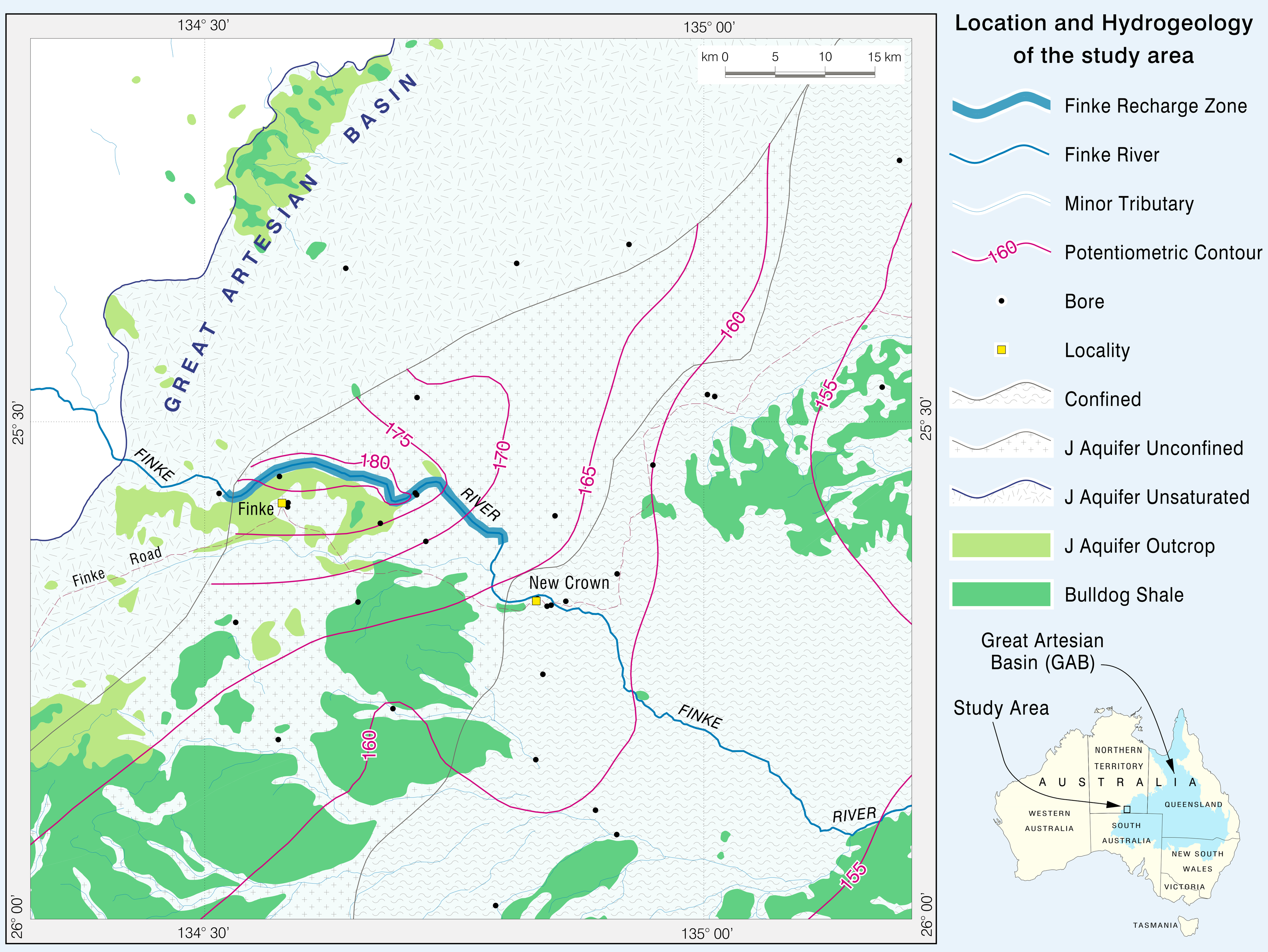
# CHARACTERISING RECHARGE THROUGH AN ARID ZONE RIVER USING AN ENVIRONMENTAL TRACER APPROACH


## BACKGROUND

The Great Artesian Basin (GAB) is Australia's largest water resource extending over 1.7 million square kilometers or 22% of the continent. Along the western margin of the GAB active recharge primarily results from episodic flow events in ephemeral rivers. Methods commonly employed to assess the recharge flux from focused river recharge are not applicable due to limited monitoring infrastructure and time series data, the irregularity of flood events and the remote nature of the study area. This investigation employs environmental tracers to characterise the spatial and temporal variation in focused recharge to the GAB aquifer.

The study area is centred around the Finke River located in central Australia approximately 200 km southeast of Alice Springs. Potential for focused recharge occurs along a discrete 35 km reach of the river between the basin margin and where the aquifer becomes confined by the overlying Bulldog Shale. The GAB aquifer (J aquifer) comprises a medium to coarse grained quartz sandstone. Average depth to groundwater in the recharge zone is 70 m below ground.

