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Investigation of the effect of stress states on hydro-mechanical behaviors of reservoir rock under fluid injection

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Injecting fluid into the formation is an effective solution for improving the permeability and production of a target reservoir. The evaluation of economy and safety of injection process is a challenging issue faced in reservoir engineering [1-2]. As known, the relative magnitude and direction of the principal stresses significantly influence the hydro-mechanical behavior of reservoir rock during fluid injection. However, due to the limitations of current testing techniques, it is still difficult to comprehensively conduct laboratory injection tests under various stress conditions, e.g. triaxial extension stress states [3]. To this end, a series of numerical simulations were carried out on reservoir rock to study the hydro-mechanical changes under different stress states during fluid injection. In this modelling, the saturated rock is first loaded to the target stress state under drainage conditions, and then the stress state is maintained and water is injected from the top end to simulate the reservoir injection process. Particular attention is paid to the difference in hydro-mechanical changes under triaxial compression and extension stresses. This includes the difference of the pore pressure propagation, mean effective stress, volumetric strain, and stress-induced permeability. The numerical results demonstrate that the differential stress will significantly affect the hydro-mechanical behavior of target rock, but the degree of influence is different under the two triaxial stress states. The hydro-mechanical changes caused by the triaxial compression stress states are generally greater than that of extension, but the difference decreases with increasing differential stress, indicating that the increase of the differential stress will weaken the impact of the stress state on the hydro-mechanical response. This study can deepen our understanding of the stress-induced hydro-mechanical coupling process in reservoir injection engineering.

Keywords: Reservoir injection; Subsurface flow; Hydro-mechanical coupling; Stress state; Triaxial experiment modelling

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