Carbon cost of the biological weathering of minerals in boreal forest soils

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Microbial communities play a key role in biogeochemical weathering of minerals in both aquatic and terrestrial ecosystems. Symbiotic ectomycorrhizal fungi colonise >95% of the fine roots of trees in boreal forests and play a significant role in mobilisation and acquisition of Ca, K, Mg and P from minerals, as well as organic substrates. Trees invest a substantial proportion of recently fixed C belowground, enabling the growth of taxonomically and functionally diverse fungi that colonise microsites in minerals and organic matter that are inaccessible to tree roots. This provision of energy-rich compounds fuels the production of biological agents such as enzymes, siderophores and organic acids that influence decomposition and weathering. Although it is increasingly accepted that ectomycorrhizal fungi do play a central role in mobilising different nutrients from both organic substrates and minerals, the amounts of C invested in these processes, their regulation and the identity of the different fungal symbionts involved are still poorly understood. We hypothesise that: (1) trees allocate more C to those ectomycorrhizal fungi (and associated bacteria) that are active in weathering of minerals than those involved in decomposition of organic matter, (2) the C demand of ectomycorrhizal fungi involved in the weathering process depends upon the chemical and physical properties of the minerals, (3) N deposition has a negative effect on the C allocation to fungi involved in mineral weathering. We tested the above hypotheses by using microcosm systems containing pine seedlings grown in boreal forest soils amended with different minerals, or systems partitioned by nylon-mesh barriers preventing roots, but allowing fungal mycelia, to grow into different mineral substrates. Seedlings were pulse labeled with $^{13}CO_2$ and ^{13}C allocated to shoot, roots, mycelium and different minerals or organic matter substrates was analysed using IRMS. Active fungal and bacterial communities assimilating plant-derived photosynthetic ^{13}C and involved in weathering of minerals were analysed using ^{13}C-RNA based stable isotope probing (SIP) and high throughput 454-pyrosequencing techniques.