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The role of CO_2 mineralization processes in the reduction of GHG emissions

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One of the methods for permanently fix CO_2 into solid matrix of carbonates can be naturally observed in weathering processes during which some very common silicate rocks spontaneously react with atmospheric CO_2. This reaction, is very slow but can be properly enhanced and, therefore, industrialized. In this way, anthropogenic CO_2 can react with suitable mineral substrates producing stable, inert and non-toxic mineralized phases that can be safely disposed of or, better, converted into valuable products. Among the various minerals considered for this purpose, Olivine ($Mg_{2-x}Fe_xSiO_4$) is very promising due to its CO_2 uptake (nominally, 0.63 $kg_{CO2}/kg_{Olivine}$, the highest among the silicate rocks) and its frequent availability in outcrops often exploited industrially. The MC reaction with Olivine is extensively studied and some technological solutions patented: usually, finely ground Olivine powder is suspended in an aqueous solution of $NaHCO_3$ and optionally a second electrolyte (e.g., NaCl) and the reaction is performed in an autoclave under vigorous mechanical stirring at 120 – 200°C and under 20 – 250 bar CO_2 pressure (P_{CO2}). The rate of carbonation is strongly influenced by P_{CO2}, temperature, average particle size of the mineral and, in lower extent, by the composition of the aqueous phase. Other phenomena may negatively influence the overall reaction rate, the most important being the formation of passivating layers of amorphous silica and/or carbonates that, covering the surface of the particles, constitute a diffusion barrier thus slowing down the entire carbonation process. Working with a rock mined from natural outcrops with an average Olivine content of 83 wt% and nominal CO_2 uptake of to 0.50 kg_{CO2}/kg_{rock}, we have selected a reactor suitable to manage a reaction that is only apparently simple, but which involves different gas-liquid-solid equilibria and optimized the reaction conditions to obtain an almost complete carbonation (> 95%) within 3 - 4 hours, under moderate P_{CO2} (70 - 90 bar). In addition to this result which ranks among the best reported in the literature, a further important turning point is represented by having discovered that the product (consisting mainly of Mg (Fe) carbonate and amorphous silica), after simple treatments, develops pozzolanic properties never reported in precedence for similar substrates. This evidence opens the way for applications as a supplementary cementitious material, limiting the production of clinker which has a very high impact from the point of view of CO_2 emissions. Therefore, this process will contribute not only to the decarbonization of Eni's processes but also to other industrial sectors such as cement production.