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Titel

Phosphorus solubilization by microorganisms at different stages of soil development

Abstract

P solubilization is an important process for ecosystem nutrition that is largely driven by soil microorganisms. However, little is known about changes of P solubilization rates and mechanisms during soil formation. Therefore, we investigated P solubilization along a climosequence in the coastal range of Chile. We analysed soil samples from four study areas in order to test the hypotheses that i) higher developed soils in temperate ecosystems show higher rates of P solubilization and silicate weathering as well as higher concentrations of organic acids compared to initially developed soils in dry ecosystems; ii) topsoil horizons reveal higher rates of P solubilization than subsoil horizons; iii) P solubilization is not driven by microbial need for P, but is a side effect of microbial metabolism.

To determine the rates and mechanisms of P solubilization as well as the silicate weathering, we conducted several incubation experiments (one month at 15°C) with soil extracts containing soil microorganisms and apatite or saprolite as P sources. In some experiments, a minimal growth medium (glucose + NH_4Cl) was used. In others, inorganic P was added additionally in order to test whether P availability affects the P solubilization rate. Inorganic P (P_i), pH, organic acids and Si were measured at regular intervals.

Our results show that up to ten times higher rates of P solubilization from the added apatite were observed in the intermediately and highly developed soils compared to the initially developed one. Si-release rates and concentrations of organic acids were higher in the intermediately and highly developed soils compared to the initially developed one. P solubilization from saprolite was small and likely masked by microbial P immobilization. Topsoil horizons generally exhibited higher rates of P solubilization than subsoil horizons and the addition of a readily available P source did not result in substantial decreases of P solubilization rates, indicating that P solubilization was not driven by microbial need for P.

We conclude that the capability of microbial communities to solubilize P from apatite and Si release rates are higher at more developed soils. Moreover, our experiments showed that the availability of carbon increased the P solubilization rates.