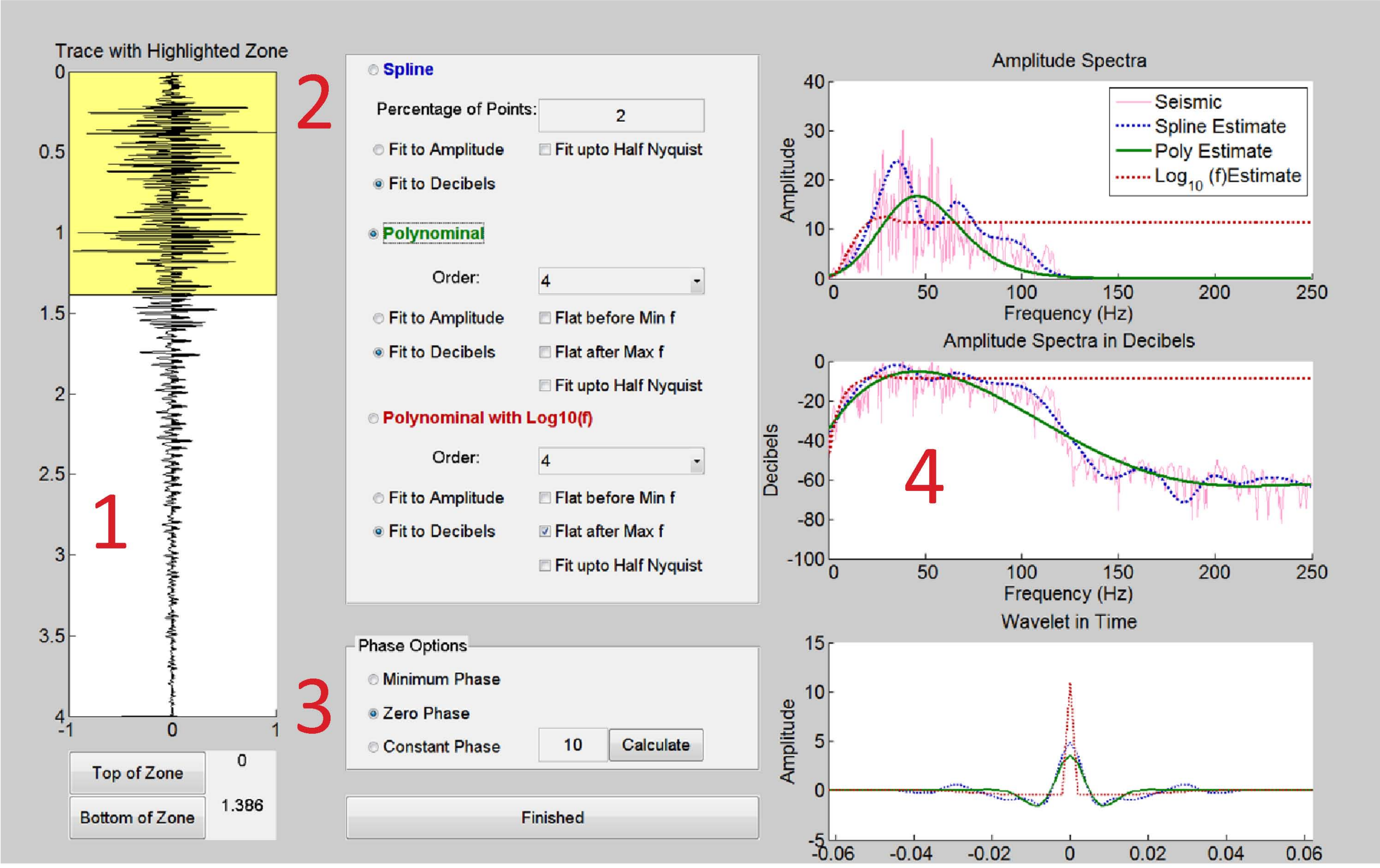
New MATLAB tools for well tying

Heather J. E. Lloyd*, Gary F. Margrave

hjelloyd@ucalgary.ca

WaveletEstimator

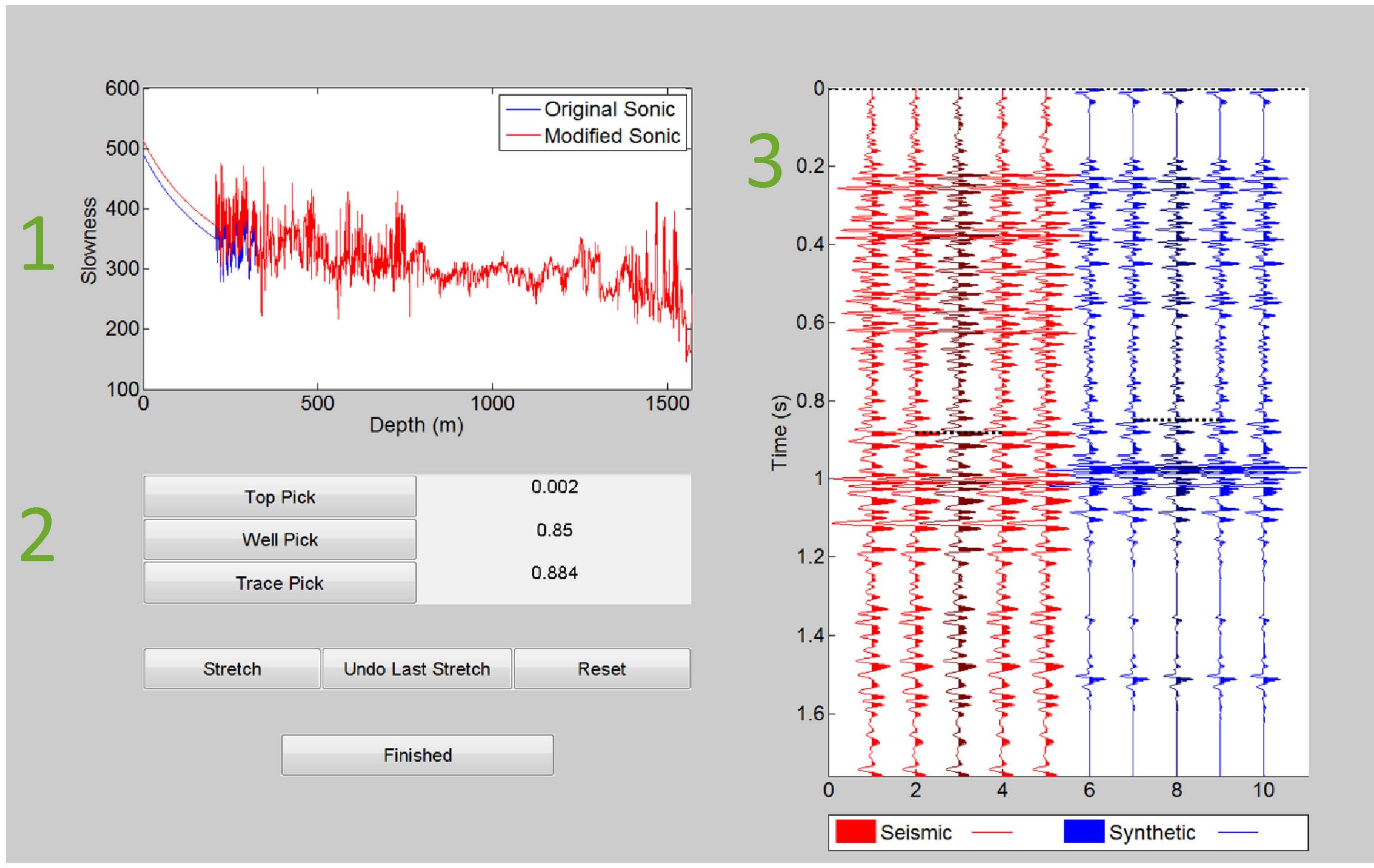


WaveletEstimator allows the user to design a wavelet using the amplitude spectra of a trace, well log or other data.

Some of the features include

1. The user can select the zone at which the analysis is to take place. This can include the whole trace or just one particular event.
2. There are three different types of models that can be used to estimate the wavelet:
   A. Spline – Spline fits a series of smooth cubic polynomials (de Boor, 1978) to the spectra. The user can specify to fit the amplitude spectra or the log amplitude spectra (decibels) The user can also choose to only fit up to half Nyquist.
   B. Polynomial – Polynomial fits a polynomial of a selected order (1 to 8) to the trace spectra. This can be fit to either the amplitude spectra or the log amplitude spectra. It is also possible to fit up to half Nyquist. The **Flat before Min f** is used to continue the maximum amplitude into the low frequencies, thus creating a low pass filter. **The Flat after Max f** option continues the minimum frequency into the higher frequencies.
   C. Polynomial with $Log_{10}f$ – This function fits a polynomial to the logarithm of frequency. It has similar options as the Polynomial option.
3. There are three different types of phase options:
   I. Minimum phase
   II. Zero phase
   III. Constant phase – The constant phase can be calculated using the *constphase* algorithm by pressing the **Calculate** button
4. The three displays show the wavelet's amplitude spectra, log amplitude spectra and the wavelet in time. When the Polynomial with $Log_{10}f$ mode is triggered the frequency axis will be converted to a logarithmic scale.

