Potential of basalt amendments to reduce N_2O emissions from agriculture

ELENA BLANC-BETES[1*], ILSA B KANTOLA[1], MELANNIE HARTMAN[2], NURIA GOMEZ-CASANOVAS[1], DAVID J BEERLING[3], AND EVAN H DELUCIA[1]

[1] Univ. of Illinois, Urbana, IL, USA (*correspondence: mblanc7@illinois.edu, ikantola@illinois.edu, ngomezca@igb.illinois.edu, delucia@illinois.edu)
[2] Colorado State University, Fort Collins, CO, USA (Melannie.Hartman@colostate.edu)
[3] University of Sheffield, Sheffield, UK (d.j.beerling@sheffield.ac.uk)

Enhanced weathering of basalt in cultivated soils is a promising strategy for atmospheric CO_2 removal. The impacts of increases in soil pH and nutrient release during the mineral dissolution of basalt on the biogeochemistry of agricultural soils may add to the climate stabilization effect of inorganic CO_2 sequestration. We used the DayCent model to assess the biogeochemical impacts of basalt amendments on annual and perennial crops and derived climate change mitigation potential. The model was parameterized with field observations from maize (*Zea mays*) and miscanthus (*Miscanthus x giganteus*) at the Energy Farm (UIUC, Champaign, IL), and used a factorial randomization of 15-year weather records to integrate climate variability in the response. Consistent with field observations, model results indicate that the application of basalt reduced N_2O emissions by 16% in maize and 9% in miscanthus, and lowered on average the N_2O emission factor (i.e. amount of N fertilizer released to the atmosphere in the form of N_2O) by 17% and 11% respectively. The predicted decrease in N_2O emissions responded to increases in soil pH with basalt additions and corresponding increases in the N_2:N_2O ratio of denitrification, with minor contributions from the impact of P additions (an integral component of basalt) on N immobilization. Model simulations indicated basalt amendments resulted in marginal increases in yields and nitrogen use efficiency (i.e. fertilizer-N recover in crop production) of maize and miscanthus. However, basalt addition increased soil P availability, maintaining the long-term productivity in crops with high nutrient requirements, and could reduce or even replace the use of P fertilizers. While enhanced weathering of basalt has great potential to mitigate greenhouse gases by sequestering CO_2, the effect on soil pH and N_2O release from cultivated soils, which at present contributes to ~70% of total anthropogenic emissions, may be more critical in the short term by amplifying climate change mitigation potential.