Utilising mining waste materials for carbon sequestration: A novel laboratory method assessing enhanced weathering potential in an arctic climate

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Implementation of the EU Green Deal and attainment of net-zero greenhouse gas emissions, requires policies supporting transition from traditional to clean energy sources, which will increase demand on mining key resources, that will likely increase CO_2 emissions and waste production. Many previous studies have assessed the potential utilisation of mafic/ultramafic mine waste for CO_2 capture (carbonation) via natural or enhanced weathering (EW). EW is the process of utilising fine grained rock material favouring carbon capture, to accelerate carbon biogeochemical cycling by removing higher amounts of CO_2 from the atmosphere than are produced in the process. In theory, this is considered a well-defined carbon dioxide removal (CDR) method, but in practice it is still not used on large scale/long period trials, and hence no widely accepted monitoring, reporting & verification (MRV) standards exist to date. More precisely, there are significant gaps in understanding physicochemical controls for carbonation, such as mineral chemistry, particle size, CO_2 supply, temperature, soil porosity, porewater pH, saturation and salinity. To consider EW as a viable CDR method, strong evidence is needed that the material sequesters more CO_2 than it emits under given conditions. Our research focuses on determining the net CO_2 flux from the EW of Ca- and Mg-rich mine wastes, considering physicochemical controls for carbonation, under various conditions (e.g. arctic climate). A series of novel laboratory experiments were set up, which indicated the potential for this material to sequester CO_2, and allowed development of the method to measure the process. CO_2 capture was particularly efficient for tailings, producing higher carbonation rates due to smaller grain size/larger surface area compared to waste rock. These findings will now be tested at field sites in Northern Europe, using a new CDR MRV methodology determining the net CO_2 flux generated from mine wastes, under the EU/UKRI-funded C-SINK project.