

## Assessing connectivity between an aquifer and coal seam gas production using water geochemistry and methane isotopes.

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Expanding coal seam gas (CSG) production has created public concern surrounding the impact on groundwater quality and quantity in adjacent or overlying aquifers. To address this potential risk, we need to map pathways of hydraulic connectivity. We show that the combined measurements of methane (CH<sub>4</sub>) concentration and isotopic composition, dissolved organic carbon (DOC) concentration and tritium (3H) activity can highlight pathways of connectivity between the Walloon Coal Measures (WCM), the target formation for CSG production, and the Condamine Alluvium in the Condamine Catchment, south-east Queensland, Australia. At 17 locations, both groundwater and degassing air samples were collected from irrigation bores. The degassing air samples were collected by pumping gas into 3 L Tedlar bags. This air was analysed for both its methane concentration and isotopic signature using a Picarro 2132-i analyser. The groundwater at each location was analysed for 3H, by counting beta decay events in a liquid scintillation counter, and for [DOC], measured by isotope mass spectrometry. To determine the isotopic signature of the WCM methane ambient air samples were collected adjacent to CSG co-produced water holding ponds. These samples were also analysed using the Picarro 2132-i analyser. We then used isotopic mixing plots to identify the source signature of CH<sub>4</sub> in the degassing irrigation bore samples and the ambient air samples adjacent to CSG water storage dams. Within the mixing plots samples graph along clear trend lines, which allows water and gas sources to be assigned. The trends in the mixing plot indicate potential local hydraulic connectivity between the WCM and the overlying Condamine Alluvium. These results demonstrate that a combination of CH<sub>4</sub> concentration and isotopic analysis, as well as groundwater geochemical data, can provide an early indication of hydraulic connectivity in areas of CSG and shale gas production.