Probing the groundwater cycle on carbonate islands using Si and Li isotopes, Rottnest Island, Australia

A. N. MARTIN[1,2,*], K. MEREDITH[1,2], A. BAKER[1], E. BRYAN[1,2] AND M. NORMAN[3]

[1]Connected Waters Initiative Research Centre, UNSW Sydney, Sydney, NSW 2052, Australia (*Presenting author: ashley.martin@unsw.edu.au).

[2]Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW 2234, Australia.

[3]Research School of Earth Sciences, Australian National University, Canberra, ACT 0200, Australia.

The critical zone represents the permeable layer of Earth's surface where rock meets life. This zone extends from the surface to deep rock aquifers, and is closely linked with the hydrological cycle. Complex hydrochemical processes occur as water is transported through this air-water-plant-soil-rock continuum. However, a greater understanding of water-rock interactions in the groundwater cycle is needed. Lithium isotopes ($^{6}Li/^{7}Li$) are useful for tracing water-rock interactions because secondary minerals preferentially uptake ^{6}Li, and waters are subsequently enriched in ^{7}Li. A similar mechanism controls the ratios of silicon isotopes (^{28}Si, ^{29}Si, ^{30}Si), but they can also be fractionated by biological activity, e.g. diatom production.

Here we report Li and Si isotope data from a well-constrained groundwater system at Rottnest Island, a small (19 km^2), carbonate island located 18 km off the coast of SW Australia. We interpret groundwater processes in terms of an existing dataset of traditional hydrogeochemical parameters such as $\delta^{13}C$, ^{3}H, ^{14}C of dissolved organic and inorganic carbon. Preliminary results show that groundwater $\delta^{7}Li$ values ranged from +29.4 to +32.8‰, and increase linearly with Li concentration. In contrast, $\delta^{30}Si$ varied from -1.1 to +1.1‰ and showed no relationship with Si concentration. Recently recharged groundwater originating from rainfall were slighly more depleted in $\delta^{7}Li$ compared to modern seawater (~3‰) with a palaeo-seawater sample plotting towards a seawater value. The Li data are interpreted to reflect mixing between rainfall sourced Li and seawater with limited water-rock interaction after groundwater recharge. However, the $\delta^{30}Si$ values suggest the old seawater is much more negative than rainfall derived groundwater indicating a source of lighter Si in the mixing zone. Analysis of further groundwater samples and rock/soil end-members is underway to further understand the controls on $\delta^{7}Li$ and $\delta^{30}Si$ at Rottnest Island.