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Scattering Characterization of Elastic Wave in Solid Media and Scale Inversion Study of Inhomogeneous Bodies

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ABSTRACT

One intriguing phenomenon in seismograms is seismic coda, once dismissed as noise. In 1969, seismologist Aki proposed that these coda waves reveal critical insights into small-scale inhomogeneities in the Earth's interior [1]. This scattering effect highlights geological complexity and offers valuable information for exploring targets like unconventional oil and gas reservoirs [2-5]. This paper examines elastic wave propagation and scattering in solid media. We validate the effectiveness of simulating wave field scattering by employing the discrete element method alongside energy radiative transfer theory. Then, we explore elastic wave scattering and scale inversion of non-homogeneous bodies in discrete and continuous media. Our discrete medium model assesses how boundary conditions and source characteristics influence wave scattering through simulations with absorbing and rigid boundaries, demonstrating successful inversion of characteristic lengths using the energy radiative transfer equation. Additionally, we analyze the impact of grading levels and element distributions on inversion outcomes in the continuous medium model, using both non-normalized and normalized data processing methods. Our findings indicate that the normalized method provides greater accuracy in scale inversion, while the energy transfer equation can effectively capture the inhomogeneity scales across various distributions.

KEYWORDS

Elastic wave scattering; inhomogeneous body; scale inversion; radiative transfer equation; discrete element method

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