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Olivine and Lime Application in the US Midwest: A Field Study for Quantifying Carbon Dioxide Removal, Soil, and Crop Health

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Enhanced rock weathering is a strategy to move atmospheric carbon dioxide (CO_2) into the ocean where it persists for millenia. In this process, the inorganic carbon cycle is accelerated by increasing the reactivity of silicate rocks and applying them to land. This climate mitigation strategy releases cations that increase soil pH similar to aglime. Two replicated field trials of olivine application were executed in 2022 to quantify CO_2 sequestration alongside soil and crop yield impacts. The 0.5-acre field trials in Michigan and Illinois included five replicates of control (no amendment), 3 t/acre aglime, and 3 t/acre olivine in soy and corn fields. Three soil measurement campaigns during the growing season allowed for the detection of trace immobile elements to quantify mineral application, and monitoring of the base cation losses provided estimation of alkalinity fluxes below the root zone. Additionally, soil pH, dissolved inorganic carbon (DIC), and soil cation-anion budgets were monitored using lysimeter-based leachate soil water data.

Over the course of the growing season, 26.5% of the base cations in the applied rock were weathered and lost in fields treated with olivine, resulting in approximately 0.6 t CO_2 removed/acre. Importantly, soil pH impacts and crop yields of soy and corn were statistically indistinguishable between olivine and aglime treatments. On average, corn yields were quantified as 172.8 ± 35.6 bushels/acre (olivine), 172.7 ± 31.7 bushels/acre (aglime) 183.7 ± 33.6 bushels/acre (control). Soy yields were measured as 59.5 ± 10.0 bushels/acre (olivine), 55.3 ± 5.8 bushels/acre (aglime), and 62.9 ± 6.0 bushels/acre (control). Soil pH increased from 6.3 ± 0.3 to 6.6 ± 0.5 from olivine application, while fields with aglime experienced a soil pH increase from 6.4 ± 0.4 to 6.9 ± 0.4. We conclude that aglime and olivine applications result in comparable soil pH buffering and crop yields. However, in contrast with liming, fields applied with olivine experienced measurable alkalinity and DIC export below the root zone.