



Basalt is spread on a field in Spring 2021 at the Illinois Energy Farm.

LC3M Progress in 2020-21

iSEE partners with the Leverhulme Centre for Climate Change (LC3M) at the University of Sheffield to investigate Enhanced Rock Weathering (ERW), a method for removing CO₂ from the atmosphere. Since 2016, crushed basalt rock has been applied to corn, soy, and miscanthus fields at the University of Illinois Energy Farm to measure the potential of Midwestern croplands to act as sinks for atmospheric CO₂, while still supporting the agriculture critical to the region. As ERW is a carbon-mitigation strategy, there is particular interest in determining the potential carbon savings in bioenergy crops, where the carbon reduction strategies can be combined for maximum effect.

In 2020-21, the Leverhulme Trust announced a renewed commitment to funding for Phase 2 (Years 6-10) of the Leverhulme Centre for Climate Change Mitigation, an award of £10m over 10 years. LC3M director Dr. David Beerling was awarded £4.7m from UK Research and Innovation to develop a multi-partner research project looking at the scientific, economic, and social acceptability of using rock dust in agriculture to capture greenhouse gases. A portion of these funds, more than \$2.1 million, will contribute to the new MiniFACE CO₂ enrichment component of the Leverhulme/Enhanced Rock Weathering research at the University of Illinois. The funding, and the work by the Illinois team, will also in turn be tied to the iSEE SMARTFARM project funded in two phases for a total of more than \$8 million by the U.S. Department of Energy's ARPA-E program.

The funding has also allowed for a new team member at Illinois: Co-PI Lisa Ainsworth, USDA Agricultural Research Service Research Molecular Biologist and Adjunct Professor of Plant Biology, who will guide a CO₂ enrichment experiment with researchers at the SoyFACE site at Illinois. The artificially increased atmospheric CO₂ mimics climate projections in the future, an interesting scenario for basalt application. Responses will show if the increased pressure of higher atmospheric CO₂ drives increased CO₂ capture by enhanced weathering. MiniFACE rings are under construction for experiments in 2022.

In 2020, LC3M began Phase 2 of the Enhanced Rock Weathering research. The University of Illinois Energy Farm applied a new rock material, known as Pioneer Valley basalt, which replaces the Blue Ridge basalt used in Phase 1, in late 2020. Pioneer Valley basalt is higher in fast-to-medium weathering components, and more similar to the basalts being used at the other Leverhulme research sites in Malaysia, Australia, and the UK. Research continues on plant growth and tissue quality, soil nutrient availability, organic carbon storage, inorganic carbon capture, and greenhouse gas emissions at the Energy Farm.

To visualize the progression of physical weathering, basalt-filled mesh bags were buried in the research plots in 2021 to expose the basalt grains to the weathering effects of the soil and plant environment. Bags will be removed after 1, 2, and 3 years and examined by x-ray powder diffraction (XRD).

Following the successful sampling and sequencing of basalt-treated soybean in 2019, maize soil and roots were collected in July 2020 for molecular sequencing with the intent of understanding the composition and dynamic of the microbial community, and how it changes with crop rotation. This component of the project seeks to understand the suppression of N₂O production after basalt application by identifying the microbial drivers of nitrogen cycling in the soil and plant root zone.

Illinois LC3M researchers contributed to the following publications in 2020-21:

- Blanc-Betes, E., **Kantola I.B.**, Gomez-Casanovas, N., Hartman, M.D., Parton, W.J., Lewis, A.L., Beerling, D.J., **DeLucia, E.H.** (2021) “*In silico* assessment of the potential of basalt amendments to reduce N₂O emissions from bioenergy crops.” *GCB Bioenergy*, 13, 224-241.
- Lewis, A.L., Sarkar, B., Wade, P., Kemp, S.J., Hodson, M.E., Taylor, L.L., Yeong, K.L., Davies, K., Nelson, P.N., Bird, M.I., **Kantola, I.B.**, **Masters, M.D.**, **DeLucia, E.**, Leake, J.R., Banwart, S.A., Beerling, D.J. (2021) “Effects of mineralogy, chemistry and physical properties of basalts on carbon capture potential and plant-nutrient element release via enhanced weathering.” *Applied Geochemistry*, in press.
- Horton, P., **Long, S.P.**, Smith, P., Banwart, S.A., Beerling, D.J. (2021) “Technologies to deliver food and climate security through agriculture.” *Nature Plants*, 7, 250–255.

Illinois LC3M researchers also made the following presentations during the past year:

- **DeLucia, E.** “Rethinking American Agriculture: Reducing Greenhouse Gas Emissions from Food Production.” AAAS, Riley Memorial Lecture, Nov. 19, 2020.
- **Kantola, I.B.** “Enhanced Rock Weathering: Basalt Amendment for Carbon Dioxide Reduction in Agriculture,” University of Illinois Department of Geology Colloquium, Oct. 10, 2020.