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Lithium isotope dynamics of closed lake systems, Rottnest Island

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Stable lithium isotopes (7Li) are useful for tracing hydrochemical processes such as water-sediment interactions and delineating the source of lithium (Li). Due to developments in trace element isotope methods, 7Li has proven to be a robust tracer of catchment processes and when used with traditional isotopic methods can provide deeper insights into environmental processes. Rottnest Island contains a number of permanent hypersaline lakes (with salinities over 330 g/L) that cover approximately 4.7 km2 area within a Pleistocene to mid-Holocene eolianite bedrock (Tamala Limestone). The lakes were once connected to the ocean but over thousands of years have become closed, and are now assumed to be driven by rainfall and evaporation cycles. This field-based study uses lithium isotope ratios measured on sediments and water to investigate Li dynamics of two closed lake systems on Rottnest Island, Western Australia. This work forms part of an ongoing six-year project.
Four sediment cores were collected from the deepest sections of the lakes. Sediment samples were collected from textural or sedimentological changes in the cores and were ground and ashed at 450°C for at least 5 h. Column chromatography procedures were undertaken and Li isotope ratios were analysed by multi-collector inductively coupled plasma mass spectrometer. Sediment, shell, salt crusts, soil, palaeosol, microbialite, groundwater, lake water, rainfall and seawater end-members were analysed for 7Li, Li concentration, carbon-13 and oxygen-18. The results showed that the Li isotopes of the lake sediments ranged from +17.3‰ to +75.6‰ with an average of +42.4‰ (n = 25). All 7Li values for sediments lie between the soil (+16.5‰ and palaeosol (+68.5‰ values. Other end-members such as the microbialites (+23.9‰, groundwaters (range from +22.8 to +35.7‰, rainfall (+24.2‰, bedrock (+21.0‰ and seawater (+33‰ samples plot within this range. The shells (+6.3‰ and salt crusts (+15.6‰ were more depleted. The reported range in isotope values is the largest observed to date, and the enriched isotope values of the sediments are related to higher Li concentrations (R2=0.7). The processes responsible for this large variation suggest evaporation trends and the change in source materials (marine vs. terrestrial) over time. The lake sediment samples provide some of the first Li isotope measurements for coastal closed lake systems in Australia. The lakes on Rottnest Island have high environmental value for the region and form a sink for 7Li. Therefore, understanding the hydrochemical processes that lead to these conditions is important for interpreting the palaeoenvironmental history of the region.