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Gross Nitrogen Mineralization and C-N-P Stoichiometry Across Soil Depth: Rhizosphere influence under Elevated CO_2

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Plant carbon is constantly released to the rhizosphere soil via active fine roots, potentially influencing the microbial community and the production of enzymes that release nitrogen (N) and phosphorus (P) from the soil organic matter (SOM). Elevated atmospheric carbon dioxide (eCO_2) concentrations are expected to alter both root distribution and plant carbon allocation belowground, thereby impacting SOM decomposition and nutrient availability. Rhizosphere processes are mainly studied in top soils but the effects of eCO_2 are likely to impact the whole soil profile. In addition, deeper soil is potentially more responsive to labile carbon inputs destabilizing stored soil carbon often considered to be protected from mineralization. Changes in SOM concentration, relative abundance of available nutrients (stoichiometry), microbial biomass stoichiometry, and the organic to inorganic P ratio with depth, suggest SOM decomposition response to root carbon exudation can differ along the profile. Although, it is unknown how eCO_2 will influence SOM processes along the profile it is often assumed that the rhizosphere processes remain constant with increasing depth.

We investigated if changes in the nutrient and microbial biomass C:N:P stoichiometry with depth influence the rate of gross N mineralization and the enzymatic activity in the rhizosphere across the soil profile in a Free Air CO_2 enrichment facility in a native Australian mature Eucalyptus woodland (EucFACE) with highly weathered and nutrient poor soil. Cores were taken to the depth of a semi-permeable clay layer, found at varying depths (from 40-90 cm depth) across the site. The clay layer is a natural boundary where precipitation partially pools and transversely drains. The soil profile was sub-divided into top-soil (0-10 cm), deeper soil (10-30 cm) and a transition zone (defined as a 10 cm interval above the semi-permeable clay layer). Soil samples were separated into bulk soil (not attached to roots) and rhizosphere soil (attached to roots). Samples were measured for C:N:P in available nutrients, microbial biomass and enzyme activity and gross N mineralization rates. Root chemistry and root abundance in each depth interval were also assessed, together with soil physical characteristics (soil texture and organic-inorganic P content).

Preliminary results show a strong rhizosphere effect throughout the soil profile increasing nutrient availability of C, N and P in the rhizosphere soil. Increases in gross N mineralization rates with eCO_2 were found though the trend was not significant. The C-N-P stoichiometry of available and microbial nutrients did not change significantly with either depth nor eCO_2, however available nutrients had a significant interaction between depth and CO_2 treatment. Enzymatic activity and organic-inorganic P content are pending. We argue that the knowledge of deeper soil rhizosphere processes is necessary for scaling native forest ecosystem response in a future climate.