Abstract

As agrarian society developed, the most fertile soils able to sustain the nutritional requirements needed for high crop yield were assigned to farming, while the more penurious soils were left to uphold the forest ecosystems. Some temperate forests are developed on acidic soils considered to be nutrient poor, as much of the inorganic nutrients are entrapped in poorly weatherable soil minerals and not easily accessed by plant roots. In an undisturbed ecosystem, the largest contribution of available nutrients comes from the recycling of organically bound nutrients via the decomposition of dead plant material. If biomass is removed, for instance with a more intensified exploitation of the forest ecosystems including whole tree harvesting, this source of nutrients is consequently decreased. The importance of soil mineral weathering as a source of nutrients, and especially that promoted by soil biota, is thereby emphasized.

This thesis addresses biotic parameters associated with mineral weathering. Different aspects of soil solution sampling strategies and analysis of different organic ligands as well as biomarkers for the estimation of fungal biomass were investigated. These chemical parameters were also evaluated as indicators of microbial activity in relation to mineral nutrient availability in soil.

With the assumption that the current nutrient status of a soil will affect the microbial interest of certain minerals as sources of inorganic nutrients, a mineral amendment trial was performed in a Swedish boreal forest soil. Overall, the amended soil presented good nutrient status, but with a possible shortage of iron. Due to this, it was hypothesized that the amended mineral with the highest iron content i.e. biotite would cause an elevation of microbial activity in its vicinity when compared to the bulk soil.

The level of microbial activity in the vicinity of the amended minerals was evaluated via quantification of organic acids and siderophores, as well as estimation of fungal biomass and enzymatic activity.

The highest microbial activity was measured for the O horizon of the investigated podzol, although nothing indicated an elevated association with the amended minerals. In the E horizon, however, elevation in microbial activity was observed in the vicinity of the biotite mineral when compared with bulk soil, although only a few of the investigated parameters differed significantly when evaluated separately.

To enable this study, a highly sensitive analytical method employing liquid chromatography and mass spectrometry was developed to quantify a number of hydroxamate siderophores. On-line pre-concentration enabled detection of these organic ligands in the pico-molar range – a necessity when analyzing natural samples.

Furthermore, an analytical method was developed for the estimation of fungal biomass via quantification of chitin-derived glucosamine, which also employed liquid chromatography and tandem mass spectrometry. Unlike currently available methods, the one presented in this thesis did not involve analyte derivatization, which resulted

in high sample throughput while simultaneously avoiding complications involved with the additional derivatization procedure.

The distribution of a group of organic ligands known as *aromatic low molecular mass organic acids* was also studied in a boreal forest podzol soil. Different sampling and samples preparation techniques, namely tension-lysimeters, soil centrifugation and liquid-soil extraction, were compared when analyzing soil solution components. Significant differences in analyte amount and species type were found between these sampling techniques. Some of the differences could be accounted for by variation in soil composition at different depths of the investigated podzol, but others could be attributed to structural differences within the studied analyte group. This clearly illustrated the intricacy of sampling and analysis when working with a sample matrix as complex and diverse as soil.

As previously, liquid chromatography and mass spectrometry was used to quantify the analytes of interest. A highly sensitive analytical method was developed that was able to detect eleven aromatic low molecular mass organic acids in the nano-molar range. High selectivity was ensured by applying multiple reaction monitoring enabled by collision induced fragmentation of the analytes.