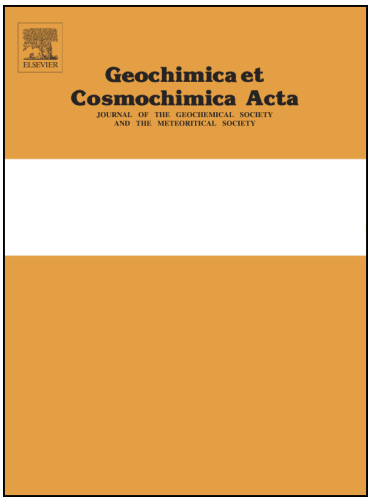

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Evolution of dissolved inorganic carbon in groundwater recharged by cyclones and groundwater age estimations using the ^{14}C statistical approach.

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Carbon isotopes, radiocarbon, hydrochemistry, Canning Basin, episodic recharge, Wallal Sandstone.

Abstract

The Canning Basin is the largest sedimentary basin in Western Australia and is located in one of the most cyclone prone regions of Australia. Despite its importance as a future resource, limited groundwater data is available for the Basin. The main aims of this paper are to provide a detailed understanding of the source of groundwater recharge, the chemical evolution of dissolved inorganic carbon (DIC) and provide groundwater age estimations using radiocarbon ($^{14}C_{DIC}$). To do this we combine hydrochemical and isotopic techniques to investigate the type of precipitation that recharge the aquifer and identify the carbon processes influencing $^{14}C_{DIC}$, $\delta^{13}C_{DIC}$, and [DIC]. This enables us to select an appropriate model for calculating radiocarbon ages in groundwater. The aquifer was found to be recharged by precipitation originating from tropical cyclones imparting lower average $\delta^{2}H$ and $\delta^{18}O$ values in groundwater (-56.9 ‰ and –7.87 ‰, respectively). Water recharges the soil zone rapidly after these events and the groundwater undergoes silicate mineral weathering and clay mineral transformation processes. It was also found that partial carbonate dissolution processes occur within the saturated zone under closed system conditions. Additionally, the processes could be lumped into a pseudo-first-order process and the age could be estimated using the ^{14}C statistical approach. In the single-sample-based ^{14}C models, $^{14}C_0$ is the initial $^{14}C_{DIC}$ value used in the decay equation that considers only ^{14}C decay rate. A major advantage of using the statistical approach is that both ^{14}C decay and geochemical processes that cause the decrease in $^{14}C_{DIC}$ are accounted for in the calculation. The $^{14}C_{DIC}$ values of groundwater were found to increase from 89 pmc in the south east to around 16 pmc along the groundwater flow path towards the coast indicating ages ranging from modern to 5.3 ka. A test of the sensitivity of this method showed that a ~15% error could be found for the oldest water. This error was low when compared to single-sample-based models. This study not only provides the first groundwater age estimations for the Canning Basin but is the first groundwater dating study to test the sensitivity of the statistical approach and provide meaningful error calculations for groundwater dating.