MICROMECHANICAL COMPUTATIONAL MODELING OF RESERVOIR COMPACTION AND SURFACE SUBSIDENCE

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Abstract

A micromechanical computational model of overburden subsidence and compaction of a naturally fractured reservoir due to fluid extraction is proposed. The deformable reservoir is characterized by two levels of hydrodynamics (flow in micro and macropores) and its computational treatment is based on a micromechanical analysis of dual porosity systems, i.e. media locally characterized by a porous matrix composed of permeable matrix blocks and the surrounding system of fractures. The homogenization technique is applied to upscale the constitutive relations available in the fine structure to the field scale. Application of this procedure yields a microstructure model of dual porosity type, wherein the poroelastic matrix blocks act as distributed sources/sinks of mass and momentum to the global macroscopic medium. The microstructural model is able to incorporate delayed secondary subsidence phenomenon, which is induced by creep effects arising from the delayed drainage of the fluid in the micropores. A two-level finite element method is proposed to solve the coupled micro-macro governing equations of dual porosity type. Numerical experiments are performed showing the influence of creep effects on the surface subsidence of an oil-field during primary recovery. The results show the strong potential of the proposed formulation in solving coupled hydro-mechanical problems with microstructure which commonly appear in reservoir simulation.

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