3D Simulations of Sonic and Resistivity Borehole Logging Measurements Using a Fourier hp Finite Element Method.

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ABSTRACT

Resistivity and sonic logging instruments are routinely used to assess and evaluate the Earth's subsurface properties and, in particular, to determine zones rich in hydrocarbons (oil and gas). Computer-aided simulations of measurements acquired with resistivity and sonic logging instruments are critical for the proper understanding of the measurements in actual logging conditions.

In this presentation, we describe a multiphysics hp-Fourier Finite Element method for simulation of sonic and resistivity borehole logging measurements in different subsurface scenarios. The resulting frequency domain based software combines a Fourier series expansion in one spatial dimension with a two-dimensional hp-Finite Element Method (FEM), and it also incorporates a Perfectly Matched Layer (PML) for truncation of the computational domain. The simulation method has been verified for various model problems, including a comparison with analytical solutions we have developed for this purpose.

Numerical results indicate that properly designed logging instruments are able to sense different material properties in the subsurface, including estimation of the main geophysical properties (such as length and thickness) of artificial hydrofractures typically used to enhance hydrocarbon recovery from a reservoir.