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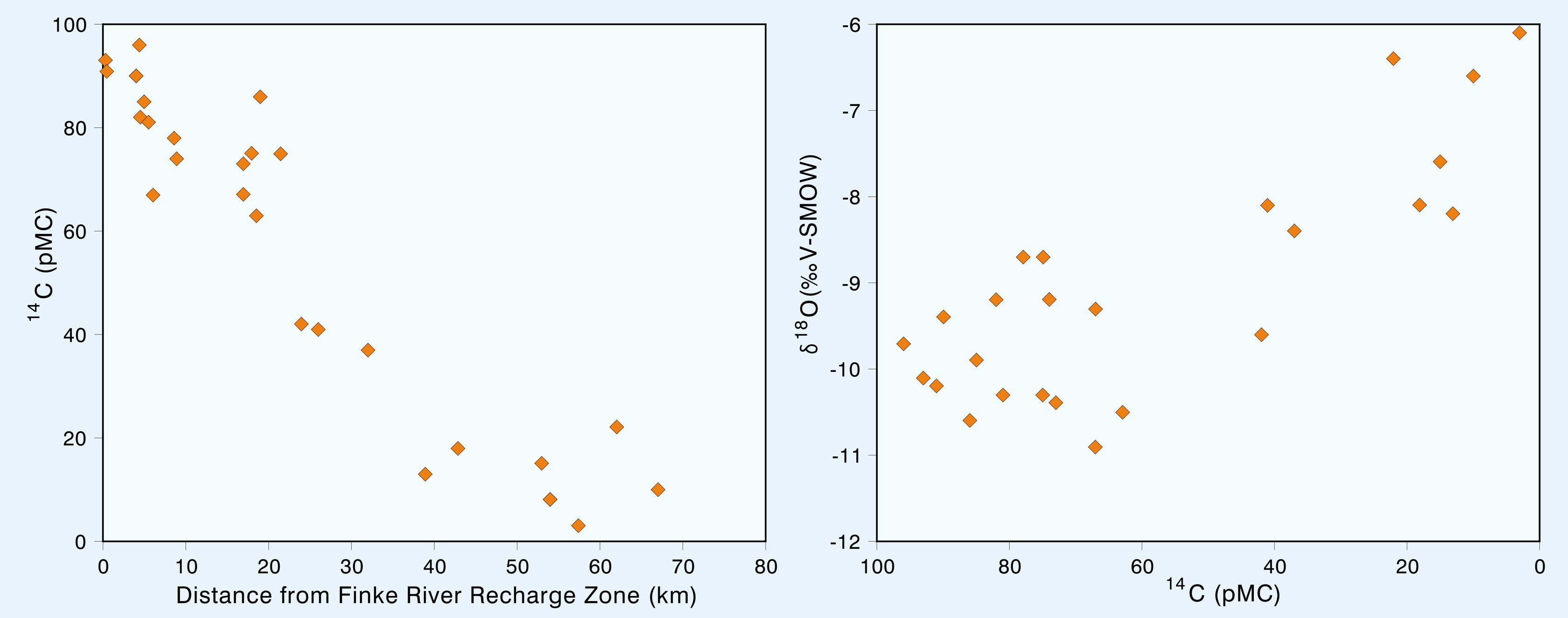
## RADIOCARBON

$^{14}C$ concentrations approach modern atmospheric levels adjacent to the Finke River and decrease down flow path away from the recharge zone indicating the Finke River is an active recharge sink. Younger groundwater (>70 pMC) shows a more depleted $\delta^{18}O$ signature in comparision to older groundwater (<20 pMC). Results suggest that older groundwater may have been recharged under a different palaeoclimate in which winter/spring rainfall was dominant. Alternatively results may imply older groundwater was emplaced through a different recharge mechanism (diffuse recharge as opposed to focused recharge).

