information and, as a precaution, SAA will output nulls when the analysis window falls below 40 ms.

This suite of three attributes helps you assess the dominant frequency characteristics within a data window. Lateral changes in any or all of the dominant frequency series may be diagnostic of frequency absorption effects caused by gas saturation or fracturing. For example, where gas saturated sands attenuate higher frequencies, you should see a lowering of one or all of the dominant frequency values.

Although calculated in a manner similar to peak spectral frequency, the dominant frequency series is more informative because it reveals the three most important points in the amplitude spectrum. The dominant frequency series may reveal subtle frequency trends associated with changing stratigraphy or lithology as well as other conditions such as tuning.

Usage

Seismic sequences can be specified as:

- a sequence interval bounded by two horizons.
- a time window centered about a single horizon.
- a specified time window above and below a single horizon.
- a constant-time window.

A typical work flow required to create seismic sequence attribute maps would consist of:

Flow #1

SeisWorks® Horizon Input: Reads an interpreted horizon file.

Flow #2

SeisWorks® Seismic Input: Input traces from all lines on which attributes are to be computed. Decimates traces on input to decrease run-times.

Sequence Attribute Analysis: Compute seismic sequence attributes.

Flow #3

SeisWorks® Horizon Output: Write time horizon file into the SeisWorks® interpretation package.

SeisWorks® Horizon Input and **Output** processes import and export interpreted horizon information. Enter the name of the SeisWorks® project to list all interpreted horizons within that project. Any horizon imports as a time horizon file. As a further option, you can specify that horizons only be imported from particular lines within a SeisWorks® project.

To ensure that a time pick is available for every trace within the SeisWorks® database, it is usually desirable to perform a global snap of all horizons within the SeisWorks® interpretation software.

Decimation is also allowed when using SeisWorks® Horizon Input to import horizons. Once in the ProMAX® processing system, picks can always be snapped in order to get picks output for every trace.

Note: Decimating the horizon table has virtually no effect on **SAA** run times, and is therefore not recommended. The most effective way to reduce **SAA** run times is to decimate the

number of traces being imported via **SeisWorks® Horizon Input**. Run-time decreases approximately linearly with decreases in the number of incoming seismic traces. For example, bringing in every other trace with the Input process causes **SAA** to execute in half the time.

Once the attributes have been computed, they can be smoothed using mean or median smoothers. Values can also be normalized such that their minimum and maximum values occur between specified points. Typically, you might normalize attribute data so all values appear at the top of the seismic section between 0 and 1000 ms. Alternatively, values can be displayed near the bottom of the section by specifying 4000 to 5000 ms. Values can also be multiplied by a scalar. This is useful when it is known that all computed values will fall between 0.0 and 1.0. For example, multiplying by 1000 causes all values to fall between 0 and 1000 ms.

Once computed, attributes can be passed back to the SeisWorks® interpretive database using **SeisWorks® Horizon Output**. These attribute files are loaded into the SeisWorks® interpretation software, where they are manipulated in the same manner as interpreted time horizon files.

You can input up to ten horizon files and compute up to twenty-one attributes for each horizon. This creates the potential of up to 210 output horizon files from a single **SAA** execution.

Prior to mistie resolution, attribute computations from various line vintages may not tie, making maps of such attributes difficult to interpret. Tying attributes between lines is performed by the interpretation package and is a critical step in enhancing the interpretability of Sequence Attribute Analysis maps. Seisworks, for example, provides an interactive grid balancing feature for correcting amplitude/time/phase mistie.

Mistie resolution, gridding, and contouring of the seismic attributes is performed within the interpretation software package. At this point, as many as several gigabits of trace data have been reduced to a single map view. the SeisWorks® 2D interpretation software currently provides a **grid-balancing** option for automatic, interactive, amplitude phase/time mistie resolution.

Note: The UNIX operating system has problem handling underscores, commas and periods within horizon or line names, and will often ignore them. Try to avoid including these special characters in your naming conventions.

References

Bahorich, M. S., and Bridges, S. R., 1992, The Seismic Sequence Attribute Map (SSAM): SEG Extended Abstract, to be presented at SEG Convention, October, 1992, New Orleans, Louisiana.

Parameters

Desired smoothing for final values

Select a smoothing option for final values. Computed attribute values are smoothed prior to being written to a time horizon file.

- **No smoothing** does not smooth the final computed values.
- **Average** uses a simple mean smoother on the computed values. This is an N-point running average smoother centered on the sample trace prior to writing to a time horizon file.
- **Median** uses a median smoother on the computed values. The median value of N traces centered on the sample trace are output to a time horizon file.
- **3-Point Median + Average** uses a 3 point median despiker followed by a mean smoother on the computed values. The three-point median filter tends to remove any single-trace spikes prior to the averaging step.

