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Combining Radon and heat as tracers to characterise surface water and groundwater exchange pathways

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Heat and Radon (222-Rn) have both been used separately as natural tracers to quantify vertical streambed fluxes and to calculate water residence times in shallow alluvial systems. Both tracers have different advantages and limitations: Heat transport is measured through temperature changes at discrete spatial points in the streambed, and methods for the calculation of vertical flux time-series exist. By contrast, grab sampled Radon activities represent integration along a flow path but the discrete sampling means that only a snapshot in time can be obtained. A pumping test was conducted at Maules Creek (Australia) in order to artificially stress the stream-aquifer system. Water was continuously pumped from an extraction well located 40 m from the creek for 8 days. A flood event occurred during the pumping test adding another level of complexity to the system. The stream-aquifer response was monitored with a transect of 25 observation bores, of which 15 were regularly sampled for Radon activities. Additionally, a total of 4 temperature arrays, consisting of 4 temperature loggers each, were installed in the streambed to measure the sediment temperature over time. Vertical streambed fluxes were calculated using the temperature data. A joint interpretation of heat and Radon results reveals subsurface heterogeneity and distinct exchange pathways. This study shows the advantage of combining at least two different tracers in order to characterise a connected system.