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Wave propagation phenomena in residual-saturated rocks

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Understanding the dynamical and acoustical behavior of porous and heterogeneous rocks is of great importance in geophysics, e.g. earthquakes, and for various seismic engineering applications, e.g. hydrocarbon exploration. Within a heterogeneous medium, oscillations with a characteristic resonance frequency, depending on the mass and internal length of the heterogeneity, can occur. When excited, heterogeneities can self-oscillate with their natural frequency. Another example of internal oscillations is the dynamical behavior of non-wetting fluid blobs or fluid patches in residually saturated pore spaces. Surface tension forces or capillary forces act as the restoring force that drives the oscillation. Whatever mechanism is involved, a resonance phenomenon within a heterogeneous medium will have an effect on acoustic or seismic waves propagating through such a medium, i.e. wave velocity dispersion and frequency-dependent attenuation. In the present investigation, we present a macroscale continuum model for porous rocks saturated with a continuous gas/non-wetting phase and a discontinuous oil/wetting phase. Prominent effects of the model are frequency-dependent wave propagation mechanism (dispersion) and internal oscillation phenomena depending on the internal length scale of the oil blobs.