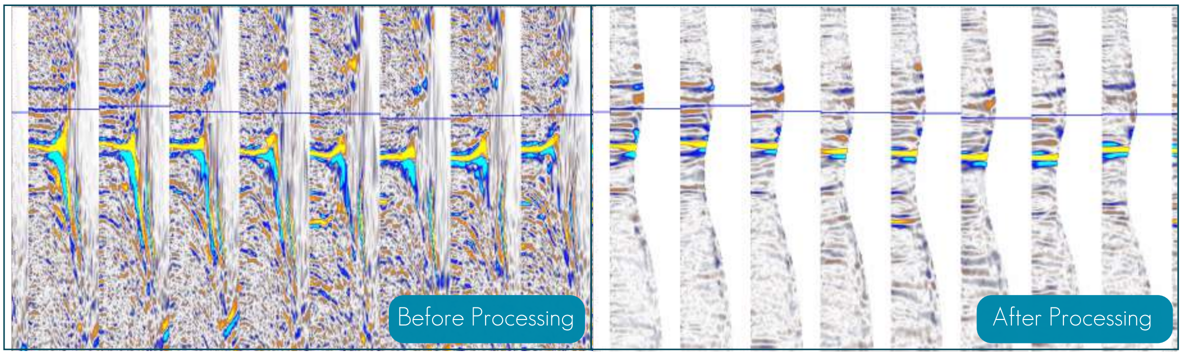
Pre-Stack Pro
PROCESSING TOOLKIT

The **Pre-Stack Pro Processing** Toolkit is the cornerstone of Pre-Stack Pro. It contains a rich suite of post-migration processing tools to generate conditioned gathers and stacks optimized for quantitative interpretation.



THE ALGORITHMS

All algorithms are highly-parallel and execute in memory for unprecedented speed and interactivity.

Random Noise Attenuation

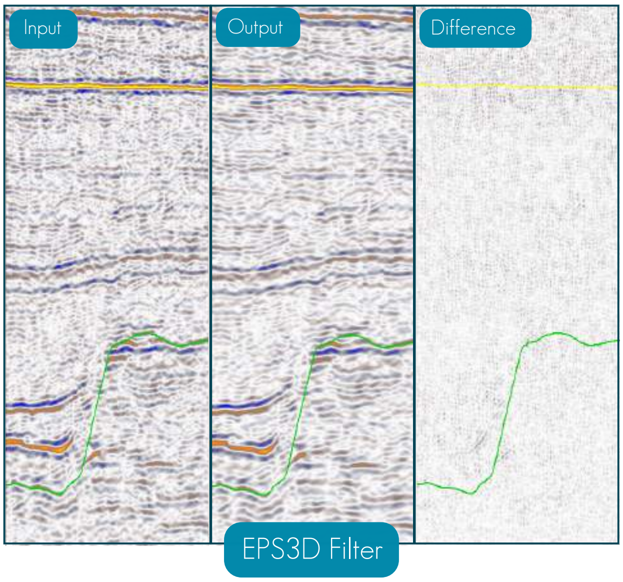
Migrated datasets often contain a surprising amount of residual noise. We have several methods for tackling the problem.

Reflection Parallel Median Filter

2D ECED removes background noise in the offset direction along the gathers. It can be applied before RMO without distorting wavelets by lateral smearing across the offsets.

3D Dip Steered Structurally Consistent Filter

3D ECED is a structure-oriented anisotropic diffusion filter for random noise attenuation. It is run in the inline and crosslines direction on common offset / angle cubes or stacks. The filter follows the structural direction of reflections. The anisotropic diffusion filter method was developed by J. Weickerert.



EPS 3D Edge Preserving Spatial Filtering

EPS3D is an alternative to EPS 3D for random noise reduction. It uses semblance-weighted spatial filtering. Down-weighting dissimilar data within the aperture allows the use of larger operators but helps to preserve faults or other discontinuities without smear. This algorithm was developed by T. Taner and the original code was supplied by Rock Solid Images.

