Numerical Rayleigh wave propagation on a thin layer

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ABSTRACT

Experiments with numerical Rayleigh waves on shallow geological models show what appear to be realistic and relevant results. It is shown that further testing with vibrator sweeps that are practical for both a vibrator and a finite-difference model would be very valuable. F-D tests with sweeps of two narrow frequency ranges were run on a single layer with uniform properties to show how the velocity of propagation depends on the thickness of the layer. Analysis of the velocity spectra of vibrator sources using different frequencies could then lead to detailed shallow shear wave velocity values.

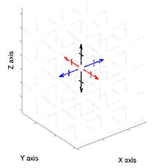

FIG. 1. The explosive source

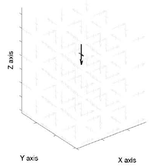

FIG. 2. The vibrator source

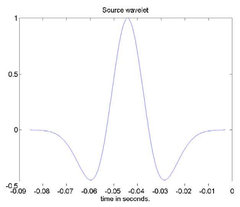

FIG. 3. The broad band 25 Hz Ricker source

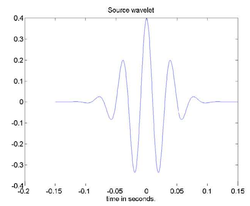

FIG. 4. The narrow band 25 Hz source

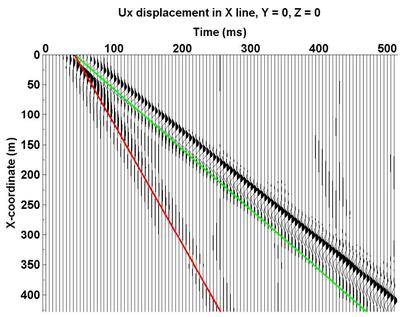

FIG. 5. The Ricker source on a thick surface layer with a Vs of 1000 m/sec. This is a flipped plot for interpretation.

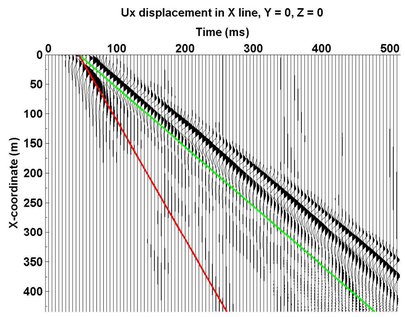

FIG. 6. The Ricker source on a 6 m surface layer with a Vs of 1000 m/sec. The shingling is velocity dispersion.

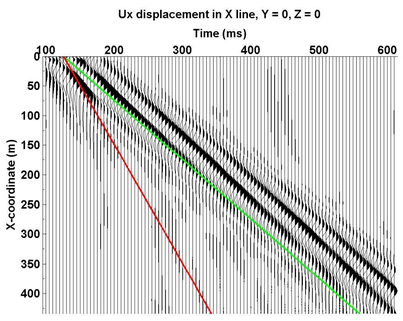

FIG. 7. The 25 Hz source on a 6 m surface layer with a Vs of 1000 m/sec. Vs velocities may be picked here.

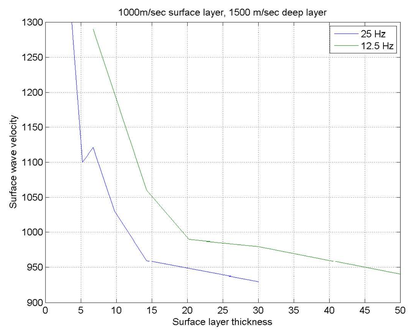

FIG. 8. 12.5 and 25 Hz source Vs velocities were picked for surface layers of several thicknesses and plotted here, allowing interpretations.

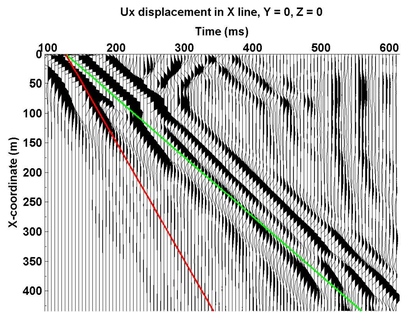

FIG. 9. A 10 m surface layer with a Vs of 1000 m/sec thins to 5 m at 85 m. The discontinuity is easily detected.

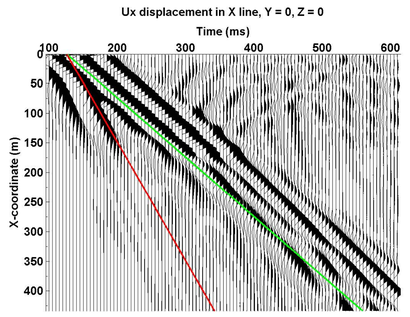

FIG. 10. A 10 m surface layer with a Vs of 1000 m/sec thins to 5 m at 80 m to 180 m. This also can be seen.

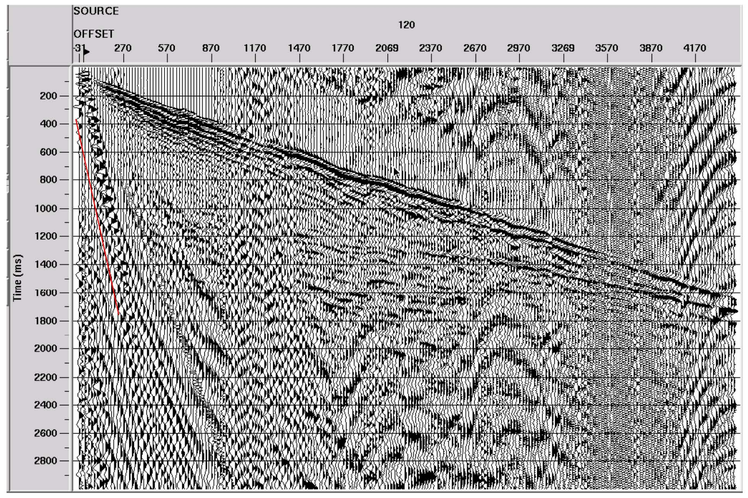

FIG. 11. Vibroseis record no. 120 from Hussar. The noise train near the red line was chosen for modelling as a 10 m layer with Vs of 170 m/sec.

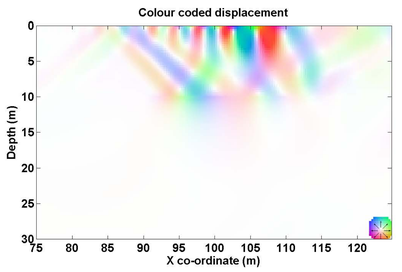

FIG. 12. A snapshot of the 10 m surface layer at a time of 750 ms. The energy is in Rayleigh waves (vertical) and trapped shear waves (+/- 45 degrees) .

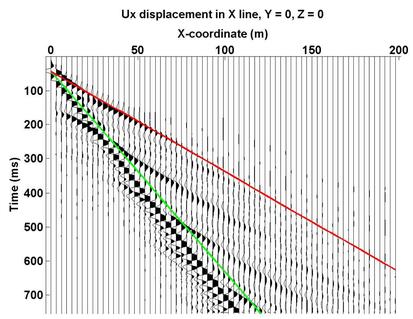

FIG. 13. A conventional trace display of the modelled noise. Compare with the real data by the red line in Figure 11.

CONCLUSIONS

Finite-difference vibrator data models have shown a reasonable approximation to the real thing, and could likely be greatly improved.

If the vibrator source and the finite-difference source could be closely matched, much could be learned about numerical models, vibrator models, and the near surface earth.