Multi-tracer approach to investigate groundwater recharge and aquifer connectivity in the Clarence-Moreton and eastern Surat basins in southeast Queensland

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The Walloon Coal Measures (WCM) in the Clarence-Moreton and the Surat basins in QLD and northern NSW contain up to approximately 600 m of mudstone, siltstone, sandstone and coal. Wide-spread exploration for coal seam gas (CSG) within both basins has led to concerns that the depressurisation associated with the resource development may impact on water resources in adjacent aquifers. In order to predict potential impacts, a detailed understanding of sedimentary basins hydrodynamics that integrates geology, hydrochemistry and environmental tracers is important. In this study, we show how different hydrochemical parameters and isotopic tracers (i.e. major ion chemistry, dissolved gas concentrations, δ2H and δ13C of CH4, δ13C-DIC, δ18O, δ2H, 87Sr/86Sr, 3H, 14C and 36Cl) can help to improve the knowledge on groundwater recharge and flow patterns within the coal-bearing strata and their connectivity with over- or underlying formations.
Dissolved methane concentrations in groundwaters of the WCM in the Clarence-Moreton Basin range from below the reporting limit (10 µg/L) to approximately 50 mg/L, and samples collected from nested bore sites show that there is also a high degree of vertical variability within the aquifer. Other parameters such as 3H, δ13C & 14C in DIC collected along assumed flow paths are also highly variable, which indicates local groundwater flow cells rather than regional flow. In contrast, 87Sr/86Sr isotope ratios of WCM groundwaters are very uniform and distinct from groundwaters contained in other sedimentary bedrock units. This suggests that 87Sr/86Sr ratios may be a suitable tracer to study hydraulic connectivity of the Walloon Coal Measures with over- or underlying aquifers, although more studies on the systematic are required. Overall, the complexity of recharge processes, aquifer connectivity and within-formation variability confirms that a multi-tracer approach is required to understand aquifer connectivity in these sedimentary basins.