ST.033
CO2 Storage Potential in Mine Tailing in Brazil: An Initial Approach

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The geologic storage of CO_2 is encouraged by the IPCC (Intergovernmental Panel on Climate Change) to contain the increase in the average temperature of the planet compared to the preindustrial era. The research agenda published by the National Academies of Sciences Engineering Medicine indicate CO_2 underground storage in sedimentary formations and mineral carbonation (or carbon mineralization) as the most promising methods to achieve the goals proposed in the Paris Agreement, UNFCCC. Mineral carbonation consists of the precipitation of carbonate minerals, as calcite or magnesite, through the reaction of CO_2 with calcium- or magnesium-rich rocks. Mafic and ultramafic mine tailings have potential use for mineral carbonation as they consist of minerals rich in calcium and magnesium like olivine, wollastonite, brucite, and serpentine. Although the mine tailings have a higher surface reactivity than subsurface geologic formations, most minerals in mafic and ultramafic rocks have relatively slow reaction rates in surface conditions. Some enhanced methods that accelerate the carbonate precipitation, such as sparging air, air-saturated water, or CO_2-rich gas through the tailings or adding microorganisms, could be considered additionally. Here an initial approach of active and paralyzed mines of nickel, copper, chromium, and vanadium, whose rock hosts are gabbros, serpentinites, and ultramafic, in Brazil is presented. Tailings, most often in the form of a wet slurry, are conventionally stored above ground behind earthen dams. In Brazil, a comprehensive national registry of dams, including tailings dams, was recently generated by Agência Nacional de Mineração (ANM) (https://app.anm.gov.br/SIGBM/Publico). This initial study totaled 11 mines of different resources in distinct geologic provinces (Fig. 1) with a total sum of 84 million cubic meters of tailings with potential for mineral carbonation. In addition to tailings dams, waste rock piles should also be considered, as they would have a larger accessible area exposed for carbonate precipitation and because they are safer, given that the dams would need additional detailed monitoring to minimize the risk of leaks. Figure 1 also highlights the extensive occurrence of basalts in the southern and southeastern regions of Brazil referring to the Serra Geral Formation, where several small to medium gravel quarries occur. The known occurrence of the Serra Geral basalts in depth also presents the potential for in situ carbon mineralization through injection and circulation of CO_2-bearing fluids through this formation. Future detailed studies of mineralogical characterization in each case are necessary for a better evaluation of the best methods and techniques to be applied in each mineral deposit. Although mineral carbonation is a small storage opportunity in terms of CO_2 volume, the mines could still offset CO_2 emissions and provide local solutions for regions with concentrated CO_2 sources.

Fig. 1. Mines with potential for carbon mineralization for CO_2 storage in Brazil, with basalt, gabbro, and ultramafic formations.