StretchWell



StretchWell modifies the sonic log allowing the synthetic to match the seismic in time.

Some of the features include:

1. The original and modified sonic log are shown so the user can track the changes made to the sonic log.
2. These buttons pick the interval that the user would like to match. The top pick is where the seismic and the synthetic already match. Well Pick picks the event on the synthetic where the event is. Trace Pick is the pick on the seismic for the same event. These picks are all manually selected by the user.
3. This display shows 5 seismic traces in red, with the center trace being at the well tie location. The Blue traces are the synthetic repeated five times. The picks are also shown as black dashed lines.

The Algorithm used to calculate the sonic log shift is based on a constant perturbation over the interval. It is described in the next column.

If we let the time that the records match be t_o and the event pick for the well be t_w and the event pick for the seismic be t_s then we can write the following expression

$$t_w = \frac{1}{10^6}\int_{z_o}^{z} S(z')\,dz' \qquad (1)$$

$$t_s = \frac{1}{10^6}\int_{z_o}^{z} (S(z') + \Delta S(z'))\,dz' \qquad (2)$$

where z_o corresponds to the time at t_o, z corresponds to the time at t_w, S(z') is the sonic function and ΔS(z') is a perturbation of the sonic function.

If we let ΔS(z') = α, a constant we get the following

$$t_s = \frac{1}{10^6}\int_{z_o}^{z} (S(z')\,dz' + \frac{1}{10^6}\int_{z_o}^{z} \Delta S(z')\,dz' \qquad (3)$$

$$t_s = t_w + \frac{1}{10^6}\int_{z_o}^{z} \alpha\,dz' \qquad (4)$$

$$t_s = t_w + \frac{1}{10^6}\alpha z'|_{z_o}^{z} \qquad (5)$$

$$\alpha = \frac{10^6(t_s - t_w)}{(z - z_o)} \qquad (6)$$

where t_s and t_w must be in one way time. Since α is a constant it is added to the sonic function between z_o and z.