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Low frequency spectral modification of geoseismic background noise due to interaction with oscillating fluids entrapped in subsurface porous rocks

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In this study, low frequency spectral modifications of the ever present geoseismic background waves (noise) due to their interaction with partially saturated porous rocks are investigated. A non-wetting fluid drop entrapped in a pore can oscillate with a characteristic eigenfrequency. Capillary forces act as the restoring forces driving the oscillations. A 1D wave equation is coupled with a linear oscillator equation, which represents these pore fluid oscillations. The resulting linear system of equations is solved numerically with explicit finite differences. The seismic background noise is reduced to its dominant frequency (0.1-0.3Hz), which is presumably related to surface waves generated by ocean waves. This frequency is used as the external source in the momentum balance equation of the elastic medium. It is shown that the resulting incident monochromatic wave initiates oscillation of the pore fluid which thereafter oscillates with its eigenfrequency. The oscillatory energy of the fluid drops is transferred continuously to the elastic rock. A first effect of this transfer is the decay of amplitude of the pore fluid oscillation. The second effect is that the elastic rock carries the eigenfrequency of the pore fluid oscillation on top of the external frequency. After applying a Fourier transformation to the velocity of the elastic rock, which can be recorded at any point, the spectrum shows two distinct peaks: the external frequency and the eigenfrequency of the pore fluid oscillation. Interestingly, such low frequency spectral modifications of the seismic background noise are observed above hydrocarbon reservoirs. The presented model is considered as one possible explanation for such modifications. Time evolution of the decaying amplitude of the pore fluid oscillation seems to be related to the thickness of the porous rock, i.e. the hydrocarbon reservoir.