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The role of clays as sealing materials for the geological storage of carbon dioxide. Preliminary results

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The aim of this work is to contribute to the knowledge of the reactions that can occur between carbon dioxide, diffused or escaped from a geological storage, and the sealing rock (usually clayed). The research provides experimental data on the expected reactive behavior of sepiolite, palygorskite, saponite, kaolinite and common clays with CO_2 in presence of water or dry conditions. From the obtained results, the physical and chemical retention of CO_2 mechanisms were determined, as well as the effect of the pressure, temperature and relative humidity on these mechanisms in order to evaluate their influence on the effective sealing of rocks with similar mineralogical characteristic.

Results and Conclusions

Sepiolite and palygorskite are capable of sequestering CO_2 through both a physical and mineral mechanism. The physical trapping is higher for palygorskite than for sepiolite. During the reaction, these minerals were attacked by CO_2, both under dry and wet conditions, leading to partial decomposition of their structure together with a reduction in volume and mechanical resistance of the rock. Therefore this attack may lead to the partial destruction of cap-rocks containing these minerals as major components, and to possible loss of CO_2. In the case of palygorskite, however, during reaction Mg-carbonate can precipitate, thus, some CO_2 is chemically bound ("trapped"). Moreover the structural integrity of palygorskite is largely preserved, and CO_2 release is inhibited.

Magnesium bentonite does not show physical adsorption of CO_2, and an increment of amorphous phase due the acid attack was detected. Nevertheless the smectite exchange cations, leads to the precipitation of carbonates.

In relation with the study realized with common clays, mainly composed of dioctahedral smectite and illite, the smectite and later illite, were partially degraded in the elapsed time. But it is noted a certain physical retention and chemical reactivity.

Finally the experiments carried out with kaolin, which contains nearly 30% of kaolinite, with illite and quartz; indicate that this material does not present physical trapping of CO_2 and any chemical reaction.

In summary, all the materials tested (others than kaolin) can physically and geochemically hold CO_2, but also are susceptible to the attack with CO_2, both in wet and in dry conditions, which can lead to their partial destruction, loss of volume and sealing. However, it has also demonstrated that the attack is not total and precipitation of carbonates can also occur, trapping some CO_2 chemically and more importantly, avoiding the progressive deterioration of the rock. In this sense, sepiolite, saponite and montmorillonite clays are the most sensitive to attack with CO_2. But in the case of palygorskite, secondary dolomite production is a positive aspect which would prevent its destruction and exhaust.