Supporting Information:

Shear-Wave Radiation Patterns from Explosive and Earthquake Sources in Scattering, Heterogeneous Media

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Contents:

Contents of *.zip file:

We have included relevant Par_Files, station files, and source files for SPECFEM2D and SPECFEM3D_GLOBE. They can be found here: Nelson, Peter; Creasy, Neala (2025), "Shear-Wave Radiation Patterns from Explosive and Earthquake Sources in Scattering, Heterogeneous Media", Mendeley Data, V2, doi: 10.17632/54kkx44886.2

Table S1. Elastic tensors for SPECFEM2D in Voigt notation. All values are to the power of 1e11. Units are in Pascals. For the isotropic model, Vp is 7783 m/s, Vs is 4500 m/s, and density is 3260 kg/m^3. C15, C35, C66, and C25 are zero.

Model	**C11**	**C13**	**C33**	**C55**	**C12**	**C23**
Isotropic	1.9747	0.6544	1.9747	0.6602	0.6544	0.6544
VTI	2.3894	0.7711	1.5995	0.5347	0.7919	0.7711
HTI	2.3894	0.7919	2.3894	0.7988	0.7711	0.7711

Figures:

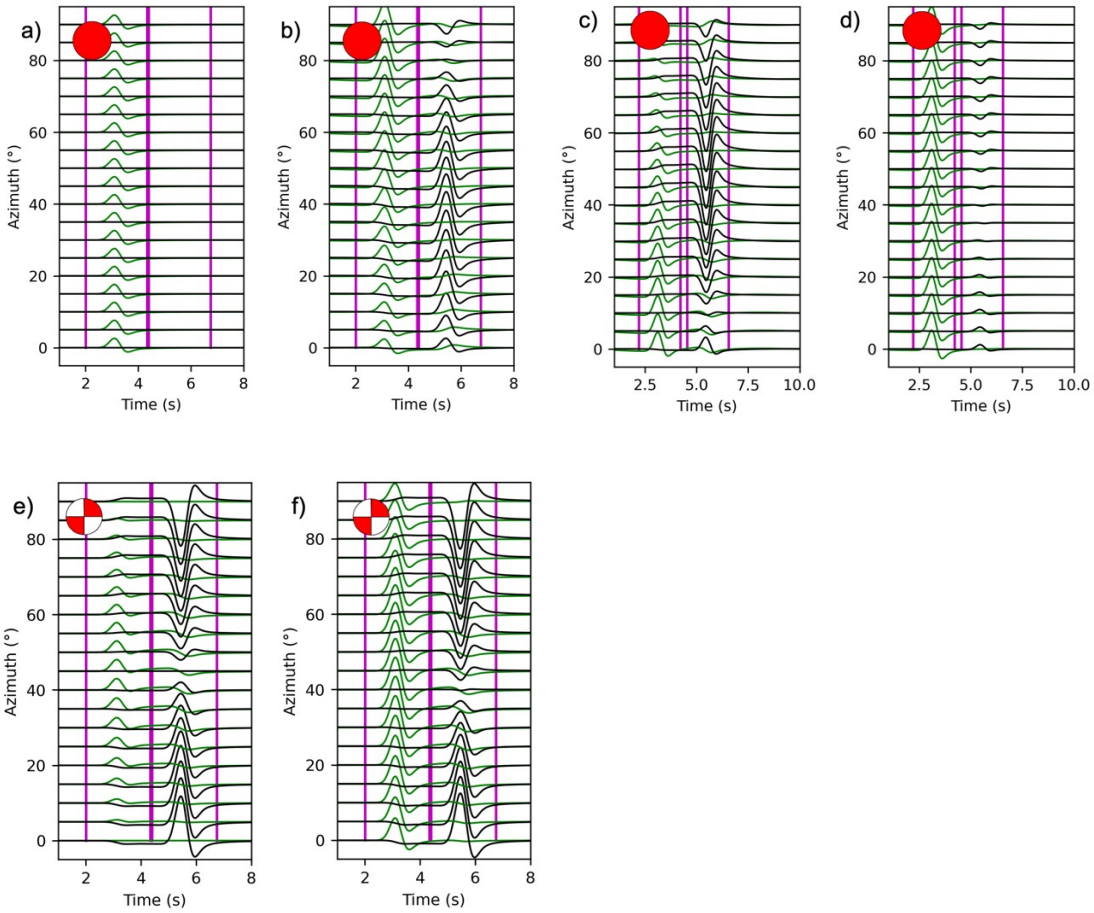


Figure S1: Corresponding seismograms in reference to Figure 3 in the main text. Vertical magenta lines are the window selections for P- and S-wave arrivals. Radial and transverse components are represented as green and black lines, respectively. Beachballs