Small-scale-induced anisotropy of a 3D subsurface model: quantitative analysis and numerical simulations of waves within

Cupillard, Paul; Mulder, Wim; Irakarama, Modeste; Mazuyer, Antoine; Anquez, Pierre

Small-scale-induced anisotropy of a subsurface model: quantitative analysis and numerical simulations of waves within

Within the last decade, non-periodic homogenization proved to be an accurate upscaling method for computing smooth equivalent media of elastic models of the earth interior. Doing so, it reveals the seismic anisotropy induced by small-scale structures and it eases the numerical simulation of wave propagation in complex geological settings by preventing from the use of fine and complex meshes or grids, provided that wave simulators can take anisotropy into account. In the present work, we investigate the small-scale-induced anisotropy of a typical subsurface model, namely the SEG-EAGE overthrust, for a fmax = 10Hz wavefield. We find that the amount of anisotropy can reach 20% locally and that orthorhombic anisotropy can be a poor approximation in some areas, suggesting that the analysis of datasets in terms of orthorhomby may be not relevant. However, while low-symmetry classes of anisotropy are naturally handled by the spectral-element method (SEM), they challenge the finite-difference method (FDM) in terms of implementation and computation cost. To estimate the benefit of using homogenized media in either SEM or FDM codes, we perform numerical simulations in both the initial overthrust model and its smooth version, using either regular SEM meshes or FDM grids of different resolution. We compare the obtained waveforms with a reference solution, which allows us to study the accuracy of the simulations as a function of the computation cost for both the SEM and the FDM.

Paul Cupillard 1, Wim Mulder 2,3, Modeste Irakarama 1, Antoine Mazuyer 1,4 and Pierre Anquez 1
[(1)University of Lorraine, GeoRessources laboratory, Vandoeuvre-les-Nancy, France, (2)Delft University of Technology, Delft, Netherlands, (3)Shell Global Solution International B.V., Amsterdam, Netherlands, (4)Stanford University, Palo Alto, CA, United States]