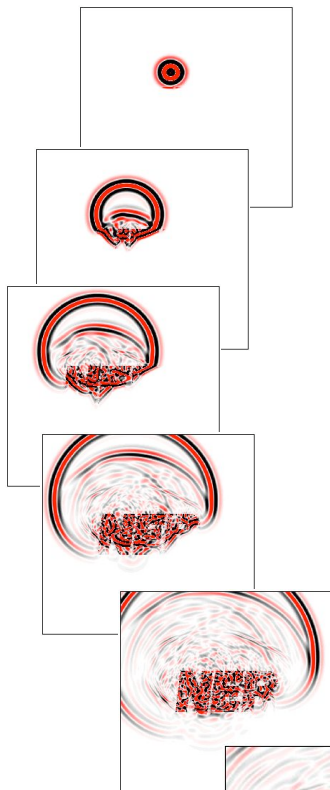
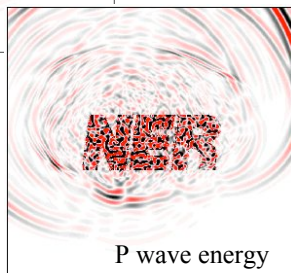


Finite difference wave propagation modeling

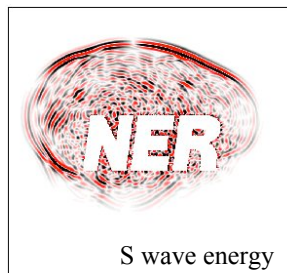
NER's in-house finite difference code, developed in partnership with the Earth Resources Laboratory at MIT, has been extensively tested and applied to a variety of applications.



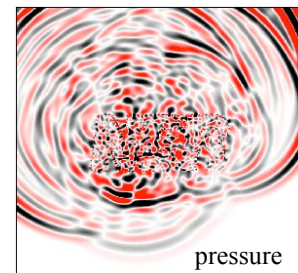
Wavefield from a point source in sandstone: letters are water filled.



P wave energy



S wave energy



pressure

Features

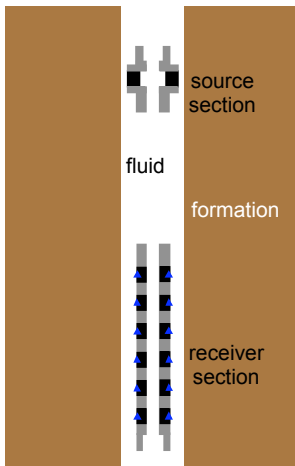
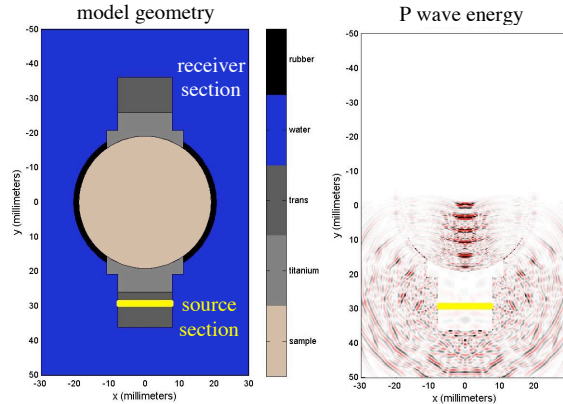
- 3D or 2D cartesian coordinates
- Discretized in velocity and stress on a staggered grid
- 2nd order in time and 4th order in space
- Absorbing boundaries
- Stretched grid to improve memory efficiency
- Standalone code for serial or MPI runs on Linux/Unix
- Model options:
 - Anisotropy up to nine elastic constants
 - Attenuation
 - Automated or user-designed model geometries
 - Many types of sources, wavelets, and receivers
- A package of Matlab GUI tools to simplify many tasks:
 - Model and array design
 - Testing for computational stability
 - Input file generation
 - Running a MEX (Matlab C) version of the code
 - Processing and visualizing output

Applications

- Laboratory acoustics design and interpretation
- Borehole geophysics
 - Downhole acoustic tool design
 - Behavior of guided waves
- Reservoir delineation.
 - Effects of fractures on reflected/scattered wavefield
 - Seismic indicators of pore fluid
 - Imaging/migration scheme development
- Mechanics of explosions and double couple sources
- Wave propagation in the crust from earthquakes/explosions

Laboratory Measurements

Finite difference modeling aids in understanding and improving laboratory acoustic measurements. For example, this model is a 2D radial slice of a laboratory apparatus designed to measure seismic velocities in unconsolidated sands under confining and axial pressure. A snapshot of the P wave energy shows reverberation in the source mount section, which may mask the first S arrival.



Borehole Geophysics

To the left is a 2D vertical cross section of a 3D downhole acoustic tool model. The source and receiver sections can be isolated, as shown, to simulate wireline, or connected for logging-while-drilling (LWD). The dipole traces and time semblance analysis results are shown to the right. This model is used to compare wireline and LWD tool designs.

Reservoir Scale Seismics

The presence of fractures affects fluid flow in hydrocarbon reservoirs, so the characterization of in situ fractures can be vital to optimizing reservoir production.

The model shown here is part of a study of the scattered wavefield due to aligned vertical fractures. The fractures, shown as blue lines, have a mean spacing of 0.4 times the P wavelength. The colormap has been exaggerated to show the scattered energy.

