

FoodBioSystems DTP - PhD Project Advertisement

Project Title:

FBS2021-47-Kirk: Enhanced weathering of silicates in arable and pasture soils to sequester atmospheric CO₂

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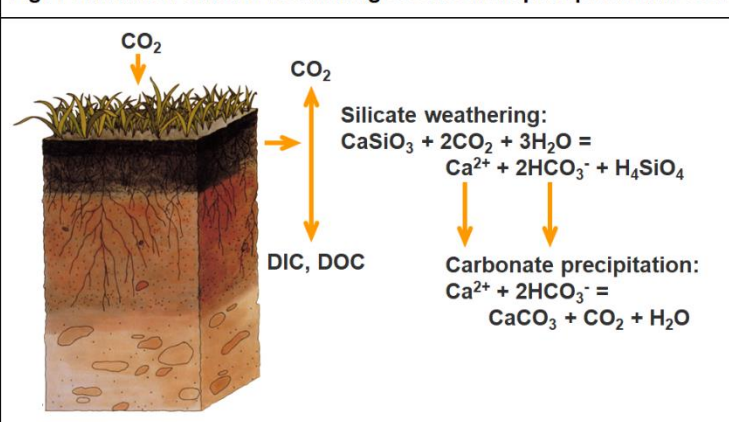
Nick Girkin, Cranfield

Project Description:

One of the most promising 'geo-engineering' methods to mitigate climate change is to capture CO₂ from the air and react it with silicate rocks to form carbonate rocks, so permanently sequestering the CO₂. A Swiss-based company (Climeworks) is already offering to do this for \$1,000 per tonne of CO₂ using a CO₂-capturing technology and pumping the CO₂ deep underground to react with basalt rocks. However this process is highly energy intensive, and the net CO₂ capture is correspondingly reduced. A less energy-intensive approach – which this project will test – is to exploit CO₂ capture by plants in photosynthesis and decomposition in soil on agricultural land, using finely-divided silicates applied on the soil to fix the CO₂ as environmentally-benign carbonates (Fig. 1). Soils are a good source of CO₂ for this because C fixed by plants and released in root and soil respiration results in the CO₂ pressures in soil air being 10–1000 times that in the bulk atmosphere. There are many sources of suitable silicate rocks and calculations have been made of the circumstances required for the C capture gains to exceed the C costs of mining and transport to application sites.

Most attention to date has been on large, regional-scale applications of silicates in warm and wet tropical areas considered to be weathering 'hot spots'. This project will consider the potential for this technology on arable and pasture land in the UK, and the extent to which it could contribute to reducing carbon emissions from UK farming to zero. Simple calculations indicate that, as a minimum, substitution of silicates for agricultural lime could offset a significant proportion of carbon emissions. Agricultural lime is typically incorporated to less than 20-cm depth. A much greater CO₂ offset could be achieved if the effects of the applied silicate reached subsoil and caused carbonate precipitation there. In principle this could be achieved by manipulating the chemistry of the surface soil and exploiting leaching processes. However, the necessary conditions for this to work are not well understood, and there are no reliable models with which to predict where such a technology would be successful, and how to develop routes to adoption by the agriculture sector.

Fig. 1 Enhanced silicate weathering & carbonate precipitation in soil



This project will explore technologies for exploiting enhanced silicate weathering to sequester atmospheric CO₂, and the potential for such technologies to reduce net greenhouse gas emissions from UK farming. Specific objectives towards these ends:

1. To test the hypothesis that it is practicable to manipulate surface soil conditions to enhance dissolution of applied silicates and precipitate leached dissolution products as carbonate in the subsoil. This will be done in controlled-environment experiments with planted soils and alternative sources and forms of silicates.
2. To develop and test a predictive model of enhanced silicate weathering in soils, including the processes governing leaching and precipitation of carbonate in subsoils. The model will be tested against the results of the experiments under Objective 1.
3. To assess the extent to which this technology might affect the mineral nutrition and trace element composition of arable crops and pasture grasses.
4. To explore routes to adoption by manufacturers of agricultural products and farmers.

Training opportunities:

This is a great opportunity to work in a project at the cutting edge of food systems and environmental science and to learn cutting-edge techniques in soil chemistry, physics and biology, plant nutrition, and mathematical modelling. The student will join a group of over 50 PhD students in the Cranfield Environment and Agrifood Theme, including students from other UKRI-funded doctoral training centres. They will have access to a full range of associated training modules. They will also benefit from interactions with an industrial partner, including work placement.

Student profile:

This project would be suitable for students with a degree in biology, chemistry, geology, environmental science or a closely related science.

Funding Note

This project is part of the FoodBioSystems BBSRC Doctoral Training Partnership (DTP), it will be funded subject to a competition to identify the strongest applicants.

The studentship is open to UK and international students (including EU countries) however due to funding rules, no more than 30% of the projects can be allocated to international students.

The funding will include a tax free stipend (minimum £15, 285 per year), support for tuition fees at the standard UK rate (currently £4,407 per year) and a contribution towards research costs. **Please note** that the host universities have not yet confirmed the level of fees charged to international students funded by the DTP. Fee levels may vary across the institutions. This information will be shared on the FoodBioSystems DTP website as soon as it becomes available.

To apply

Please go to [FoodBioSystems DTP website](#) for information on how to apply for this studentship. The closing date for applications will be 8 February 2021.