represent the source type. (a, e) Homogenous medium is placed around the source. In the first heterogenous case (b, f), a 1 km region of randomized velocity anomalies of either positive 25% or negative 25% velocity and density variations are placed around the source, similar to a checkerboard. We also tested a Gaussian autocorrelation function (ACF) with an RMS

of 25% (c) and 10% (d) and a correlation length of 35 m with an explosive source. The source and receiver geometry are that of Figure 2 and the dominant frequency of the sources are 1 Hz.

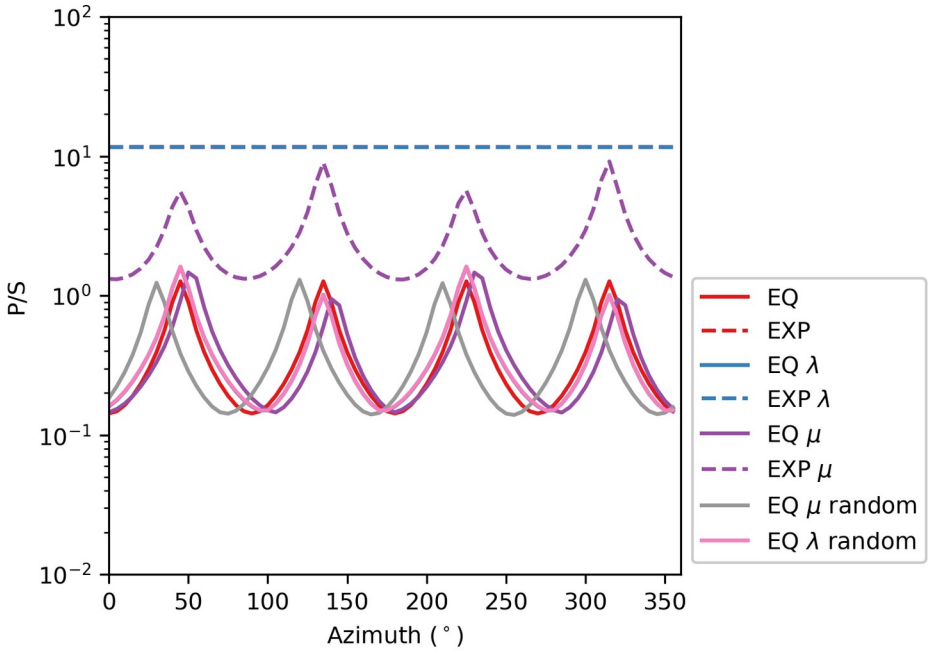


Figure S2: The farfield S-wave is a result between the interaction of the source heterogeneities, specifically changes in rigidity. We illustrate simulations of P/S ratios in 2D by only using small-scale heterogeneities by varying three separate variables: density (ρ) and the Lamé parameters (λ and μ). For each scenario, we simulated a 1 km region of small-scale heterogeneities where we randomized only density (orange lines) or one of the Lamé parameters (λ = blue lines and μ = purple lines) by ±25% for earthquake and explosive sources. Red lines are for the presence of no small-scale heterogeneities and exactly match the orange density perturbation simulations.

