RefMod: software program for reflectivity modeling

Todor I. Todorov* and Gary F. Margrave
todorov123@gmail.com

RefMod software

RefMod is a software designed to generate body-wave synthetic seismograms based on the reflectivity method. The model consists of flat elastic isotropic layers, with a point source (explosion) on the surface and receivers on the surface. The software generates two-component seismograms: vertical and horizontal components. The reflectivity method of modeling has a number of advantages. It generates broadband synthetics, includes inter-bed multiples and mode-conversions. Attenuation is easily incorporated by using complex velocities.

The software is developed in JAVA programing language, which makes it platform independent: Windows, Mac OS, Linux, UNIX. It is multi-threaded, i.e. one can use the power of multicore processors. The generated vertical and horizontal component shot gathers can be exported as SEGY files.

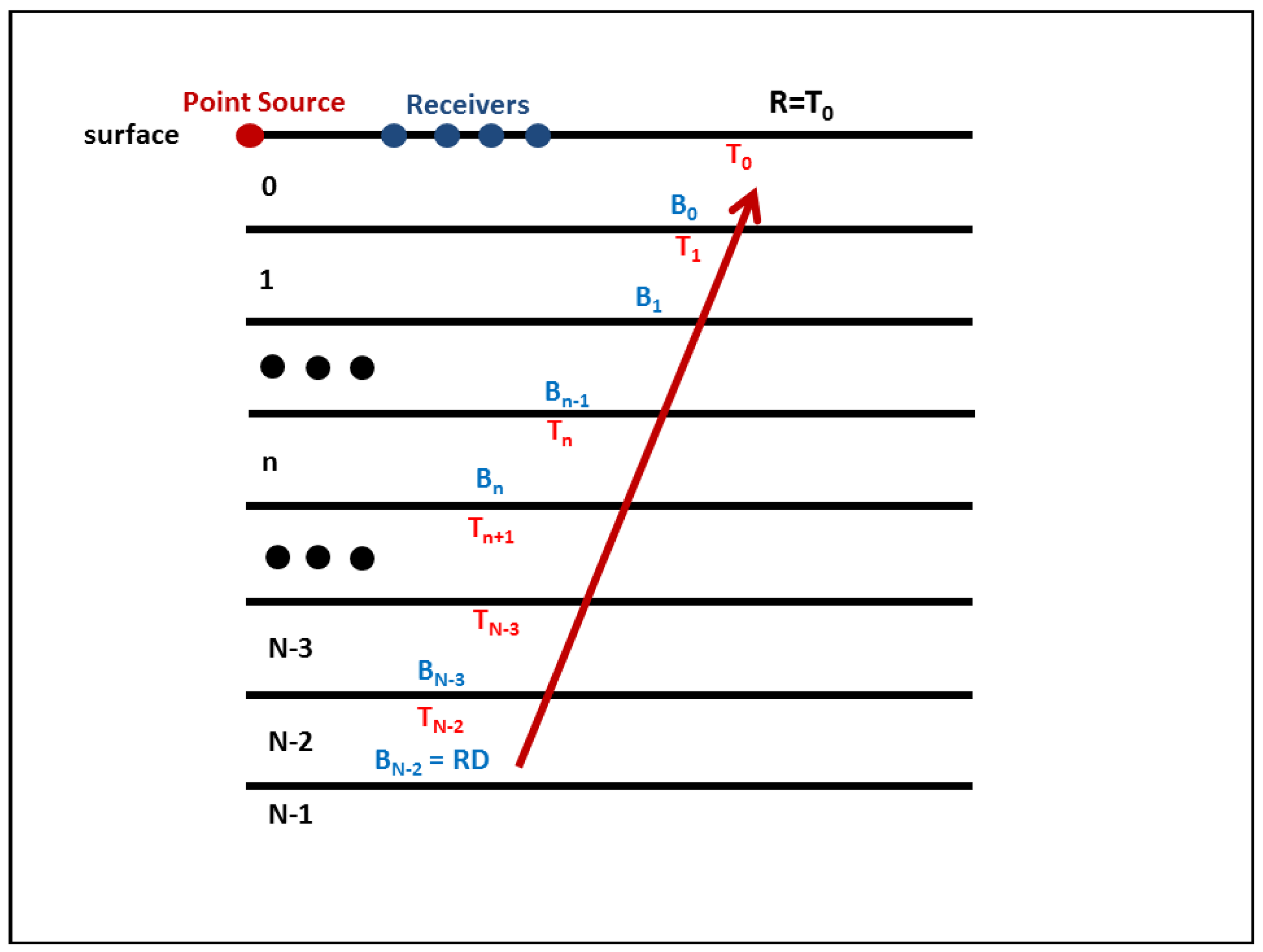

Figure 1: The reflectivity modeling method computes synthetic seismograms in a stratified earth model.