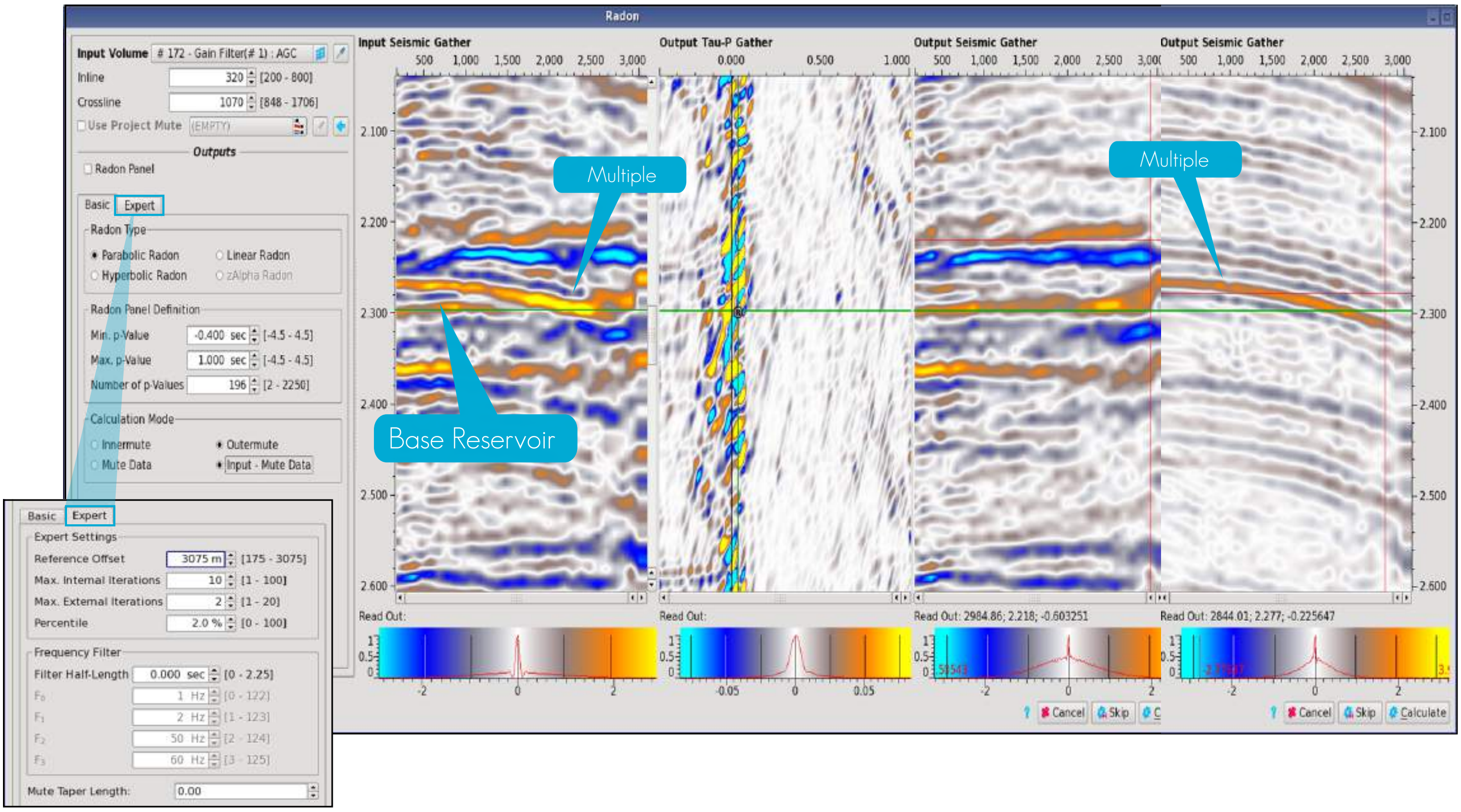
Coherent Noise Removal

One of the most common issues seen in "final datasets" is the presence of non-flat, coherent events that interfere with your primary. If left untouched, the remnant multiple parabolas and linear dipping events may hinder interpretation. These can be attenuated in the radon domain.

Parabolic Radon

Parabolic Radon transforms are commonly used to attenuate medium to long period multiples. The conventional transform generates aliasing artifacts and edge effects, and tends to show coupling of primary and multiple energy so there is imperfect separation in the output. It has therefore become standard to use a high resolution transform. Such transforms include some method of focusing the energy in the Radon domain, to reduce the smearing and mis-positioning associated with aliasing and edge effects.

Our implementation uses the technique described by M. Sacchi. It achieves a very clean separation of primaries and multiples even with relatively small moveout differences and it is robust against aliasing. The user has control over the focusing step, which can therefore be optimised for different data sets.



