Monitoring hydromechanical responses in aquifer by distributed fiber-optic strain sensing: From lab to field

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Pore fluids control deformation of porous media by the fluid-to-solid hydromechanical (HM) coupling in which a change in fluid pressure can modify the effective stress and deform the porous medium (Wang, 2000). The HM coupling mechanism provides a possibility that to understand aquifer characteristics and fluid activities during fluid extraction and/or injection operations, e.g., in geological CO_2 storage (GCS), by monitoring rock strain changes. We successfully measured such HM deformations using a high-resolution distributed fiber optic strain sensing (DFOSS) tool in both laboratory and field scale studies. From the DFOSS-obtained HM information, we are able to track the pressure impact zone, understand the permeability structure of the aquifer formation and identify the preferential flow layers. Moreover, we can track the fluid migration front during CO_2 displacing water and the mechanical response of CO_2 breaking through to a low-permeability layer or caprock. The application of DFOSS would be beneficial to guide the aquifer pressure management for safe GCS with prior or simultaneous water extraction (Buscheck et al., 2012).

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