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Source-water independent Processes influence the Hydrogen isotopic Composition of Lipid Biomarkers - two Examples: Salinity and Leaf Water Evapotranspiration

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Stable hydrogen isotope ratios (H/D or δD) of sedimentary lipid biomarkers from aquatic and terrestrial autotrophic organisms are increasingly used to reconstruct changes in paleohydrology. While a number of studies have confirmed that the H/D ratios of a variety of lipid biomarkers reliably tracks the H/D ratio of the water source in natural as well as laboratory environments, mounting evidence suggests that additional (environmental and physiological) factors exert control on the amount of net hydrogen fractionation between source water and lipids.

Here we present evidence from a natural hypersaline lake system on Christmas Island that salinity decreases the net hydrogen isotope fractionation in cyanobacterial lipids by about 1‰ per salinity unit. Lipids produced via different biosynthetic pathways (acetogenic, mevalonate and non-mevalonate) respond in a similar manner to changes in salinity. Thus, we hypothesize that the isotopic composition of intra-cellular water, the biosynthetic hydrogen source, becomes enriched in deuterium at increasing salinities due to restricted exchange with extra-cellular (environmental) water during evaporation.

Likewise, evapotranspiration from leaves of terrestrial plants leads to isotopic enrichment of the biosynthetic source water as a function of relative humidity and leaf physiological properties. We present evidence for significant seasonal changes in the H/D composition of leaf-wax lipids, as a result of physiological responses of plant leaves to seasonal changes in plant-atmosphere evaporative demand.

While these processes complicate the reconstruction of source water δD values, the additional variability imprinted in lipid biomarkers has exciting potential for paleoecohydrological use of lipid biomarker δD values. We will discuss how variability in biomarker δD can potentially be used to reconstruct salinity as well as changes in evapotranspiration.