Mineral surface alterations in the rhizosphere of conifers

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The production of fertilizers and pesticides consumes high levels of energy from fossil fuels, emits large amounts CO_2, increases ground- and surface water pollution and soil degradation around the world. Part of the problem is a lack of fundamental understanding about mineral-derived nutrient dynamics in forests to maintain high, but sustainable, production of high quality wood products. The goal of this study was to investigate the physical and chemical alterations of mineral particles and microbe-mineral interactions in the rhizosphere of various conifers. Controlled column growth experiments were set up in the laboratory with plants, symbiotic fungi and limited amounts of Ca, Mg and K and mineral samples were also collected from a field experiments at two sites to achieve the goals of the project.

The overall results have shown that symbiotic fungi can promote chemical dissolution as well as applying physical forces to produce fungi diameter, channel shaped branching features and that they take up base cation nutrients during the dissolution process. On the other hand, based on laboratory testing, abiotic processes can also contribute to similarly sized and shaped channels on mica surfaces because it is soft, easily scratched by sharp and hard objects such as sand grains. Base cation limitations under forest ecosystems did not promote dense fungal colonization of the minerals in the buried mesh bags, which contradicts laboratory studies. The column experiments confirmed that the presence of trees decreased drainage water pH by 2 units, thus acidified the systems and increased weathering rates compared to controls without trees. However, the weathering rates remained low in all treatments. Microscopic chemical analyzes of mineral cross sections indicated a slight depletion of cations below the formed “biolayer” and fungal hypahe but these changes were not significantly different from the analyzed controls.

The results supports that symbiotic relationship between higher plants, fungi and bacteria can facilitate increased uptake of limiting nutrients from mineral sources in the rhizosphere implying that mineral amendments can be utilized to aid sustainable forest management if they are supplied in sufficient amounts and composition.