EFFECTS OF EARLY DIAGENESIS ON THE ISOTOPIC SIGNATURE OF WOOD: INCUBATIONS IN AQUATIC MICROCOSM

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Introduction

The stable isotopes of organic matter (OM) of soils and sediments are often used to infer paleoenvironments and OM sources. Accurate paleoenvironmental reconstructions require to precisely constrain the effects of diagenesis on the isotopic composition of OM. However, the fate of carbon and, especially, nitrogen isotopic signature in OM is not well understood. Plants constitute major contributors to the terrestrial OM pool and plant debris generally undergo significant underwater degradation before burial in sediments. The present study thus aims at documenting changes in δ^{13}C and δ^{15}N values of plant OM through early diagenesis in aquatic environment reconstituted in laboratory. Wood samples were incubated in distilled water and river water for 73 weeks, and monitored for their bulk biogeochemical composition (%C, %N, δ^{13}C and δ^{15}N; (Tramoy et al., 2017). Sub-millimetric powder and centimetric pieces of wood were used to investigate the influence of sample size on degradation. As micro-organisms are the main degrading agent of OM, fungal development and bacterial activity were also monitored by macroscopic examination and ecoplates Biolog, respectively.

Degradation state

Mass loss of wood pieces in river water was three times greater than in distilled water (30% *vs* 10%; Figure 1). According to macroscopic observations, this difference was attributed to the development of white-rot fungi that colonized the pieces of wood incubated in river water, whereas soft-rot fungi developed in distilled water. The greater efficiency of white-rot fungi for degrading wood is probably responsible for the greatest mass loss of wood pieces in river water. Characterization of microcosms with Biolog ecoplates (Garland and Mills, 1991) showed that the potential metabolic activity of bacteria was two times higher in distilled water than river water, although the functional diversity of bacterial communities was similar in both types of water. These results confirm that fungi are the main agents of wood degradation, with an increased efficiency of white-rot fungi when compared to soft-rot fungi.

Geochemical effects

The carbon content of the wood pieces and their isotopic composition showed similar patterns in both types of water: (i) carbon content increased of ~2% during the first 20 weeks before it returned to initial values at the end of the experiment, whereas δ^{13}C values remained relatively constant. This might suggest that despite obvious wood degradation, its carbon isotopic composition is not significantly modified by diagenesis. Although difficult to interpret, the relative C- and ^{13}C-enrichment (around +2.5 % and +0.3 ‰, respectively) of wood powder during the 73 week incubation may suggest small influence of microbial respiration (i.e.

degradation of C- and ^{13}C-depleted plant components). Then, the higher influence of degradation in powder than in pieces of wood suggests that degradation is dependent on debris size. In contrast, nitrogen dynamics of wood pieces showed a variability ~5 times higher than that observed for carbon and opposite patterns in the different types of water (Figure 1): (i) N release associated with ^{15}N-depletion in distilled water, attributed to uptake of ^{15}N-enriched pool (i.e. proteins) by fungi, and (ii) N accumulation associated with ^{15}N-enrichment in river water thanks to fungal development within the wood. Similar behaviors are recorded for wood powders with much lower variability than in wood pieces, suggesting that variability in wood pieces is due to initial variability along the wood.

Conclusions

Results confirm the strong impact of early diagenesis on nitrogen isotopes of organic matter (unlike carbon). However, most of the δ^{15}N changes could be attributed to fungal activity that imports or exports nitrogen from (in) the wood in response to variations in N-availability of their (micro-)environment. Thus, early diagenesis may average an environmental signal by integrating the δ^{15}N values of individual signals (woods, fungi, water) and microbial processes. Considering the non-linear behavior of early diagenesis, this integration is probably almost instantaneous on the geological time scale, which may not preclude paleoenvironmental reconstructions.

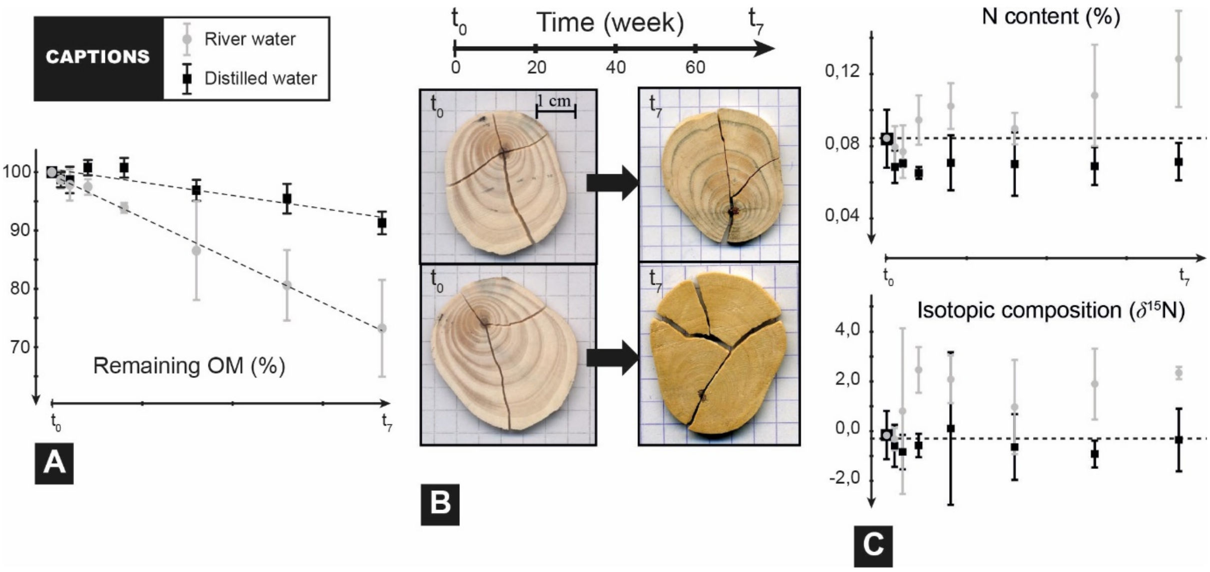

Figure 1: *A, Mass loss of wood pieces relative to time in river (in grey) and distilled water (in black); B, their morphology at t_0 and t_7 (after 73 weeks of degradation in water) and C, the nitrogen dynamic relative to time. Vertical bars. Vertical bars correspond to the standard deviation (2σ) based on triplicates.*

References

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