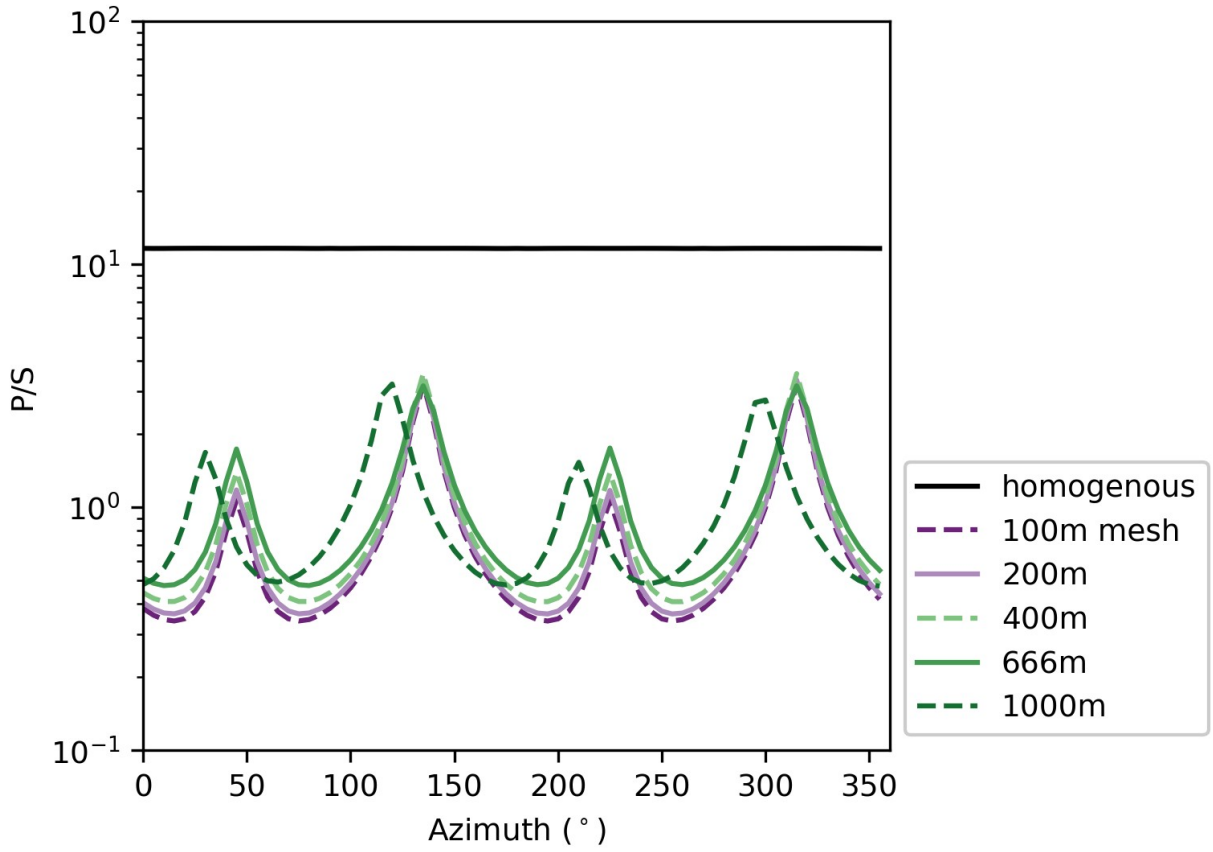


Figure S3: Windowed P/S ratios for 2D synthetic seismograms plotted as a function of azimuth from the source for different mesh sizes with an explosive source. In all scenarios, there is a region of small-scale heterogeneities except for the homogenous case (black line with a mesh spacing of 200 meters), but we vary the mesh resolution (element size) of the entire simulation (100 meters = dashed dark purple, 200 m = light purple, 400 m = dashed light green, 666 m = solid medium green, and 1000 m = dashed dark green). In all other simulations we use 200 m mesh. Within this anomaly, we simulate a region of small-scale heterogeneities that is 1 km large, where the anomalies are represented as randomly alternating between ± 25% Vp, Vs, and density from the background values.

