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‘Multiple ‘old’ water sources in an upland catchment’

Alex Atkinson (1,2), Ian Cartwright (1,2), Ben Gilfedder (1,2), Harald Hofmann (1), Nicolaas Unland (1,2)

(1) School of Geosciences, Monash University, Clayton, VIC 3800, Australia (alexander.atkinson@monash.edu), (2) National Centre for Groundwater Research and Training (NCGRT), Flinders University, School of the Environment, Adelaide, Australia

The upper catchments of river systems often represent a significant proportion of the total catchment area, and are therefore a source of large volumes of fresh water. Where flow regimes are perennial, during the dry season river flow is controlled by ‘old’ water sources; determining the residence time and spatial distribution of old water discharge in these areas is important for regulating river flow and water quality further downstream.

Using environmental tracers such as major ions, stable isotopes (δ2H, δ18O), 222Rn and high precision 3H and 14C measurements, this study aims to characterise pathways and residence times of old water sources in the upper catchment of the Gellibrand River, located in the Otway Ranges of Victoria, Australia.

Between March 2011 and June 2012, water samples were taken from the main river channel, an upper catchment tributary (Barramunga River) and soil water and groundwater sources at a bimonthly frequency. Results from chemical mass balances using Cl, 222Rn and 3H demonstrate that where the aquifer is present the river is a largely gaining system with between 30-60% of river water derived from older groundwater, revealed by 14C analysis to be between 1,500 - 10,000 years old.

On the hillslopes of the upper catchment underlain by impermeable basement rock, the story is quite different. Old water here is stored in subsurface soil layers, draining through a network of diffuse surface and subsurface soil pipes toward the river. Using 3H data, river water draining from these hillslopes is calculated to have a mean age of 10 - 30 years, indicating that old soil water in these areas can have residence times on a decadal timescale.

This study highlights the need to understand the mechanism of hillslope soil piping, a phenomena that is being increasingly observed in river catchments around the world. Many questions still remain unanswered as to how are they are formed, how they transmit ‘old’ and ‘new’ water during baseflow and stormflow events, and what effect does this drainage pattern have in relation to water quality and in response to drought?