**Poststack Inversion (Old)**

**Poststack Inversion** produces the wide-band reflectivity series, or a pseudo-velocity log, given an input seismic trace and corresponding low frequency interval velocities derived from a sonic log or RMS stacking velocities.

**Theory**

Most programs attempt to combine low-frequency velocity information obtained from sonic logs or stacking velocities with the higher frequency seismic trace data representing the reflection coefficients to output a pseudo-velocity log with relevant absolute velocity values.

It is assumed that the seismic trace represents a band-limited, zero-phase sonic log reflectivity series. The spectrum is assumed to be flat within the band-pass limits given to the program. In order to correctly scale the seismic trace, you must input a scale factor equivalent to the RMS reflection coefficient level expected in the data window. This factor may either be estimated, or obtained from an actual sonic log. **Poststack Inversion** offers the following three inversion methods:

- **Frequency Domain Recursive inversion**
  
  This method assumes that the wide-band reflectivity series is the sum of the reflectivity series derived from the low-frequency interval velocity information and the seismic trace high frequency reflectivity series. The low-frequency interval velocities are converted to reflection coefficients by assuming a constant density. Both the velocity-derived reflection coefficients and the seismic trace reflection coefficients are transformed to the frequency domain where they are added together under a controlled bandwidth to produce an estimate of the wide-band frequency domain reflectivity series. This result is then transformed back to the time domain. The time domain reflectivity series is then integrated to produce a velocity trace.

- **Time Domain Recursive Inversion**
  
  As with the first method, this method assumes that the wide-band reflectivity series is the sum of the reflectivity
series derived from the low-frequency interval velocity information and the seismic trace high frequency reflectivity series. In this case, however, the low-frequency intervals do not need to be converted to reflection coefficients before the two are summed. The seismic trace is integrated in the time domain to produce an estimate of the local nature of the velocity log. The integrated trace and low frequency velocity function are then added together in the time domain to produce an estimate of the wide-band velocity log.

In both of the above methods there will be spectral data missing between the maximum sonic log/stacking velocity frequency and the minimum seismic data frequency; in addition, the output pseudo-log will be band limited at high frequencies by the upper seismic trace frequency. You should be aware of the bias in the output log because of this frequency restriction.

- **Sparse-spike inversion**

  The earth reflections are modeled as a sparse-spike series, L1 norm. Input interval velocities are first converted to reflection coefficients, and then transformed to the frequency domain. This interval velocity-derived, complete, low frequency reflection coefficient function is used to constrain the solution output in the low-frequency region, so that the output interval velocity trend is correct. The seismic data is also transformed to the frequency domain, and forms the mid-frequency set of constraints. Using these two sets of constraints, an estimate of the full-band reflectivity can be made using the **Linear Programming** algorithm.

**Usage**

This algorithm is sensitive to the bandwidth of the wavelet and the amplitude of the wavelet sidelobes. The data should contain at least two or more octaves of bandwidth. The inversion probably will not work well if the wavelet has large amplitude sidelobes, as would be the case for a Ricker wavelet.

Low frequency interval velocity are obtained from **Velocity Manipulation**.
References

Berteussen, K.A. and Ursin, B., Approximate Computation of the Acoustic Impedance from seismic data, SEG 51st meeting.


Parameters

Type of inversion to use

Select the inversion type from:

- **Recursive (freq domain)**, which is very fast.
- **Recursive (time domain)**, which is very Fast.
- **Sparse-spike**, which is L1 norm frequency domain inversion. This is slow, but gives a wider-band output.

Select interval velocity parameter file

Select an interval velocity file to use as the low-frequency impedance trend. Output values should be at the same sample rate as the input data. Correct sampling produces a smooth impedance trend, suitable for input to the inversion.

Window start time (ms)

Enter the start time of the processing data window. The start time should be below the mute time of the stack. If it is necessary to invert data containing zero-valued samples, a small amount of white noise can be added to the data.

