Soil pH regulation and N_2O emission mitigation by mafic rock application

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The emission of the greenhouse gas N_2O from agricultural soils will continue to increase unless we find ways to lower the N_2O/N_2 product ratio of denitrification. This ratio depends on the activity of the enzyme N_2O reductase, which is most likely controlled by the soil pH. This implies that N_2O emissions could be reduced by liming acid soils. However, the net effect of such liming is uncertain because it induces the emission of carbonate derived CO_2. We propose the use of mafic rocks as an alternative to liming. If effective, there would be an immediate reduction on climate forcing by eliminating the emission of carbonate derived CO_2 and decreasing N_2O emission. In a laboratorty study we quantified respiration, carbonate derived CO_2 and N_2O emission after incorporating lime, olivine and anorthosite into moderatly acidic soils. Liming caused an immediate increase in soil pH, enhanced soil respiration, and induced a 70% reduction of the N_2O emission. Finely ground olivine induced similar effects, though weaker than lime, but with no carbonate derived CO_2. Anorthosite had no detectable effect on soil pH, but a slight effect on N_2O emissions after 140 d.

The degree of dissolution of the olivine and anorthosite after soil incubation were assesed by SEM on individual grains. This showed substantial but highly variable dissolution. Acid pitting was the major dissolution mechanism. We found significant signs of secondary phases forming, however, there was no evidence that these inhibited dissolution significantly. Anorthosite showed much less dissolution than olivine.

Controlled dissolution rate measurements with different acids were also performed with a set of rock powders to evaluate their suitability for field application.

The results confirm the postulated potential for reduced agricultural climate forcing by using mafic minerals, depending on the choice of mineral. However, relevant field experiments are needed to confirm these results and the choice of minerals is essential.