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B35L-1560 - Greenhouse constraints on the inorganic carbon sequestration potential of enhanced silicate weathering in agriculture



Wednesday, 15 December 2021



16:00 - 18:00



Convention Center - Poster Hall, D-F

Abstract

Enhanced silicate weathering (ESW) is a natural climate solution that sequesters carbon dioxide (CO₂) by spreading crushed silicate rocks on the surface of the Earth. One of the primary applications of ESW is in agricultural settings, where the dissolution of silicate minerals sequesters CO₂ as alkalinity (bicarbonate) and releases cations (e.g., Ca²⁺, K⁺, Mg²⁺) into the soil solution as nutrients for crops. Model estimates for ESW at scale suggest significant potential for ESW to offset carbon emissions while providing value to farmers through improved crop yields and soil fertility. However, carbon sequestration rates from ESW are poorly constrained and may be underestimated due to difficulties in accurately tracking the products of silicate mineral dissolution.

This project presents new constraints on carbon sequestration rates for ESW through detailed accounting of dissolution products in a controlled greenhouse setting. Our experimental design mimics growing conditions in Northfield, Minnesota with corn (*Z. mays*) being grown for 120 days in native silty loam soil sourced from a local agricultural field and watered to match average rainfall conditions for the area (~500 mL per week). We added crushed basaltic rock powders equivalent to 20 tn ac⁻¹ to the upper 10 cm of soil for treatment plants (n = 6) versus control (n = 6, no rock dust added). To quantify weathering rates, we compare two methods: (1) a bicarbonate-based approach tracking soil inorganic carbon, soil pH, water pH, and alkalinity, and (2) a cation-based approach using conductivity and elemental analyses of soil, water, and plant tissue. Additionally, we assess the agricultural impacts of ESW from changes in corn biomass and elemental composition, as well as soil health indicators of pH, cation exchange capacity, and organic matter. The goal of our work is to help provide locally relevant constraints in order to promote ESW as a scalable natural climate

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Reaction

Water + Carbon dioxide
 $\text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{Carbonic Acid}$
 H_2CO_3

Silicate Minerals
Ex: $\text{CaAl}_2\text{Si}_2\text{O}_8$
 $\text{CaMgSi}_2\text{O}_6$

Carbonic Acid
 H_2CO_3

Cations
Ex: Ca^{2+} , Mg^{2+} , K^+

Clay Minerals
Ex: $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$
 $\text{Ca}_{10}(\text{Mg},\text{Si})_4\text{O}_{22} \cdot n\text{H}_2\text{O}$

Bicarbonate
 HCO_3^-

Cations
(Ex: Ca^{2+} , Mg^{2+} , K^+)
Bicarbonate
(HCO_3^-)

Properties

Crops:
- biomass
- elemental composition

Soil Properties:
- elemental composition
- bulk density
- pH
- cation exchange capacity

Soil Water:
- total alkalinity
- pH
- elemental composition

Dimensions

Rock dust
(top 10 cm)

Top Soil
(top 25cm)

Subsoil
(bottom 25cm)

Gravel
(bottom 5 cm)

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B35L - Challenges and Opportunities of Managing Soil Carbon as a Natural Climate Solution II Poster

Kate Lajtha, Oregon State University, Corvallis, OR, United States and Ronald Amundson, University of California Berkeley, Berkeley, CA, United States



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Biogeosciences

Similar

Field trials testing carbon sequestration and agricultural co-benefits of enhanced silicate weathering with basaltic soil amendments in a corn-soybean agricultural field in Northfield, Minnesota

Ella Milliken¹, Jahmaine Renzo Yambing¹, Sarah Cameron Leibovitz², Sophie Grace Naylor³, Fiona Anstey², Demetrius C Blackmon - Jimenez¹ and Daniel Maxbauer⁴, (1)Carleton College, Geology, Northfield, MN, United States, (2)Amherst College, Geology, Amherst, MA, United States, (3)Colgate University, Geology, Hamilton, NY, United States, (4)Carleton College, Geology, Northfield, United States

Soil Carbon Sequestration from Enhanced Weathering During a Historic Drought Year

Iris Holzer¹, Mallika Arudi Nocco², Nina Bingham¹, Heath Goertzen³ and Benjamin Z Houlton⁴, (1)University of California, Davis, Department of Land, Air and Water Resources, Davis, CA, United States, (2)University of California Davis, Department of Land, Air and Water Resources, Davis, CA, United States, (3)University of California, Davis, John Muir Institute of the Environment, Davis, CA, United States, (4)Cornell University, Ecology and Evolutionary Biology / Global Development, Ithaca, NY, United States

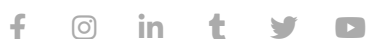
George Guillen, Florida International University, Miami, FL, United States; Texas A&M University College Station, College Station, FL, United States, Salvatore Calabrese, Texas A&M University, Department of Biological and Agricultural Engineering, College Station, United States, A. Peyton Smith, Texas A&M University College Station, Soil and Crop Sciences, College Station, TX, United States, Gretchen R Miller, Texas A & M University, Civil & Environmental Engineering, College Station, TX, United States, Rodolfo Marcondes Silva Souza, Texas A&M University College Station, College Station, United States, Andreas Khechfe, Humboldt State University, Arcata, CA, United States, James K Brumbelow, Texas A&M University College Station, Civil & Environmental Engineering, College Station, TX, United States and Georgianne W Moore, Texas A&M University, Department of Ecosystem Science and Management, College Station, TX, United States

Assessing the permanence and performance of enhanced weathering for carbon sequestration using geospatial modelling.

Lindsay Hornstein, Dobbs Ferry, New York, UNITED STATES, F. Garrett Boudinot, Cornell University, Ecology and Evolutionary Biology, Ithaca, NY, United States and Benjamin Z Houlton, University of California Davis, Department of Land, Air and Water Resources, Davis, CA, United States

Corn and Alfalfa Yield Responses to Enhanced Weathering and Organic Soil Amendments in California

Heath Goertzen¹, Maya Almaraz¹, Nina Bingham², Iris Holzer², Jaeun Sohng², Emily Geoghegan², Erin Manaigo² and Benjamin Z Houlton³, (1)University of California, Davis, John Muir Institute of the Environment, Davis, CA, United States, (2)University of California, Davis, Department of Land, Air and Water Resources, Davis, CA, United States, (3)Cornell University, Ecology and Evolutionary Biology / Global Development, Ithaca, NY, United States


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