Window end time (ms)

Enter the end time of the processing data window. This value should be set to avoid zero-valued samples in the data.
**Value of RMS reflection coefficient series in data window**

Enter the expected RMS reflection coefficient value as estimated from well logs for scaling the seismic data. Since the seismic band is not always flat, some variations may exist. If you are obtaining velocities that are too high, reduce this value. Conversely, increase this value if the velocities are too low.

**Type of output**

This appears if **Sparse-spike** for **Type of inversion to use**. Select the type of output from:

- **Impedance** outputs impedance values.
- **Reflection coefficients** outputs wide band reflection coefficients.

**Minimum frequency to consider in data**

Enter the minimum spectral region with a good signal to noise ratio. This value must be greater than the maximum frequency in the data, and greater than the maximum frequency in the low-frequency velocity trend.

**Maximum frequency to consider in data**

This appears if **Recursive (freq domain)** or **Sparse-spike** to **Type of inversion to use**. Enter the maximum spectral region with a good signal to noise ratio. This must be greater than the minimum frequency in the data.

**Maximum frequency to use in low-frequency velocity trend**

This appears if **Recursive (freq domain)** or **Sparse-spike** to **Type of inversion to use**. Enter the true upper frequency limit for which the input interval velocities represent the sonic log, typically less than 5 Hz. Too high a value will incorrectly bias the pseudo-log output. Too low a value will leave out information that would improve the final match between the pseudo-log and the actual sonic.

A checking method for the frequency content is: use **Trace-Vel Table Transfer** to create traces from the velocity field that could then be analyzed in **Spectral Analysis**.
Note: The sparse spike inversion may fail with an unbounded solution if this value is set unrealistically high or the minimum frequency in the data set unrealistically low.

Variation allowed in fitting data (%)
This appears if Sparse-spike for Type of inversion to use. Enter the variation in % of the constraint limits. Keeping within the range of 1%-15% will allow the program to find a solution consistent with the seismic data and noise level. As this parameter is lowered, the program takes more time to find a solution which satisfies the reduced tolerance.

Variation allowed in interval velocities (%)
This appears if Sparse-spike to Type of inversion to use. Enter the variation in % of the constraint limits. As the value is lowered, the program takes more time to find a solution which satisfies the reduced tolerance.

Number of samples in each processing segment
This appears if Sparse-spike to Type of inversion to use. Enter the number of samples to include in each time window to invert. The inversion may be run over a single time gate or multiple time gates. Multiple time gates run faster, but will not give identical results to single time gates.

Common Problems/solutions
Problem: Low-frequency trend in the pseudo-log output doesn’t match the input low-frequency interval velocity trend.

Solution(s): Increase Maximum frequency to use in low-velocity trend to a high enough value to correctly represent the low frequency interval function. Decrease Maximum reflection coefficient in data to reduce the effect of the seismic data on the output.

Problem: When using sparse-spike inversion, the Maximum allowable iterations in linear programming solution number is exceeded by the program without outputting an acceptable solution.

Solution(s): The program is unable to make headway in minimizing the L1 norm and produces an answer on each iteration that is no better than the previous one. One solution
is to slightly change the data window, and try again. In addition, the frequency range parameters may be set incorrectly. Try reducing **Maximum frequency to use in low-velocity trend**.

**Problem:** The recursive inversion output doesn’t match the sparse spike inversion output.

**Solution(s):** The sparse-spike inversion fills in the frequency gap between **Maximum frequency to use in low-velocity trend**, and **Minimum frequency to consider in data**. This interval is probably large enough in this case to cause the differences.

**Problem:** Highly variable low frequency trend is output.

**Solution(s):** Output the interval velocities at the same sample rate as the data with **Velocity Manipulation**.

**Problem:** Color bar values range only from negative to positive 1 and do not correspond to velocity inversion values.

**Solution:** In **Screen Display**, set **Trace Scaling Mode** to **Range Limited** and take min/max amplitude values from the data.