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Editorial

Special Issue "Climate Change, Carbon Capture, Storage and CO_2 Mineralisation Technologies"

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This Special Issue presents sixteen scientific papers that explore the application of carbon capture and storage technologies, mitigating the effects of climate change. Emphasis has been given on mineral carbonation techniques that combine innovative applications to emerging problems and needs. The aim of this issue is to contribute to the knowledge of the ongoing research regarding climate change and CCS technological applications, focusing on carbon capture and storage practices. Climate change is a global issue that is interrelated with the energy and petroleum industry. In this scope, there is an increasing demand for new low cost and energy efficient techniques that reduce the CO_2 emissions. The use of fossil fuels is the primary source of CO_2 emissions, which is one of the main greenhouse gases. Carbon capture and storage (CCS) is regarded as one of the most efficient technologies that allows carbon intensive industries to continue to operate with lower CO_2 emissions. CCS offers double benefits combining the reduction in greenhouse gas emissions with the direct use of captured carbon for enhanced oil recovery (EOR). Mineral carbonation is a permanent and secure CCS and sequestration technology that gives the solution in cases of smaller to medium emitters. It is based on the in situ (injecting CO_2 into the earth's surface) or ex situ (chemical reactor systems) production of carbonate minerals through the chemical reaction of CO_2 with Ca, Mg, and Fe-silicate minerals.

In this Special Issue, Drexel et al. [1] investigated the wettability alteration by carbonated water injection (CWI) on a coquina carbonate rock analogue of a pre-salt reservoir, and its consequences in the flow of oil. Pore-scale simulations showed that CWI altered the wettability of the carbonate rock from neutral to water-wet. Zarogiannis et al. [2] employed a systematic approach to identify the impact that operating parameter variations and different solvents exert on multiple CO_2 capture performance indicators. Moita et al. [3] examined experimentally the mineral carbonation of CO_2 in plutonic ophiolitic mafic rocks through a set of laboratory experiments on cumulate gabbro and gabbro-diorite specimens from the Sines Massif (Portugal). Tectonically related deformation processes upon coal affecting their nanopore structure and their relation to CO_2 adsorption are presented by Wang and Long [4]. The subject of ophiolitic-related rocks from southern Portugal and their potential for mineral carbonation of CO_2 was brought forward by Pedro et al. [5] confirming that they exhibit the appropriate mineralogical and geochemical features for this purpose. An interesting study is presented in this Special Issue to investigate the suitability of metallurgical slugs of different chemical and mineralogical composition as clinker substitute in cement manufacture [6]. This study revealed that the most critical parameter in the compressive strength development of the slag cements is the mineralogical composition of the slag.

Zhou et al. [7] present a research study on the role of atomic stress in calcite nucleation, based on molecular dynamics simulations on amorphous Ca-carbonate gels. The research results indicate that the gelation reaction strongly depends on the development of local molecular stresses within the Ca and C precursors, which progressively get released upon gelation. Numerical simulations on CO_2

bubbles dissolving into the seawater, as well as on the diffusion of dissolved CO_2 by ocean flows, indicate that all leaked and rising CO_2 bubbles are dissolved into the seawater before reaching the free surface [8]. The results of this research study provide important outcomes on the behavior and environmental risk of CO_2 leakage. Kim et al. [9] present an experimental study for the development of a carbon-capturing concrete. The research was based on the use of blast-furnace slag instead of cement. CO_2-adsorption and diffusion properties of metal-organic frameworks (CoRE-MOFs) was investigated based on machine learning methods and Monte Carlo/molecular dynamics simulations [10]. The simulation results provide valuable guidelines for the synthesis of new MOFs in experiments that capture low-concentration CO_2 directly from the air. Fedunik-Hofman et al. [11] investigated the kinetic parameters of $CaCO_3$/CaO reaction systems in energy storage and carbon capture. The research outcomes indicate a strong association between the experimental conditions, material properties, and the kinetic method with the kinetic parameters. Chemical reactions between synthetic sandstones, formation water and CO_2 were investigated based on experimental studies and numerical modelling [12]. The research results provide new geochemical insights on the dissolution mechanisms of CO_2 under high-pressure/temperature conditions.

Microporous carbonspheres for CO_2 adsorption were designed and prepared by deploying potassium oxalate monohydrate and ethylene diamine (EDA) [13]. The study revealed that carbonization temperature increase results in an increase in the specific surface area of the subsequent CO_2 adsorption. Wang et al. [14] provide a case study in Qinghai (China) that aims to investigate: (a) the change in carbon footprint (CF) caused by agrochemical and agricultural energy inputs, (b) the contributions of various inputs to the total carbon footprint (TCF), and (c) the different changing trends between carbon intensity in output value (CV) and carbon intensity in area (CA) for the period 1995–2016. Air purification tests on dusty and clean samples by deploying different light sources and setups, were conducted on photocatalytic pavement blocks from a 7 year service bicycle lane in Poland [15]. The research outcomes show that samples maintained their nitric oxide removal capability with 4–45% reduction rate based on the light source and their surface cleanliness. Gal et al. [16] investigated the soil-gas concentrations and flux at the TOTAL Lacq-Rousse carbon capture and storage (CCS) pilot site, in southern France. The research reveals that near surface gases are naturally produced and they are not associated with the ascending CO_2 from the storage reservoir.

The guest editors remain positive that the readers will enjoy the articles presented in this beneficiary Special Issue of "Climate Change, Carbon Capture, Storage and CO_2 Mineralisation Technologies".

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