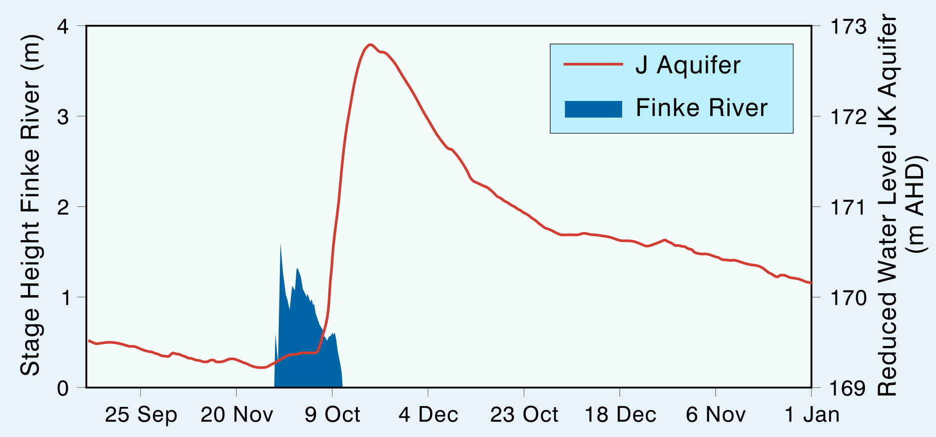



## RECHARGE RATES

Recharge rates were estimated using groundwater velocities derived from $^{14}C$ data down gradient of the recharge zone applying a method based on Vogel (1967). $^{14}C$ data was calibrated using Oxcal Version 4.1 (Bronk Ramsey, C. 2009) applying a southern hemisphere calibration curve (McCormac et al, 2004). No correction models were applied as the presence of modern groundwater in recharge zone and the absence of carbonate minerals in the aquifer suggest isotopic fractionation is minimal. Calculated recharge rates form focused recharge through the Finke River ranged from 240 - 900 mm/year.

A piezometer nest was installed directly adjacent to the Finke River in May 2010. Pressure loggers installed in the piezometers and in the base of the river bed recorded a recharge event in October 2010.

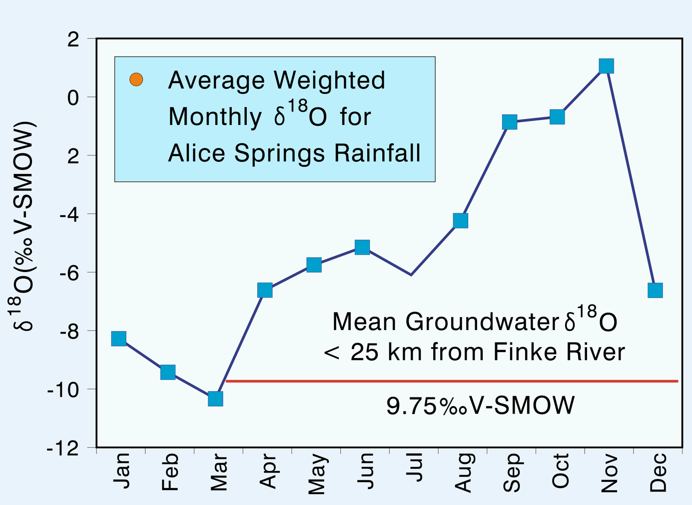
The hydraulic data was used to estimate a recharge rate for the flow event using an analytical mounding solution based on Hantush (1967). Recharge rates were estimated at 150 mm/day with a total recharge of 1275 mm for the event. Rates compare favourably with annual $^{14}C$ recharge estimates when the biennial frequency of recharge events is considered.

