**ABSTRACT**

Geological sequestration of carbon dioxide (CO2) in underground formations is the most promising way to decrease the greenhouse emissions into atmosphere. The understanding of long term effects of CO2 storage in carbonate aquifers is challenged by many uncertainties including geochemical effects of CO2 on carbonates and the coupled chemical–mechanical effects. The carbon dioxide dissolves in water forming bicarbonate which will dissociate to carbonic acid. This acid dissolves calcites in carbonate rocks. As a result, the petrophysical, electrical, and mechanical properties of the aquifer changes through this interaction. It is therefore necessary to study the effect of carbon dioxide sequestration on the integrity of a given formation to get safe and effective long-term storage of CO2 sequestration in deep saline aquifers.

This study investigates the fate of carbonate rocks destined for long term storage of Carbon dioxide and for CO2-EOR projects. Previous works focused on the applicability of electrical resistivity measurements to track CO2 migration by way of resistivity change as a function of CO2 saturation changes during CO2 sequestration. Many others also studied the effect of CO2 injection on the petrophysical and electrical resistivity of rocks. Previous works of these types use continuous flow of fluid in and out of rock samples and such flow experiments lasted only few hours. The fate of formation resistivity under static condition and at longer storage period was not considered. In this study we will investigate the effect of CO2 storage on the mechanical properties of carbonate aquifer rocks that were exposed to soaking with CO2. Furthermore, the effect of the duration of CO2-brine contact time or solubility time on these properties was investigated. CO2 was stored in the cores at 2000 psi and 100oC for different time periods ranging from two weeks to three months. The cores were then analyzed for the mechanical properties using acoustics, unconfined compression, and indirect tensile strength testing machines

In this study, a full suite of experiments was used to characterize and study CO2 effect on rock samples under flow and static conditions. They include resistivity index, drainage, aging in crude oil, water flooding, CO2 sequestration, CO2 flooding, and post NMR spectroscopy. Other supporting experiments are CT scan, XRFD, and Chromatography. MICP and NMR measurements showed that all core samples are of bimodal pore type and are very homogeneous. CT scan was used to confirm that fractures and vugs were not present in the samples.

The results of this study have established that the electrical behavior of carbonate rocks under long term CO2 storage is dynamic under a static flow condition. It stretches the scope of reservoir evaluation and surveillance using resistivity logging technique. It has been observed from an extensive laboratory study that: saturation exponent changed with time during CO2 storage and that the extent of change is dependent on the extent of CO2/brine/rock interaction (CBRI); that a change in formation resistivity does not necessarily translate to a change in fluid saturation or fluid migration but can be an indication of CBRI; that the combination of resistivity log and temperature log have been observed and proposed for monitoring rock/fluid interaction and scale formation in-situ and in real-time; and that CO2/oil/brine interaction (COBRI) during CO2-EOR cause hysteresis effect on saturation exponent. Post CO2 storage analyses confirmed rock grain dissolution, scale formation, and altered rock pore geometry.

Soaking CO2 for longer times changes the rock petrophysical and mechanical properties significantly. The initial mechanical strength plays a very important role in this process. The carbonate cores with higher initial compressive strength had lower effect of CO2 storage on the mechanical parameters compared to those with low initial mechanical strength.