Theory

At the center of the reflectivity method is the computation of the overall reflectivity matrix **R**. The computation is done in frequency-slowness domain (ω-*p*). The basic steps of the algorithm are:

- For each frequency ω
    - For each slowness *p*
        - Compute **R**(ω,*p*)
    - Integrate (sum) over *p*
    - Multiply with the source spectrum
- Inverse Fourier transform

Definitions:

- **BM** – reflectivity matrix at the base of a layer
- **TM** – reflectivity matrix at the top of a layer
- **E** – phase shift matrix
- **RD**, **TD**, **RU**, **TU** – reflection and transmission coefficient matrices at an interface between two layers.

The computation starts at the bottom of the stratified model, assuming no up-going wavefield. Then applying the following two equations, one can propagate the reflectivity matrix at the bottom of the last layer to the top of the first layer:

$$[TM] = [E][BM][E]$$

$$[BM]_{n+1}=[RD]+[TU]([I]-[TM]_{n+1}[RU])^{-1}[TM]_{n+1}[TD]$$

Then the reflectivity matrix $\mathbf{R} = \mathbf{TM}_0$.

The next step is the computation of the frequency dependent amplitudes of the vertical and the horizontal components:

$$\begin{pmatrix} u_H \\ u_V \end{pmatrix} = -2\omega^2 v_{p0} F(\omega)\left(\sum_p \mathbf{JURS}_1 + \sum_p \mathbf{JURS}_2\right)$$

where **J**, **U**, **S** are matrices described in the CREWES report.

Finally, an inverse Fourier transform is applied to obtain the synthetic seismograms.

