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A method to investigate inter-aquifer leakage using hydraulics and multiple environmental tracers

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Informed aquifer management decisions regarding sustainable yields or potential exploitation require an understanding of the groundwater system (Alley et al. 2002, Cherry and Parker 2004). Recently, the increase in coal seam gas (CSG) or shale gas production has highlighted the need for a better understanding of inter-aquifer leakage and contaminant migration. In most groundwater systems, the quantity or location of inter-aquifer leakage is unknown. Not taking into account leakage rates in the analysis of large scale flow systems can also lead to significant errors in the estimates of groundwater flow rates in aquifers (Love et al. 1993, Toth 2009). There is an urgent need for robust methods to investigate inter-aquifer leakage at a regional scale.

This study builds on previous groundwater flow and inter-aquifer leakage studies to provide a methodology to investigate inter-aquifer leakage in a regional sedimentary basin using hydraulics and a multi-tracer approach.

The methodology incorporates geological, hydrogeological and hydrochemical information in the basin to determine the likelihood and location of inter-aquifer leakage. Of particular benefit is the analysis of hydraulic heads and environmental tracers at nested piezometers, or where these are unavailable bore couplets comprising bores above and below the aquitard of interest within a localised geographical area.

The proposed methodology has been successful in investigating inter-aquifer leakage in the Arckaringa Basin, South Australia. The suite of environmental tracers and isotopes used to analyse inter-aquifer leakage included the stable isotopes of water, radiocarbon, chloride-36, 87Sr/86Sr and helium isotopes. There is evidence for inter-aquifer leakage in the centre of the basin ~40 km along the regional flow path. This inter-aquifer leakage has been identified by a slight draw-down in the upper aquifer during pumping in the lower aquifer, overlap in Sr isotopes, δ2H, δ18O and chloride concentrations as well as hydrochemical evidence of mixing with shallower groundwater with shorter residence times.

References

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