Reflectivity modelling by finite difference

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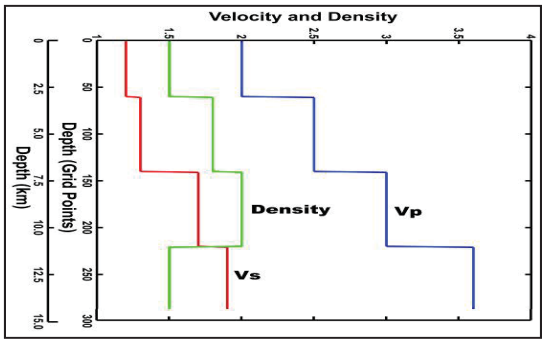
ABSTRACT

The reflectivity method has been used for several decades to create *exact* synthetic traces for wave propagation in plane parallel layered media (e.g. Müller, 1985). For the problem of coupled P-S_v wave propagation in a radially symmetric isotropic homogenous plane parallel layered medium, the radial coordinate is temporarily removed by Hankel transforms, a Fourier time transform applied, and the resultant depth problem is handled by propagator matrix theory or variations thereof.

We take an alternate approach suggested by Mikhailenko (Mikhailenko, 1985), that uses *finite* Hankel transforms to temporarily remove the radial coordinate and finite difference methods to deal with the resultant problem in depth and time. A finite difference problem in one spatial dimension and time avoids many of the numerical difficulties inherent in problems with higher order spatial dimensions. If the additional assumption that the time dependence of the source wavelet is band limited in the frequency domain is made, the problem is fairly well defined, apart from initial and finite boundary conditions. The approach indicated here was referred to as the pseudo-spectral method in past decades. In recent CREWES volumes there are reports by P.F. Daley dealing with certain aspects of this theory. CREWES is releasing Matlab software this year that implements this theory.



Left: FIG. 1. Velocity/Density – Depth structure (in finite difference depth points and km) for model 1, in km, km/s, and gm/cm^3. Predominant frequency of the source wavelet is 30Hz.

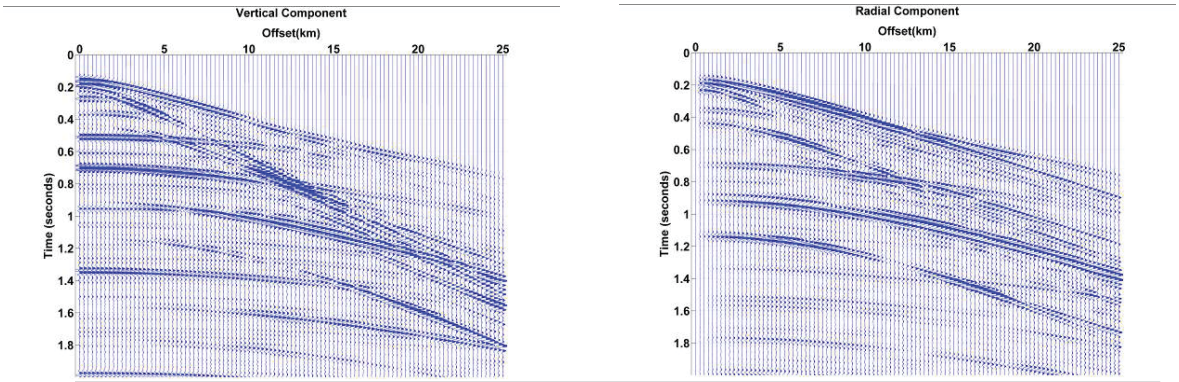


FIG. 2. Vertical (right) and horizontal (left) components of particle displacement for the model shown in Figure 1, an explosive surface point source of *P*– waves and a line of receivers at the surface. In the two figures shown the direct *P* – wave and non-geometrical surface effects have been removed.

Mikhailenko, B.G., 1985, Numerical experiment in seismic investigations, Journal of Geophysics, **58**, 101-124.