Description of doctoral project and research results achieved to date

One of the main concerns related to the storage of CO$_2$ in the subsurface is the risk of leakage from the reservoir. Leakage may occur when changes in pressure and temperature in the reservoir result in a degradation of the caprock integrity. This phenomenon is comprised of several highly complex processes. Determining the role of such processes with computational approaches is therefore essential for predicting the behavior of these systems in CO$_2$ storage operations. However, modeling capabilities are still lacking in this research area, especially in the behavior of existing fracture networks in fault damage zones.

In this project, we develop coupled models for understanding the effect of processes such as flow, temperature, geomechanics and chemistry in a fractured reservoir. We focus on the mechanical response to these processes in the region surrounding fractures and investigate mathematical modeling techniques which simulate these phenomena.

Existing methods are not able to resolve with high accuracy processes within the fracture. Since these processes form a key component in the entire process, there is a significant limit as to what we are able to model. Therefore, we are developing new mathematical methods to overcome this limitation.

In the past year, we have made notable progress with regard to modeling flow within fractures and the coupling of this flow to the surrounding reservoir. This work is recorded in a paper submitted to SIAM Journal of Numerical Analysis, which is currently under review. The continuation of this work will consist of the geomechanical response in the surrounding region. The ultimate goal is to obtain a model which accurately couples flow and mechanics while taking fracture networks into account.