Application of Tidal Response of Groundwater to Caprock Confinement in CO_2 Geological Sequestration

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Aquifers deeper than 800 m and confined by thick and extensive aquitard are supposed to be suitable for the sequestration of CO_2, whereas, nowadays, groundwater leakage is an incremental vital problem (e.g., US Environmental Protection Agency, 2016). Hence, sustained observation of the confinement of aquifers should be needed to detect any leakage. Here, 1)-we proposed to combine the lunar diurnal (O_1) and semidiurnal (M_2) tidal responses to improve the calculations based on the tidal response leaky model, which provides an effective means for long-term fluid leakage monitoring; and review the leakage model under complex conditions (heterogeneity and anisotropy induced by shale) to evaluate reservoir sealing more accurately; Those have scientific guiding and application values to the actual engineering site selection. 2)-Besides, we also proposed to combine the O_1 and M_2 tidal components to improve the calculations based on the tidal response fracture model, which is used to calculate the distribution of near-surface fractures economically, minimally invasive and accurately; That is important for oil and gas exploration, geothermal transmission, waste storage and downward leakage of the surface wastes. 3)-In addition, we also compared the above two models and analyzed the application conditions: In the leaky aquifer model, changes arise from changes in permeability and storage, which calls for the homogeneous and isotropic aquifers; in the fracture model, changes are due to changes in apparent orientation of transmissive fractures, which calls for the relatively high permeability aquifers, so that the pore-pressure could distribute uniformly quickly, and that the well senses the change in pressure in the fracture as tidal strains compress and dilate the fracture. We conclude that relatively high permeability aquifers are less susceptible to impacts from seismic waves, and thus have small changes in water levels and hydrogeological properties.

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