Application of noble gas to alarm the CO_2 leak and to constrain the mass distribution of leaking plume for different leakage conditions

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Noble gas tracer has been used to understand the various reservoir interactions governing the mass distribution of CO_2-rich plume in geological carbon storage site. However, its applicability has been limited to reservoir scale and not been actively used for monitoring work in a shallow aquifer system even though it is frequently adopted for the public water resources. This study aims to delineate overall physical processes involved in the mass balance of the CO_2 plume using noble gas tracers while CO_2-rich plume moved in a shallow aquifer system. Two times of artificial injection were performed to simulate the CO_2 leakage event in a shallow groundwater system. Firstly, a brief leakage event was assumed where small amount of CO_2 entered the shallow groundwater system and moved in a natural pressure gradient. Secondly, a massive amount of CO_2-rich water was released into shallow aquifer and plume moved in a steep pressure gradient system during leakage event. In both cases, overall mass distribution of CO_2 and noble gas was explained in the physical interactions such as solubility-controlled process and mixing process. The massive injection test, however, showed the different evolution pattern at the plume boundary at which light element fastly returned to background level by diffusion process. Therefore, the heavier noble gas showed a faster respondse at monitoring point compared to the light element. This study defined that the monitoring efficiency of noble gas tracer is dependent on the leakage condition.