Examples

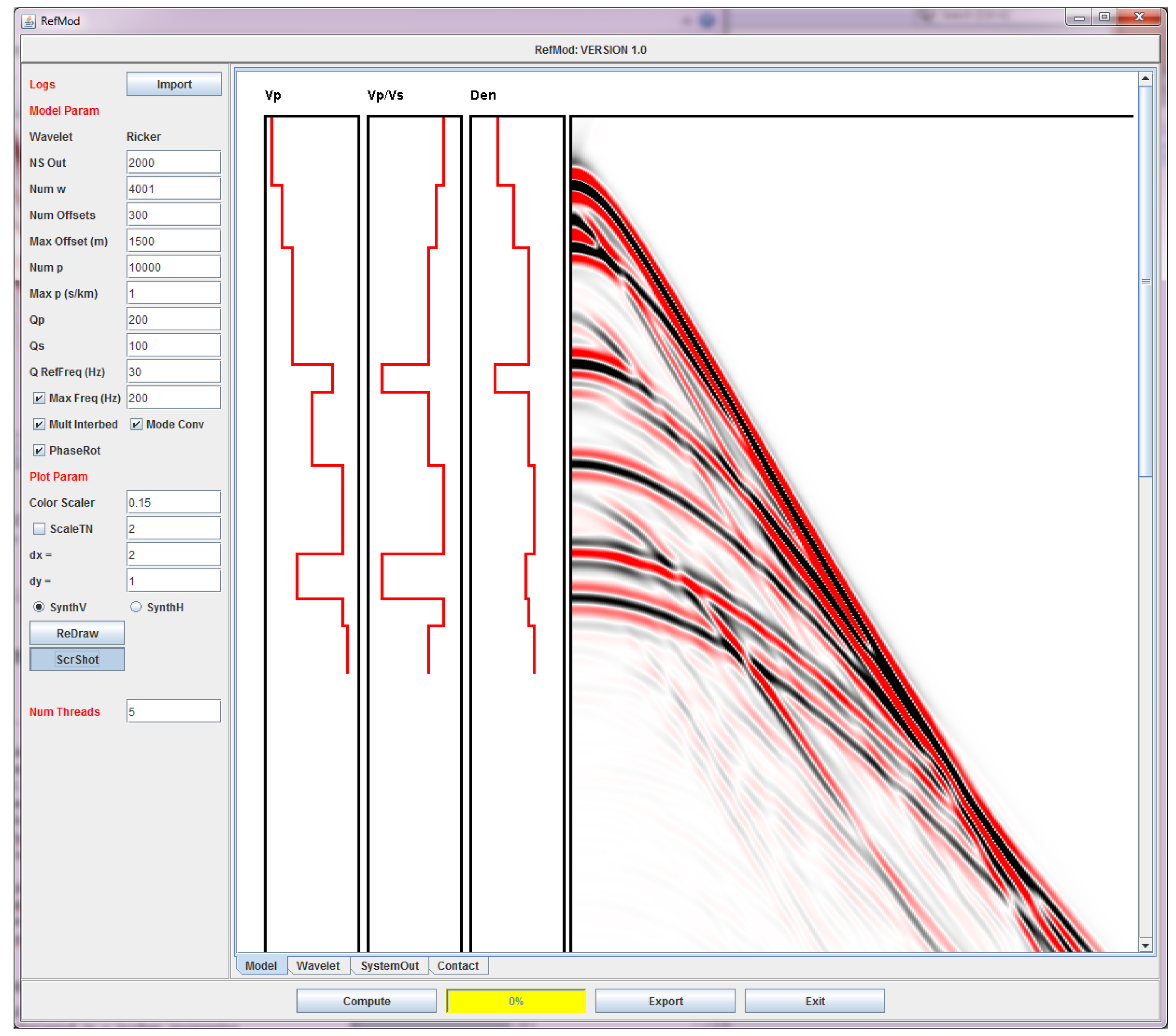

Figure 2: Vertical-component shot-gather seismogram, computed for the shown set of logs.

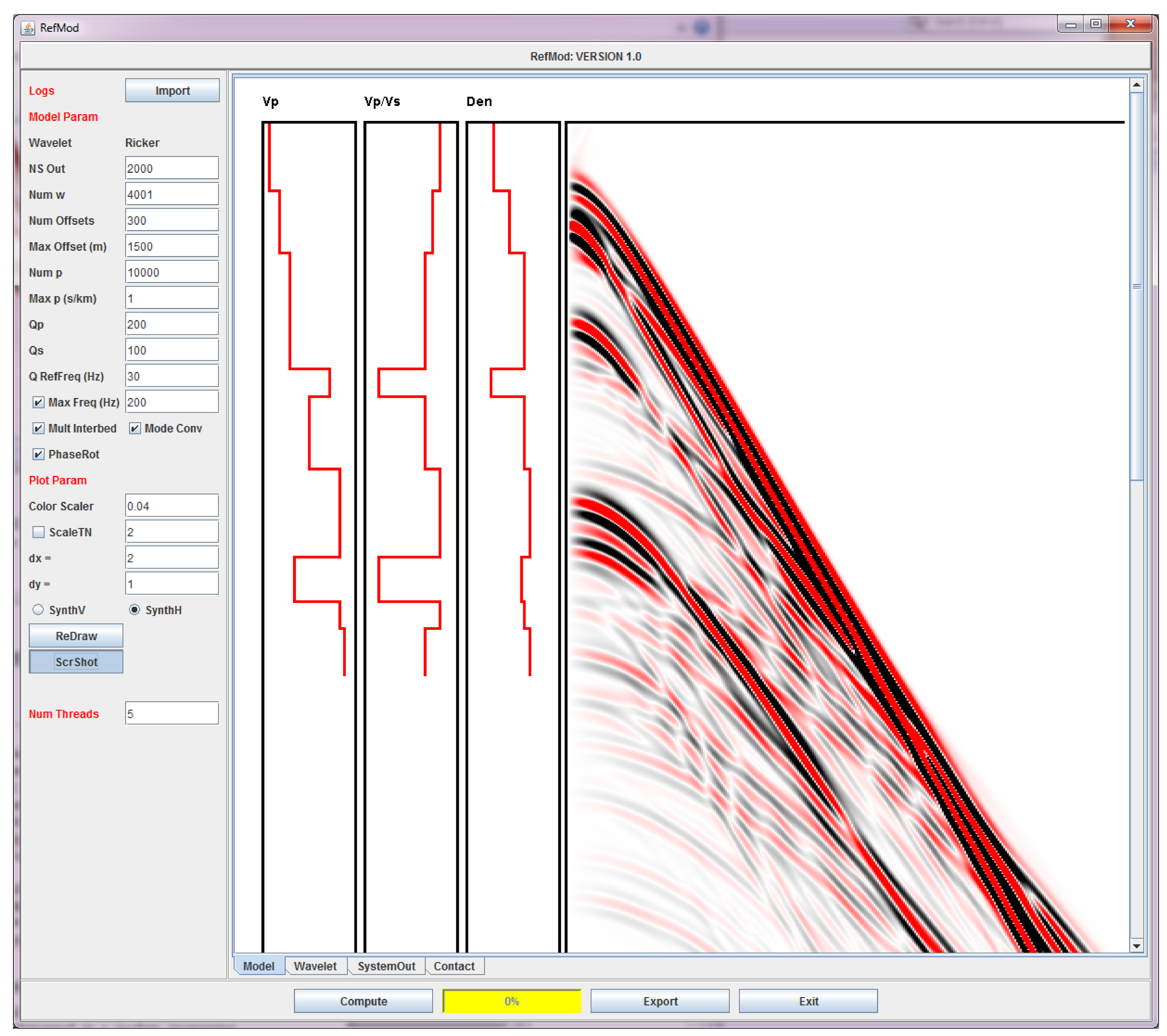

Figure 3: Horizontal-component shot-gather seismogram, computed for the shown set of logs.