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Investigating multiple mine tailings for enhanced weathering methods and CO_2 sequestration

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Anthropogenic CO_2 inputs to the atmosphere are a key cause of global warming, and it is now clear that the Paris Agreement target of limiting the global average temperature increase to 1.5°C cannot be achieved without CO_2 removal from atmosphere on the order of tens of gigatonnes (Gt) per year by 2100. Attention is turning to accelerated CO_2 removal through enhanced weathering and carbonation of silicate mine tailings. The principle is to accelerate natural chemical weathering, whereby minerals dissolve in a reaction with CO_2 and water to form soluble bicarbonates. These products are stored as alkalinity, or precipitate as carbonate minerals. This natural reaction consumes CO_2 and stores it safely for hundreds of thousands of years, but is a slow process, taking several hundred years or more to occur. Enhanced weathering aims to accelerate the weathering and precipitation processes in such a way that significant amounts of CO_2 are removed from the atmosphere on human timescales (up to tens of years).

Recent studies[1-2] have highlighted the high potential for Gt-scale removal through enhanced weathering of both annually produced and historic silicate tailings, but critical uncertainties remain regarding which materials are appropriately reactive, how reactions can be sufficiently sped up and how such approaches can be upscaled for industrial implementation. In this study, we investigate the reactivity of a range of silicate mine tailings with CO_2 and water. The sample set, derived from mines distributed globally, includes materials considered to be chemically favourable[1-2] (e.g., diamond kimberlites, olivine dunites), materials that may be promising[1-5] (e.g., Al red muds, borates, Cu volcanics) and materials of unknown/minor promise (e.g., lime-treated Cu tailings, SO_2-processing Al products). The aim is to identify the tailings that show suitable potential for CO_2-water-rock reactions for reactor schemes with implemented enhanced weathering methods for Gt-scale CO_2 removal.

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