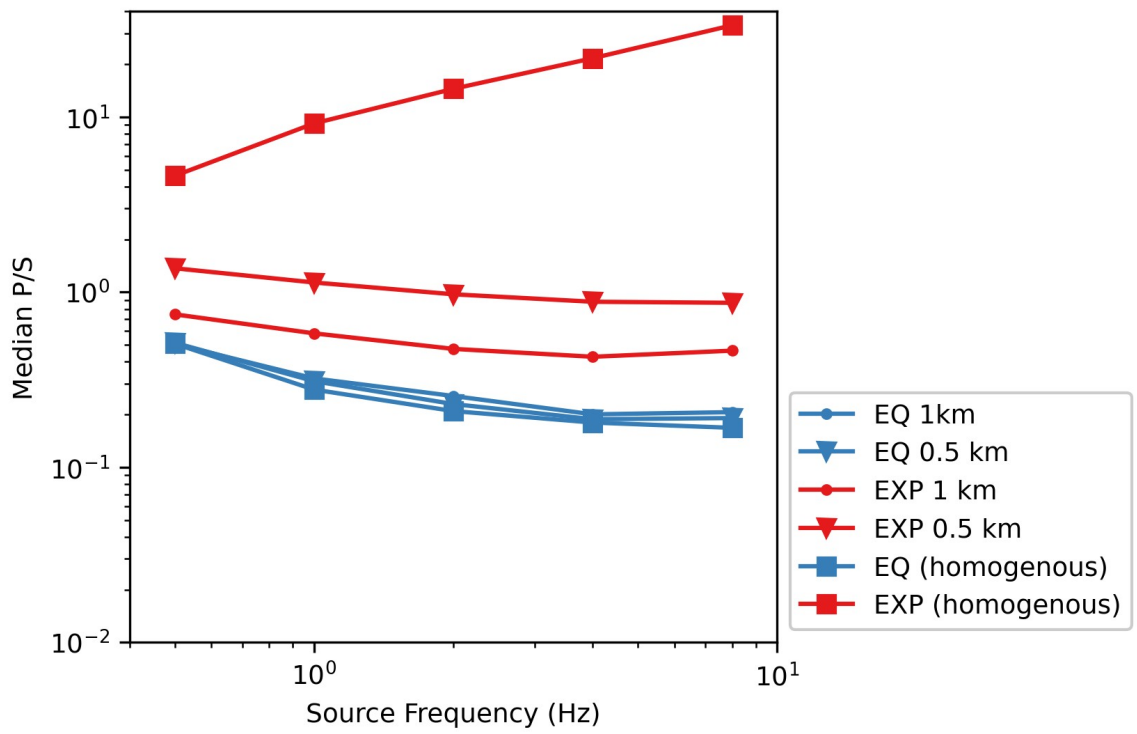


Figure S4: Median P/S ratios for all azimuths of each simulation type from Figure 7 in the main document for different source frequencies. Red lines represent explosive sources, and blue lines are earthquake (strike slip) sources. Circles are for simulations with a 1km region of small-scale heterogeneities; triangles are for simulations with 0.5 km region of small-scale heterogeneities; and squares include no small-scale heterogeneities. Additional simulations are included for the homogeneous case with the same source types used (earthquake and explosion).

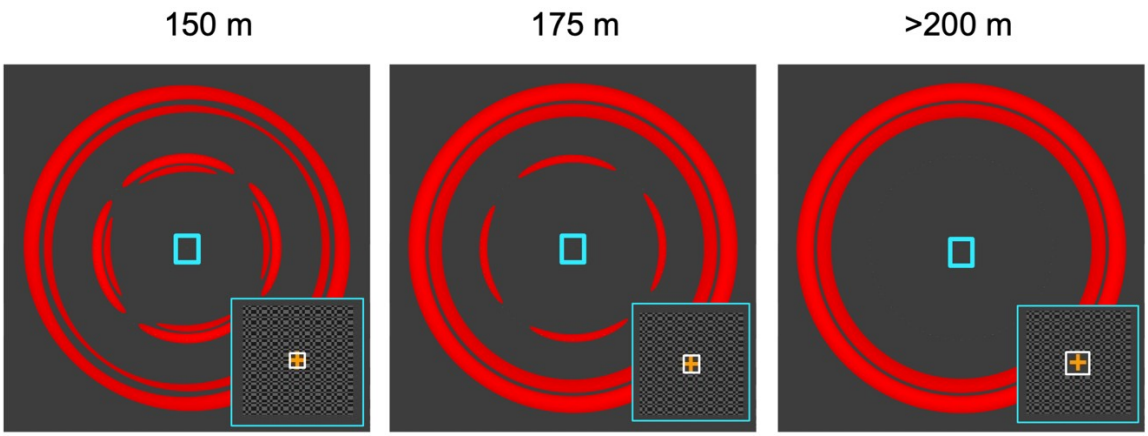
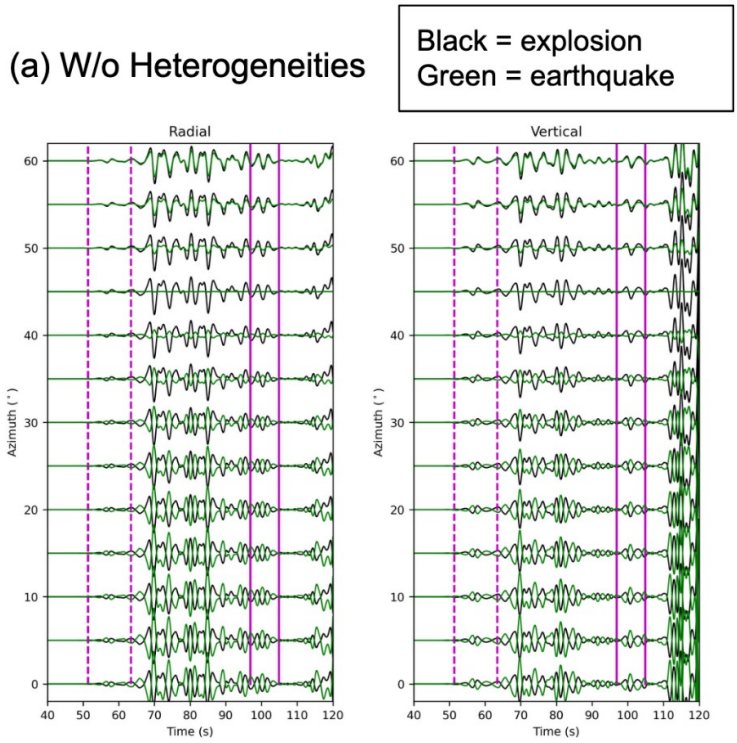


