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Mineralization of CO_2 for Carbon Sequestration using Flue Gas Desulphurization Gypsum

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Past efforts for carbon sequestration using CO_2 mineralization have proven effective for long-term stable storage of CO_2 but were prohibitive due to slow reaction rates and high cost. Recent mineralization studies reacting flue gas desulphurization (FGD) gypsum ($CaSO_4 \bullet 2H_2O$) with CO_2 in an alkaline solution, have shown conversion of gypsum into calcium carbonate ($CaCO_3$) to be a rapid and effective method for carbon sequestration. However, these studies used sodium hydroxide and ammonia to increase solution pH. The use of ammonia makes this mineralization method inefficient due to the production of ammonia being a significant CO_2 source. The goal of this study was to obtain high FGD gypsum-to-calcite conversation percentages at ambient temperature while eliminating the need for ammonia. A stirred reactor was utilized to study the effects of P_{CO2} (10, 30, 60, and 250 psi), solution pH (12, 13, 13.5 and 14), solid-to-solution ratio (1:100, 1:80, 1:40, 1:100), and reaction time (10, 15, 30, and 120+ minutes) variation on the rate of conversion. The amount of carbonate produced was calculated from Rietveld refinement of XRD patterns to determine the impact of each variable. Experimental results showed varying degrees of FGD gypsum to $CaCO_3$ conversion. Solution pH was a primary control on conversion rates, with complete conversion occurring under all conditions at pH 13.5 and 14. Time also played a significant role in conversion rates, from 0% conversion at pH 13 after 360 minutes of reaction time, to approximately 75% conversion at pH 13 after 15 minutes of reaction time. The most cost-effective conversions took place at low P_{CO2} (10 psi), pH 13 and a reaction time of 15 minutes, with a conversion rate of around 75%. The results of this study demonstrate that FGD gypsum can serve as a viable feedstock for CO_2 mineralization, potentially providing an inexpensive method for carbon sequestration.

Biography

Jonathan Riddle received a bachelor's degree in science at the University of North Alabama. After receiving his degree, he took a hiatus of four years to teach English in Japan. Afterwards, he decided to continue his geologic career and is currently a master's student at the University of Alabama. He began studying environmental issues and was awarded the Outstanding Research Paper from Geosyntec in 2018. He has been working with his professor, Dr. Rona Donahoe, on carbon mineralization. His is currently investigating more effective ways to use flue gas desulphurization gypsum for CO_2 sequestration. He will be finishing his master's degree in December of this year in environmental geochemistry.