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Selective release and sequestration of nutrients and Rare Earth Elements operated by litter during the degradation

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During water uptake, trees can absorb nutrients to supply their metabolic demand, but also take in elements that are not strictly necessary for their needs.

Once absorbed by roots, elements can fractionate within different tissues according to the metabolic role they play or the affinity they have towards specific compounds. Such fractionation could play an important role for processes involved in the recycling of elements during the degradation of trees debris. As such degradation would be more intense on labile tissues, it would enhance the release of certain elements fractionated in the above-mentioned tissues, while more resistant compounds would restrict the access to pools of other elements.

In this framework, we hypothesized that during the wet degradation of the litter, the combination between the fractionation of the elements and the different resistances to degradation would result in a detectable chemical signature, which is specific for each tissue and which would be transmitted to soil solutions after percolation of incident waters into the soil.

To test our hypotheses we measured concentrations of Na, K, Mn, Mg, Ca, Pb, Al, Fe and Rare Earth Elements (REE – i.e. the lanthanides and the Y) in fresh leaves and in different litter fractions (sorted by degradation degree) of two tree species (Pseudotsuga menziesii and Douglas-fir) grown on the same soil. Leaching experiments with ultra-pure water were also performed on the above-mentioned samples in order to observe how the different fractions of litter can contribute to the release of elements. Finally, REE patterns of our samples were compared with the ones of soil and soil solutions at 20, 40 and 60 cm deep.

We coupled REE and nutrients studies, since the former represent extremely useful geochemical tracers for Critical Zone processes thanks to their features (lanthanide contraction, electron configuration and oxidation states).

We show that both tree species exhibited a preferential release of Na, K, Mn, Mg, Ca during the degradation, while Al, Fe, Pb and REE tended to stay bound to the solid. Furthermore, we observed that anomalies in leachates REE patterns (such as Ce, Eu and Gd enrichments) are mirrored into the respective soil solutions.