Amino acid nitrogen isotopic composition patterns in lacustrine sedimenting matter

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Amino acids (AAs) comprise a large fraction of organic nitrogen (N) in plankton and sedimenting matter. Aquatic studies of organic N compounds in general and of AAs in particular, mostly concentrate on marine environments. In order to study the cycling and fate of organic N and AAs in lakes, we measured the N isotopic composition (delta N-15) of bulk organic matter (OM) and of single hydrolysable AAs in sediment trap and sediment samples from two Swiss lakes with contrasting trophic state: Lake Brienz, an oligotrophic lake with an oxic water column, and Lake Zug a eutrophic, meromictic lake. We also measured the N isotopic composition of water column nitrate, the likely inorganic N source during biosynthesis in both lakes. The delta N-15-AA patterns found for the sediment trap material were consistent with published delta N-15-AA data for marine plankton. The AA composition and primary delta N-15-AA signatures are preserved until burial in the sediments. During early sedimentary diagenesis, the delta N-15 values of single AAs appear to increase, exceeding those of the bulk OM. This increase in delta N-15-AA is paralleled by a decreased contribution of AAs to the total OM pool with progressed degradation, suggesting preferential AA degradation associated with a significant N isotope fractionation. Indicators for trophic level based on delta N-15-AAs were determined, for the first time in lacustrine systems. In our samples, the trophic AAs were generally enriched in N-15 compared to source AAs and higher trophic delta N-15-AA values in Lake Zug were consistent with a higher trophic level of the bulk biomass compared to Lake Brienz. Especially the difference between average trophic delta N-15-AAs and average source delta N-15-AAs was sensitive to the trophic states of the two lakes. A proxy for total heterotrophic AA re-synthesis (Sigma V), which is strongly associated with heterotrophic microbial reworking of the OM, was calculated based on delta N-15 values of trophic AAs. Higher Sigma V in Lake Brienz indicate enhanced heterotrophic bacterial reworking of AAs under oligotrophic conditions. Despite changes in the delta N-15-AA values within the sediments, the proxies based on these values were consistent over the studied sediment profile, indicating the preservation of trophic signatures; therefore, our results underscore that delta N-15-AA analysis of sedimentary records represents a promising tool to assess trophic levels and bacterial re-synthesis in lakes.
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