Figure S5. Wavefield snapshots at 6.5 seconds for set of simulations displayed in Figure 6. Each simulation contains a ring of small-scale heterogeneities in the source region, but they differ by have a small patch around the source itself that is homogenous. The first case has a small homogeneous region that is 150 m by 150 m, then followed by 175 m region, and lastly the 200 m region. The insets shows region of heterogeneities (1 km by 1 km) with a smaller region of homogenous values (white box) around the source (yellow cross).


(a) W/o Heterogeneities
Black = explosion
Green = earthquake
Radial
Vertical
Azimuth (°)
Time (s)

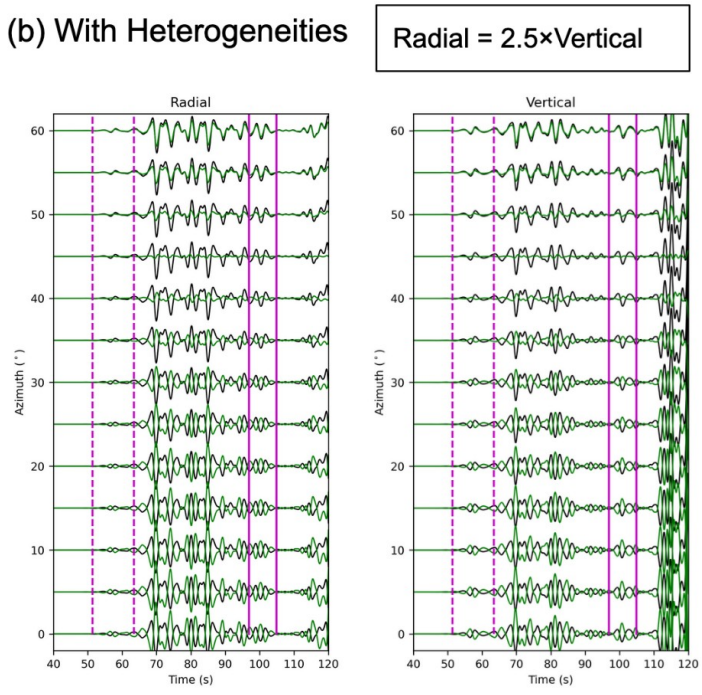

(b) With Heterogeneities
Radial = 2.5×Vertical
Radial
Vertical
Azimuth (°)
Time (s)

Figure S6: (a) Corresponding vertical and radial component synthetic waveforms to Figure 11 in the main text of explosion (black) and earthquake (green) simulations without heterogeneities, while (b) includes heterogeneities. The P-wave and S-wave arrivals are within the dashed and solid magenta lines, respectively.