Linear Radon

The linear Radon transform uses the same algorithm as the parabolic transform, with all the same controls and advantages.

In both cases, the user controls all parameters of the transform: the range of p-values and the sampling in moveout. The graphical preview allows tight control over the muting in the tau-p domain, and displaying both the output primaries and the removed noise lets the user check for efficient noise removal and that primaries remain undamaged.

The user can output the data in the Radon domain for further processing in this space, and then transform them back in to the time-offset domain using the inverse Radon transform.

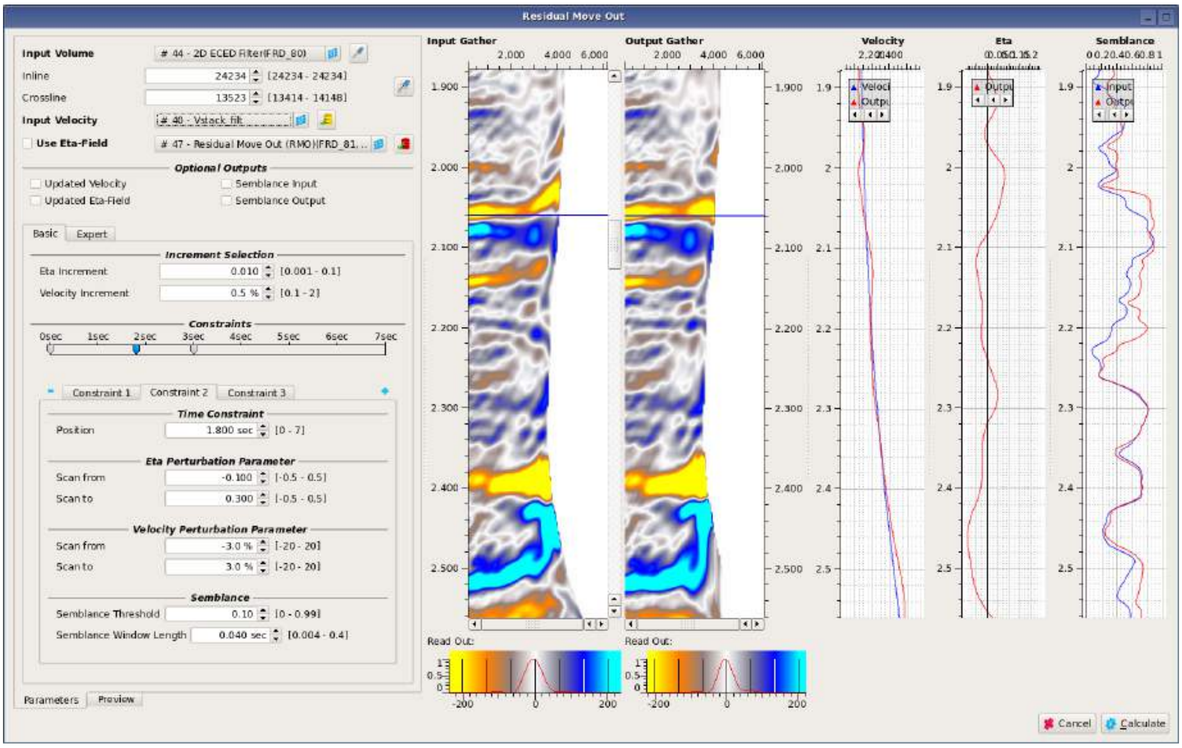
Getting the Correct Velocities

Seismic data often needs to be flattened along offsets / angles for a reliable quantitative analysis. Pre-Stack Pro gives you the tools to perform a fine-tuned flattening with your preferred method.

Residual Moveout

RMO is an automatic semblance-based picking tool which updates the RMS velocity and **η** field using Alkhalifah's higher-order moveout equation. It scans over a range of perturbations to both the initial velocity field and the initial **η** field simultaneously and takes the velocity, **η** pair which maximises the semblance. To avoid instability where the incidence angle range is too low, the perturbation range for both parameters can be varied in time. In addition, a time-variant semblance threshold is used to avoid picking noisy data. Instead velocities and **η** are interpolated from good picks. This tool is normally used on a dense grid of data. Besides the updated gathers, the updated dense velocities and **η** fields are output for QC, possible filtering, and further use.

