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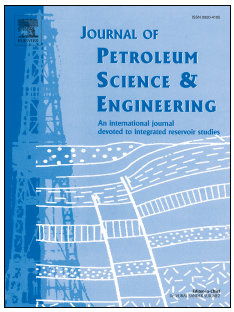

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4D multi-physical stress modelling during shale gas production: a case study of Sichuan Basin shale gas reservoir, China

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Abstract: To investigate the time-lapse, three-dimensional (4D) stress during shale gas production, a multi-physical modeling method is proposed. This model enfranchises multiple years' scale dynamic production data. A finite difference method (FDM) reservoir simulator is used to couple thermal-hydrological-chemical (THC) processes, while a finite element method (FEM) geomechanical simulator takes on the role of a thermal-hydrological-mechanical (THM) coupling calculator. In order to couple the flow model with the geomechanical model, an interface (coupling) Python code is provided to communicate data between the finite difference (FD) and finite element (FE) grids. A set of FORTRAN routines are assigned to interpolate initial stress field and mechanical parameters into the geomechanical model based on field and experimental data. Ultimately, a 4D multi-physical model of Sichuan Basin shale gas reservoir (China) is proposed and analyzed. Based on the simulation results, the continuous reduction in reservoir pore pressure leads to evolving changes in the stress state and reservoir properties beyond the pre-consolidation pressure. Transversely isotropic characteristics have a considerable effect on the changes in the reservoir stresses and poro-elastic parameters. The results provide some fundamental insights for optimizing well patterns, ensuring wellbore stability, re-fracturing design and locating, drilling and completing infill wells.

Keywords: Multi-physical modeling; 4D stress; Sichuan Basin shale gas reservoir; Interface code; Transverse isotropy