Reuse of Treated Mine-Impacted Water as a Potential Resource for Accelerated Carbon Sequestration

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Abstract

Mine impacted water (MIW) can refer to any water impacted by a mining process including AMD and brines all of which pose a major environmental threat. The vast quantities of MIW present in South Africa has created serious problems in the water cycle. However this has also provided opportunities where these waste streams could be considered resources under the right conditions. South Africa is not only water scarce but also one of the top 20 CO_2 polluters, world-wide. Average global monthly temperatures are now cresting at 1 °C above pre-industrial levels while atmospheric CO_2 levels seem to have permanently breached 400 µmol/mol. These levels are projected to increase to over 800 µmol/mol by the end of the century if no action is taken. The work presented here provides a potential CO_2 sequestration mechanism using MIW.

Carbon sequestration is defined as a natural/artificial process by which CO_2 is removed from the atmosphere and held in solid/liquid form. Carbon mineralisation for carbon sequestration involves the leaching of Ca-Mg-Fe cations from silicate minerals which are then reacted with CO_2 to form inert carbonate minerals, sustainably trapping CO_2. However, due to the slow kinetics of the initial dissolution step the research focus has shifted to speeding up the dissolution of the target minerals, and identifying more reactive mineral resources. Alternatively, we investigated through batch tests under varying conditions of pH and temperature, the potential of a variety of Ca-Mg-Fe-rich MIWs to function as resources for carbon sequestration where the costly, rate-limiting mineral dissolution step was bypassed altogether. In addition, we investigated the water treatment potential of the carbonation reaction, to co-precipitate and encapsulate other elements present in the MIW into the stable carbonate products, to lead to cleaner effluents.

The work conducted was designed to answer questions relating to; a) how to cost-effectively maintain the alkaline pH required for carbonation, b) the effect of other MIW components on the carbonation reaction, c) how this in turn affected the final carbonate product and d) the effect of elemental encapsulation on MIW quality.

New regulations being imposed worldwide aiming to mitigate the risks of global warming necessitates the R&D of new technologies for carbon sequestration. Linking these technologies to the use of the vast MIW resources present in South Africa that could themselves be treated in the process provides an attractive opportunity on two fronts.

Keywords: Mine-Impacted Water, Carbon Sequestration, Treatment, Encapsulation