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Accelerated Concrete Dissolution and CO_2 Mineralisation using Small Organic Molecules as Catalysts

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Construction and demolition waste (CDW) represents a significant proportion of industrial waste. In Europe, ~ 850 million tons of concrete waste were generated in 2018, most of which ended in landfills or was used in low value applications [1]. Historically, the construction industry (including cement production) is the largest CO_2 emitter, responsible for 30-45% of total CO_2 emissions. One of the promising strategies for addressing both CDW management and CO_2 emissions is to use waste concrete to mineralise CO_2. Research indicates that carbonating end-of-life concrete can trap CO_2 and the end product can be reused, mitigating some of the emissions associated with new concrete production [2]. However, reuse of demolition waste is limited by slow dissolution kinetics. The main parameters are pH, temperature and the presence of organic compounds that can affect the solid-water interactions. At high pH, hydroxide ions facilitate breaking the silicate chains, releasing alkali metals and various hydroxide species. Fast dissolution in a short time can lead to uncontrolled metal leaching, for example, Ca, Al, and Mg that then form a passivating layer, which can inhibit further reactions [3]. Chelating ligands are known to influence calcium aluminosilicate dissolution rates under alkaline conditions [4]. However, dissolution is slow and divalent cation release is low. The development of robust organic compounds, to act as catalysts for this process, is relatively unexplored.

We are investigating the behaviour of small biogenic molecules and their derivatives in promoting accelerated element leaching (e.g., Ca, Al, Si, Mg, Fe) and subsequent CO_2 mineralisation, to form secondary carbonate phases. In particular, we have investigated crushed concrete-water-organic molecule interactions in batch conditions at pH 10 and higher, to understand the molecular level processes by which organic molecules speed silicate dissolution and promote secondary mineral formation.

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