Number of traces for smoothing final values

This appears if **Average**, **Median**, or **3-Point Median + Average** to **Desired smoothing for final values**. Enter an odd number of traces to center on either side of the sample traces. For the 3-point median + average filter, this value determines the number of traces used in the mean smoother that follows the 3-point median filter.

Decimate output values

Select **Yes** to decimate output values. Select **No** to write all computed output values to a horizon file. Decimating output values will display the computed attributes more rapidly during interpretation and reduces storage requirements for each attribute.

Output every Nth value, N=

This appears if **Yes** to **Decimate output values**. Enter the trace increment for outputting values to the horizon file.

Caution: This option is generally not recommended. It is preferable to decimate seismic traces via **SeisWorks® Seismic Input** instead and then decimate horizons in order to match those traces.

Final scaling option

Select the final scaling option. Scaling options are:

- **Normalize** normalizes the output values to minimum and maximum scale and bias. It is often convenient to normalize values so as to place all computed values very shallow (0-1000 ms) or very deep (5000-6000 ms) in the section.
- **Norm Line** normalizes each line or primary group to a minimum and maximum value. It is often convenient to normalize values so as to place all computed values very shallow (0-1000 ms) or very deep (5000-6000 ms) in the section.
- **Scale** scales attribute values by a constant. This option is useful where all values of the attribute are known to fall between 0.0 and 1.0, such as, covariance coefficients.
- **None** does scale or normalize.

Minimum value after normalization

This appears if **Norm Line** or **Normalize** to **Final scaling option**. If **Norm Line** is selected, the minimum computed value for a given attribute on a given line is set equal to this number. If **Normalize** is selected, the minimum computed value for a given attribute is set equal to this number.

Maximum value after normalization

This appears if **Norm Line** or **Normalize** to **Final scaling option**. If **Norm Line** is selected, the maximum computed value for a given attribute on a given line is set equal to this number. If **Normalize** is selected, the maximum computed value for a given attribute is set equal to this number.

Scalar to apply

This appears if **Scale** to **Final scaling options**. Enter a constant to multiply all attribute values.

Form of attribute output

Select how to output attributes from:

- **Horizon** outputs attributes to horizon tables.
- **Database** outputs attributes to CDP database parameters.

Stamp output with time and date?

Select **Yes** to output unique attribute horizons or parameters stamped by time/date. Select **No** to overwrite previous runs.

Basis for time window analysis

Select the means by which this time window is controlled. The choices are:

- **Centered Window** centers the time window about the specified horizon.
- **Sequence Interval** sets the window as the time interval existing between one horizon and the next specified horizon. If you do not want a window below the last horizon, enter **0** for Analysis window length below the last horizon.
- **Time above and below** allows the window to be a defined time above and below the horizon.
- **Constant time** does not vary the window laterally. This option is useful for data that has been previously flattened on a horizon or has very low dip rates.

Analysis window length below last horizon

This appears if **Sequence Interval** to **Basis for time window analysis**. Enter the value in ms below the last defined horizon for attribute calculations. This parameter is needed where a deep horizon has been selected and there are no horizons beneath it.

Horizon time

This appears if **Constant Time** to **Basis for time window analysis**. Enter the center time in ms of an analysis window.

Horizon analysis window width(s)

This appears if **Centered Window** or **Constant Time** to **Basis for time window analysis**. If **Centered Window** is selected, enter the window width(s) in ms for each horizon. Up to ten widths can be specified. The number of window width values and selected horizons must match.

If **Constant Time** is selected, enter a single width value in ms. The analysis window is centered on the **Horizon time** and extends *width/2 ms* above and below.

If a window is less than or equal to 40 ms in width, none of the spectral attributes will be computed. Null values will be output to the table or database.

Horizon analysis window width(s) above/below

This appears if **Time Above and Below** to **Basis for time window analysis**. Access the text editor and define the window above/below pairs for each horizon. Up to ten pairs of values can be specified. The number of horizon pairs entered must match the **Number of horizons to be specified**.

Note: If you specify a time window that is entirely above a horizon, use a positive value for time above and a negative value for time below. If you specify a window that is entirely below a horizon, use a negative value for time above and a positive value for time below. This option is especially useful for analyzing many thin sequences that parallel a given horizon.

Calculate values for every trace?

