Detecting inter-aquifer leakage and recharge using multiple environmental tracers

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Inter-aquifer leakage can be an important component of groundwater flow with relevance to groundwater resource evaluation and extraction industries including ore extraction and unconventional gas. The presence of secondary permeability features or preferential pathways through an aquitard can increase the rate of fluid movement causing enhanced inter-aquifer leakage and can be identified by variations from expected environmental tracer behaviour.

Inter-aquifer leakage and recharge in a regional sedimentary basin were investigated in an arid environment using an integrated approach.

The methodology incorporated geological, hydrogeological and hydrochemical information in the basin to determine the likelihood and location of inter-aquifer leakage. The suite of environmental tracers and isotopes used included $\delta^{18}O$, $\delta^{2}H$, ^{14}C, ^{36}Cl, $^{87}Sr/^{86}Sr$, He and U isotopes. Of particular benefit was the analysis of hydraulic heads and environmental tracers at bore couplets, comprising bores above and below an aquitard within a localised geographical area.

The methodology was successful in investigating inter-aquifer leakage and recharge in the western margin of the Great Artesian Basin, South Australia. There is evidence for inter-aquifer leakage in the centre of the basin ~40 km along a regional flow path. This was identified by a slight draw-down in the upper aquifer during pumping in the lower aquifer. By combining tracer based dating techniques (e.g. ^{4}He) with the analysis of reactive tracers (e.g. $^{87}Sr/^{86}Sr$) in bore couplets, we were able to identify changes in groundwater residence time and isotopic signals in response to rapid water movement from one aquifer to another.