An alternative RMO method uses a pre-stack volume of pre-computed time-shifts and performs curve-fitting to update the velocities and **η**. The time-shifts may come from the Align 2 module, described below. A robust curve-fitting algorithm helps to reject noisy time shifts. The user has control over the maximum permitted variations from the input field for both velocity and **η**.



Time Variant Event Alignment

The Align 2 algorithm is a time-variant event alignment method. It computes trace-to-trace timeshifts between neighbouring traces in a gather that maximize semblance in a moving window.

Our implementation includes many controls to avoid jumps and cycle skips. A time-variant correlation window length allows the use of shorter windows in the shallow to maintain resolution of the higher bandwidths. Longer windows are utilized in the deep to reduce the influence of noise. In addition there are constraints on the maximum permitted time-shift and pick rejection based on signal-to-noise thresholding. These controls, coupled with the built-in time-shift filtering in the inline, crossline, offset and time directions, allow the user to obtain optimum results without instability. The time-shifts can be output for QC or further processing.

Amplitude Enrichment Algorithms

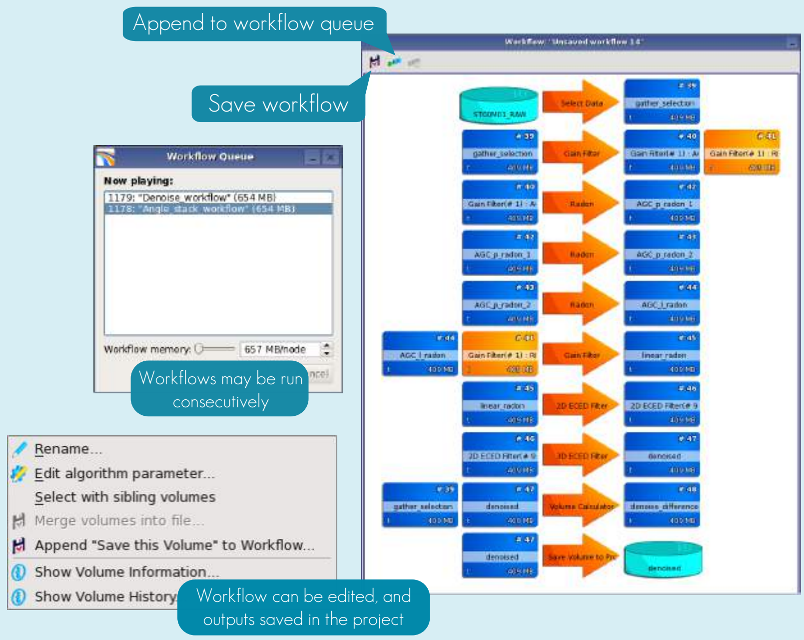
Amplitude issues are another common problem in "final output volumes". Many datasets show near trace ringing, or abrupt drops in frequencies and amplitude at the far offsets or angles. The Processing Toolkit has the means to help.

Spectral Balancing

This algorithm performs time-variant spectral matching across offsets / angles. A near-mid stack reference trace is created, and decomposed into frequency sub-bands by a Gabor-Morlet wavelet transform. All of the offset traces in the gather are likewise decomposed, and the individual sub-bands are matched to the reference before being recombined. This algorithm was originally developed by RSI.

AVA Scaling

This pair of algorithms is designed to match the amplitude versus offset behaviour of the seismic data to that of the well synthetics in preparation for calibration of AVA responses or for inversion. Multi-well scalar computes one amplitude scalar per offset over a user-defined window. A set of scalars can be calculated for each well that has synthetics, and these are then applied to the seismic data in AVO Scaling. They can be processed with spatial smoothing and de-spiking before application.



The Workflow

Users can create complete flows from a sequence of filter-test parameters interactively and play back the workflow in batch mode on an entire 3D survey of gathers.

UTILITIES

- Integrated gather and map viewers for ease of QC
- Inline and crossline trace interpolation to match denser interpretation grid
- Offset / angle trace interpolation
- Time / depth resampling
- Time / depth conversion
- Offset / angle domain conversion
- Offset / angle stacking and partial stacking
- Phase rotation
- Matching filters
- Bulk time shift application
- Time dependent gain filtering and AGC
- Q modelling and filtering
- RMS amplitude calculation
- Forward and reverse Fast Fourier Transform
- NMO correction
- Full SEGY header customization for export

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