This appears if **Sequence Interval, Centered Window, and Time Above and Below Window types** to **Basis for time window analysis**. Select **Yes** to calculate attributes for every input trace. This option removes the need to snap the horizon table to every trace. Select **No** to calculate attributes only for traces with picks in the horizon files.

Number of horizons to be specified

This appears if **Sequence Interval, Centered Window, and Time Above and Below Window types** to **Basis for time window analysis**. Enter the number of input horizons about which windows are constructed and analyzed. Maximum number of input horizons is 10.

Note: The same horizon can be specified multiple times.

Select FIRST horizon file

This appears if **Sequence Interval, Centered Window, and Time Above and Below Window types** to **Basis for time window analysis**. Select a horizon file in the Parameter Tables window.

Additional parameters will appear if more than 1 is entered for Number of horizons to be specified. Select a horizon file in the Parameter Tables window for each horizon.

Analyze basic amplitude statistics?

Select **Yes** to compute trace amplitude statistics.

RMS amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**. Select **Yes** to compute the RMS amplitude within the time window for each incoming trace.

Average absolute value of amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**. Select **Yes** to compute the average absolute amplitude within the time window for each incoming trace.

Largest peak amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the largest peak amplitude value found within the time window for each incoming trace.

Average peak amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the mean of all peak amplitude values found within the time window for each incoming trace.

Largest trough amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the largest trough amplitude value found within the time window for each incoming trace.

Average trough amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the mean of all trough amplitude values found within the time window for each incoming trace.

Tuning amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the tuning amplitude. Sample at window top minus sample at bottom.

Maximum absolute amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the maximum absolute amplitude within the horizons.

Total absolute amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the total absolute amplitude, or reflection intensity, within the horizons.

Total amplitude

This appears if **Yes** to **Analyze basic amplitude statistics**.
Select **Yes** to compute the total amplitude, integration of amplitude, within the horizons.

Average energy

This appears if **Yes** to **Analyze basic amplitude statistics**. Select **Yes** to compute the average energy, average of sample squares, within the horizons.

Total energy

This appears if **Yes** to **Analyze basic amplitude statistics**. Select **Yes** to compute the total energy, sum of sample squares, within the horizons.

Analyze complex trace statistics?

Select **Yes** to perform a Hilbert Transform on all incoming traces to derive complex trace statistics.

Average reflection strength

This appears if **Yes** to **Analyze complex trace statistics**. Select **Yes** to compute the average reflection strength of the horizons. The mean of these complex amplitudes is then output for each input trace.

Average instantaneous frequency

This appears if **Yes** to **Analyze complex trace statistics**. Select **Yes** to compute the average instantaneous frequency values for each incoming trace.

Average instantaneous phase

This appears if **Yes** to **Analyze complex trace statistics**. Select **Yes** to compute the average instantaneous phase values for each incoming trace.

Slope of the reflection strength

This appears if **Yes** to **Analyze complex trace statistics**. Select **Yes** to compute the slope of the reflection strength of the horizons. The slope of a least-squares regression fit is then output for each trace. If complex amplitudes remain fairly constant over the entire seismic sequence interval, slope will be approximately zero. If reflection strength is increasing toward the bottom of the interval, the slope will be positive. A decrease in amplitude toward the bottom of an interval will cause the slope to be negative.

Slope of the instantaneous frequency

This appears if **Yes** to **Analyze complex trace statistics**. Select **Yes** to compute the slope of the instantaneous frequency values of all horizons. The slope of a least-squares regression fit is then output for each trace. If instantaneous frequency values remain fairly constant over the entire seismic sequence interval, slope will be approximately zero. If instantaneous frequencies are increasing toward the bottom of the interval, the slope will be positive. A decrease in frequencies toward the bottom of an interval will cause the slope to be negative.

Analyze spectral statistics?

Select to **Yes** to perform a Fourier Transform within the time window of each incoming trace. Spectral statistics are then derived from these frequency spectra. If a window width is less than or equal to 40 ms, the spectral statistics will not be computed and null values will be output for these attributes.

Peak spectral frequency

This appears if **Yes** to **Analyze spectral statistics**. Select **Yes** to compute the peak frequency within the horizons.

Spectral slope from peak to maximum frequency

This appears if **Yes** to **Analyze spectral statistics**. Select **Yes** to compute the slope of the frequency spectrum in dB/Hz as a linear fit between the peak frequency and the frequency specified in **Maximum frequency for spectral estimates**.

Maximum frequency for spectral estimates

This appears if **Yes** to **Analyze spectral statistics**. Select a value that is the desired maximum coherent frequency of interest for spectral estimates. Results may differ depending on the analysis window widths and the sample rate of the data. Wider windows and/or finer sampling should give smoother results.