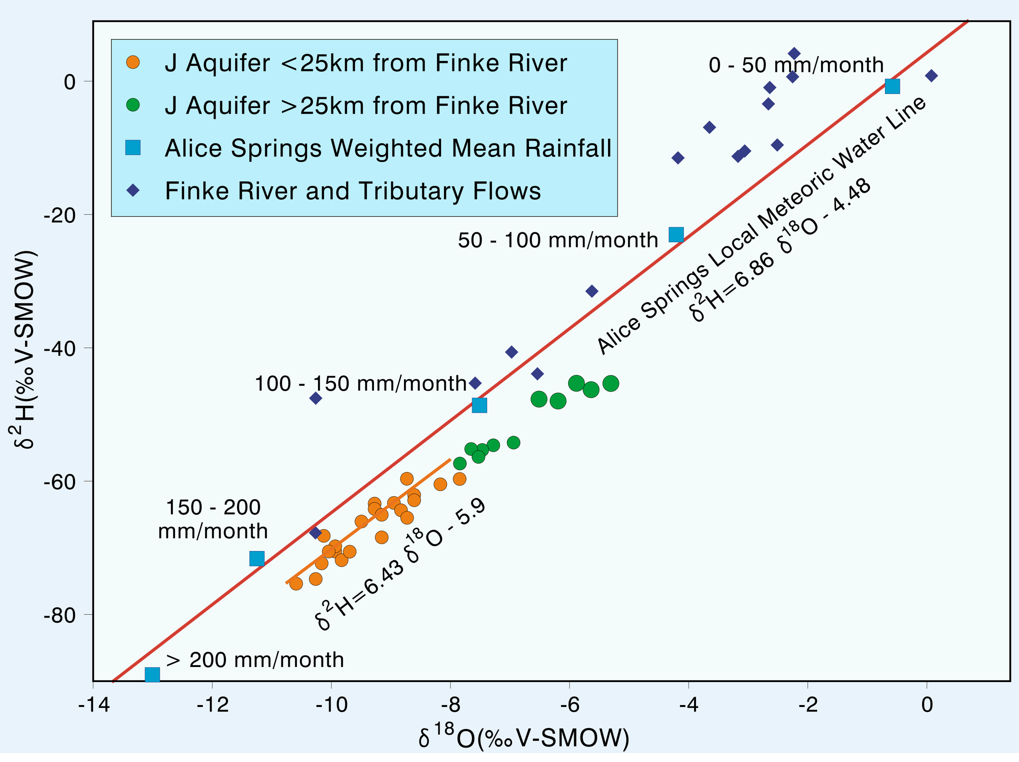



## STABLE ISOTYPES OF WATER

Groundwater samples within 25 km of the recharge zone plot with a similar gradient to the Alice Springs Local Meteoric Water Line and indicate minimal evaporation occurred during recharge. Concentrations of $\delta^2H$ and $\delta^{18}O$ close to the recharge zone are consistent with concentrations in rainfall for months where mean rainfall is in excess of 100 mm. Rainfall events of this magnitude only occur on a biennial frequency. Only a single surface water plots in domain of groundwater samples and may suggest recharge is biased towards larger flow events. Average $\delta^{18}O$ of groundwater within 25 km of the recharge zone is -9.75‰

Comparison with monthly weighted totals for Alice Springs rainfall suggests recharge occurs almost exclusively between January and March which corresponds with summer monsoonal weather systems.



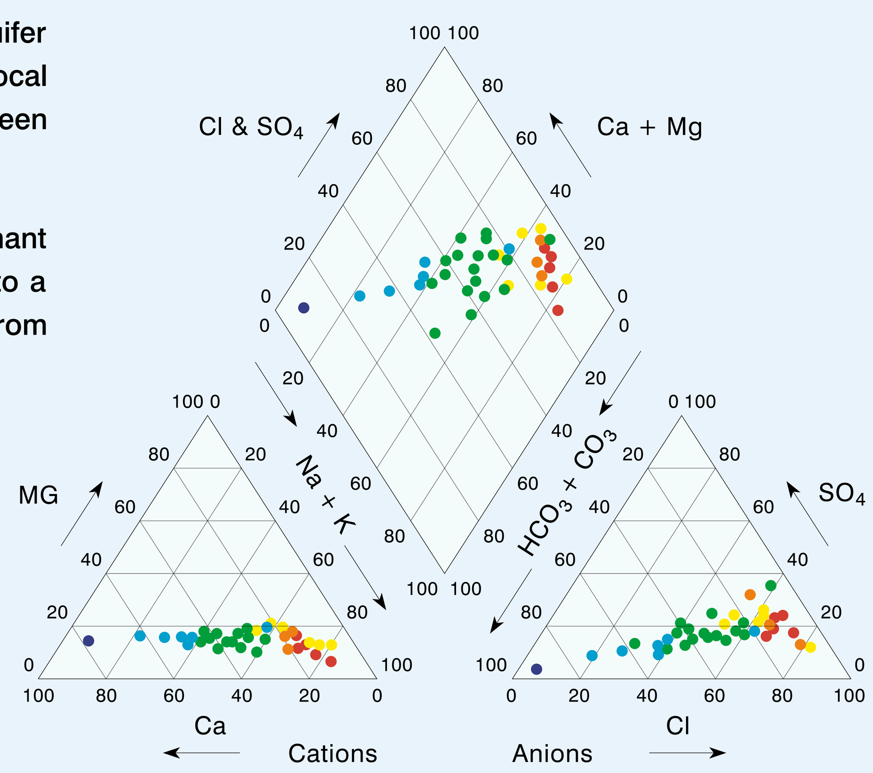




## HYDROCHEMISTRY

The piper diagram presents groundwater from the J aquifer categorised by distance from the recharge zone, in addition to local rainfall and Finke River water samples from flow events between 2008 and 2011.

The diagram shows a clear evolution from Ca-$HCO_3$ dominant groundwater in rainfall and the recharge source water through to a Na-Cl type groundwater as distance increases down flow path from the recharge zone.

Sampling distance from Recharge Zone
- 1 - 20 km
- 20 - 40 km
- 40 - 60 km
- > 40 - 60 km
- New Crown rain
- Finke River Surface Water




## CONCLUSIONS

**Stable isotopes ($\delta^2H$ and $\delta^{18}O$) in GAB groundwater link Finke River recharge to summer monsoonal rainfall occurring in months with total rainfall in excess of 100 mm.**

**Radiocarbon and stable isotope trends suggest older groundwater was recharged through an alternate recharge mechanism or under different palaeo-climatic conditions.**

**Recharge rates estimated using radiocarbon derived groundwater velocities are in good agreement with recharge rates calculated from hydraulic observations of a recharge event.**

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Australian Government, National Water Commission

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