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Imaging and characterizing shallow sedimentary strata using teleseismic arrivals recorded on linear seismic arrays

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Unconsolidated, near-surface sediments can influence the amplitudes and frequencies of ground shaking during earthquakes. Ideally these effects are accounted for when determining ground motion prediction equations and in hazard estimates summarized in seismic hazard maps. This study explores the use of teleseismic arrivals recorded on linear receiver arrays to estimate the seismic velocities, determine the frequencies of fundamental resonance peaks, and image the major reflectors in the Atlantic Coastal Plain (ACP) and Mississippi Embayment (ME) strata of the central and southeastern United States. These strata have thicknesses as great as 2 km near the coast in the study areas, but become thin and eventually pinch out landward. Spectral ratios relative to bedrock sites were computed from teleseismic arrivals recorded on linear arrays deployed across the sedimentary sequences. The large contrast in properties at the bedrock surface produces a strong fundamental resonance peak in the 0.2 to 4 Hz range. Contour maps of sediment thicknesses derived from drill hole data allow for the theoretical estimation of average velocities by matching the observed frequencies at which resonance peaks occur. The sloping bedrock surface allows for calculation of a depth-varying velocity profile, under the assumption that the velocities at each depth do not change laterally between stations. The spectral ratios can then be converted from frequency to depth, resulting in an image of the subsurface similar to that of a seismic reflection profile but with amplitudes being the spectral ratio caused by a reflector at that depth. The complete data set thus provides an average velocity function for the sedimentary sequence, the frequencies and amplitudes of the major resonance peaks, and a subsurface image of the major reflectors producing resonance peaks. The method is demonstrated using three major receiver arrays crossing the ACP and ME strata that originally were deployed for imaging the crust and mantle, confirming that teleseismic signals can be used to characterize sedimentary strata in the upper km.