Analyze frequency statistics?

Select **Yes** to compute any of the non-transform, single trace frequency statistics.

Frequency between zero-crossings

This appears if **Yes** to **Analyze frequency statistics**. Select **Yes** to compute an average frequency of samples between the horizons using zero crossings.

Effective bandwidth

This appears if **Yes** to **Analyze frequency statistics**. Select **Yes** to compute the effective bandwidth of samples between the horizons.

Arc length

This appears if **Yes** to **Analyze frequency statistics**. Select **Yes** to compute the arc length, average vibration path length, of samples between the horizons

Analyze correlation statistics?

Select **Yes** to compute cross-correlation statistics.

Covariance coefficient to next CDP

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute a normalized cross-correlation between one trace and the next adjacent trace. This number indicates how similar one trace is to its neighbor, and varies between 0.0, no correlation between two traces, to 1.0, one trace being identical to its neighbor.

Correlation window time shift to next CDP

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the time shift in ms between one trace and the next adjacent trace.

True event dip (ms/ft or ms/meter)

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute true event dip in ms/ft or ms/m between one trace and the next adjacent trace.

Event dip within horizons (ms/ft or ms/meter)

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the true event dip minus the dip of the

horizon(s) controlling the time window. This removes the effect of any post-depositional tilting that may have occurred.

Distance interval between traces

This appears if **Yes** to **True event dip** or **Event dip within horizons**. Enter surface distance between adjacent stacked traces (CDP interval) in ft. or m. Distance units should be consistent with those specified in **True event dip** or **Event dip within horizons**.

Maximum trace-to-trace time shift

This appears if **Yes** to **Analyze correlation statistics**. Enter a value, in ms, greater than the maximum trace-to-trace time shift expected in the data.

Average signal-to-noise ratio

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the average signal-to-noise ratio at the center trace using samples between horizons.

Correlation length

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the correlation length at the center trace using samples between horizons.

Correlation components

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the correlation components (P1, P2, or P3) for traces using samples between horizons.

Principle component option

This appears if **Yes** to **Correlation components**. Select which principle value to output from **P1, P2, P3**.

K-L signal complexity

This appears if **Yes** to **Analyze correlation statistics**. Select **Yes** to compute the signal complexity $(P2-P3)/(P1-P2)$ for traces using samples between horizons.

Number of traces in analysis window

This appears if **Yes** to **K-L signal complexity**. Specify the number of traces over which to average computed individual trace spectra.

Analyze sequence statistics?

Select **Yes** to compute basic amplitude statistics.

Energy Half-time

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the energy half-time, the proportion of time required for the energy contained within a time interval to build up to one-half of the total energy contained within the entire interval.

Slope at Energy Half-time

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the slope of the energy curve at percent of time interval to obtain half energy.

Ratio of positive to negative samples

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to output the number of positive samples divided by the number of negative samples as a ratio.

Percent greater than threshold

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the percent of window with values greater than **Threshold**.

Percent less than threshold

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the percent of window with values less than **Threshold**.

Threshold

This appears if **Yes** to **Percent greater/less than threshold**. Enter the threshold value used to compute the percent greater or lesser than threshold.

Number of peaks?

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the number of peaks in the samples between horizons.

Number of troughs?

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the number of troughs in the samples between horizons.

Reflection heterogeneity?

This appears if **Yes** to **Analyze sequence statistics**. Select **Yes** to compute the reflection heterogeneity for the samples between horizons.

Frequency Series?

Select **Yes** to compute the 3 maximum entropy spectral poles. As with the other spectral attributes, the output for this attribute will be nulls if the window is less than or equal to 40 ms wide.

Sort dominant frequencies?

This appears if **Yes** to **Frequency Series**. Select **Yes** to sort the dominant frequencies from lowest to highest frequency.

Common error messages

“Program error: attempted to END an empty table!”

SAA found no attributes to write out to a table, and therefore found itself trying to close out an empty table. The most frequent reason for this error is that none of the traces you brought in have an interpretation on them for the specified horizon(s). To confirm this, comment out **SAA** temporarily and append a **Trace Display** to your flow. Once the first screenful of traces is displayed, click with **MB1** on the **Picking** menu bar, choose **Other Horizons**, and then select the horizon(s) from the existing tables on which you are performing **SAA**. If an interpretation exists on these particular lines, you will see a line drawn on the screen that corresponds to this horizon. If no such line appears after

scrolling through all of the screen displays, then you have confirmed the source of your problem.

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