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基于微CT技术的砂岩数字岩石物理实验

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Digital rock physics of sandstone based on micro-CT technology

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摘要 数字岩石物理技术可弥补传统岩石物理实验的诸多不足，为岩石物理学研究提供一个新平台.本文以常规砂岩为研究对象，利用微CT扫描结合先进的图像处理技术建立了具有真实孔隙结构特征的三维数字岩芯模型；应用Avizo软件内含的多种形态学算法进行数字岩芯孔隙结构量化及表征研究，统计获取了孔隙度、孔隙体积分布及孔径分布特征，建立了等价孔隙网络模型；将Avizo与多场耦合有限元软件Comsol完美对接，实现了孔隙尺度的渗流模拟并计算获得绝对渗透率，对于考虑固相充填孔隙的情况，模拟计算了岩石有效弹性参数，并与近似Gassmann方程良好验证.本文所提出的将Avizo与Comsol结合使用的方法丰富了现有的数字岩石物理研究手段，为其大规模发展提供了一条新途径.

关键词 数字岩石物理, 砂岩, 孔隙结构, 微CT扫描, 岩石物理参数

Abstract: Digital rock physics technology makes up for the disadvantages of traditional petrophysical experiments, and has opened up a new platform for petrophysics research. Taking sandstone as study object, this paper introduces a systematic process of digital rock physics: based on micro-CT scanning and advanced image processing technology we build a three-dimensional digital core model with real pore structure characteristics; with the application of Avizo software which contains a variety of morphological algorithm, the research of quantification and characterization of the pore structure is conducted, the porosity, pore volume distribution and pore size distribution characteristics are obtained by statistical methods, and the equivalent pore network model is built; the Avizo and Comsol multiphysics softwares are interactively combined in this paper, which realize the pore-scale flow simulation as well as the absolute permeability calculation; for the case of the solid phase pore-filling, the effective elastic parameter of the rock is simulated, the result has a good validation with the approximate Gassmann equation. Our study enriches the existing research approaches of digital rock physics, simultaneously opens up a new pathway for its wide-scale development.

Keywords Digital rock physics, Sandstone, Pore structure, Micro-CT scanning, Petrophysical parameters

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