# PS Geomechanical Analysis of $CO_2$ Sequestration in the Bakken Formation*

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## Abstract

The purpose of this research is to determine the integrity of the Bakken shales and the capability to resist the buoyancy-drive flow of $CO_2$ to avoid risk of leakage and excessive fracture length. The effect of $CO_2$ sequestration on the mechanical properties of the Middle-Bakken is evaluated by measuring the geomechanical index properties before and after soaking with $CO_2$. We investigate the impact of $CO_2$ sequestration on the mechanical parameters based on the sequestration time intervals and determine if $CO_2$ sequestration will reactivate faults in the Bakken Formation. This information will be used to develop appropriate injection strategy, estimate injection potential and quantifying injection-induced seismicity risk.

Cores will be derived from active wells producing from the Bakken Formation (Upper, Lower and Middle member) in North Dakota, precisely in Dunn and McKenzie counties. The uniaxial compressive test (UCS) and the trial compressive test will be conducted on the cores, a non-destructive test when load is gradually applied to the cores and a transducer connected to the cores to measure the acoustic emission and to analyze the mechanical changes and behavior of the cores. The cores will also be saturated with $CO_2$ for 2-90 days and the cores will be analyzed for changes in the geomechanical properties at various intervals. We expect the pores of the cores to change mechanically when exposed to $CO_2$. CT scans will provide internal pore structure of Bakken Formation cores to define the pattern of the changes. Scanning electron microscope (SEM) will be used to study the electron behavior in the internal structure of the cores.

# Geomechanical Impacts of $CO_2$ Storage on Rock Properties and Potential for Fault Reactivation

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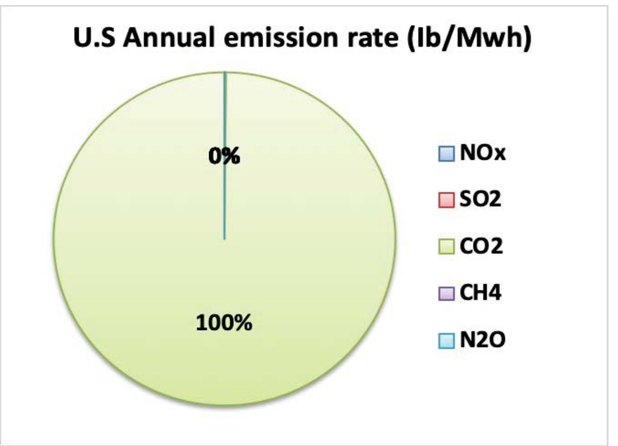
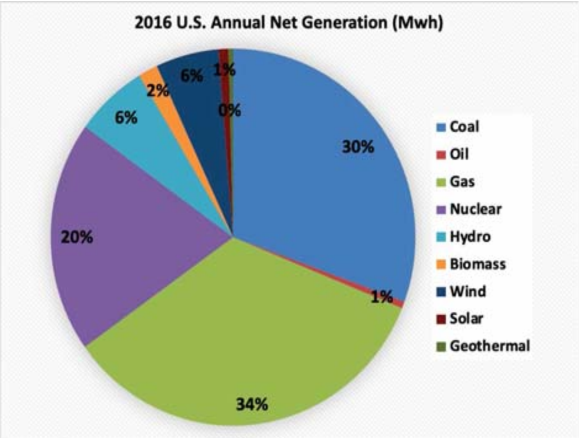
## Introduction

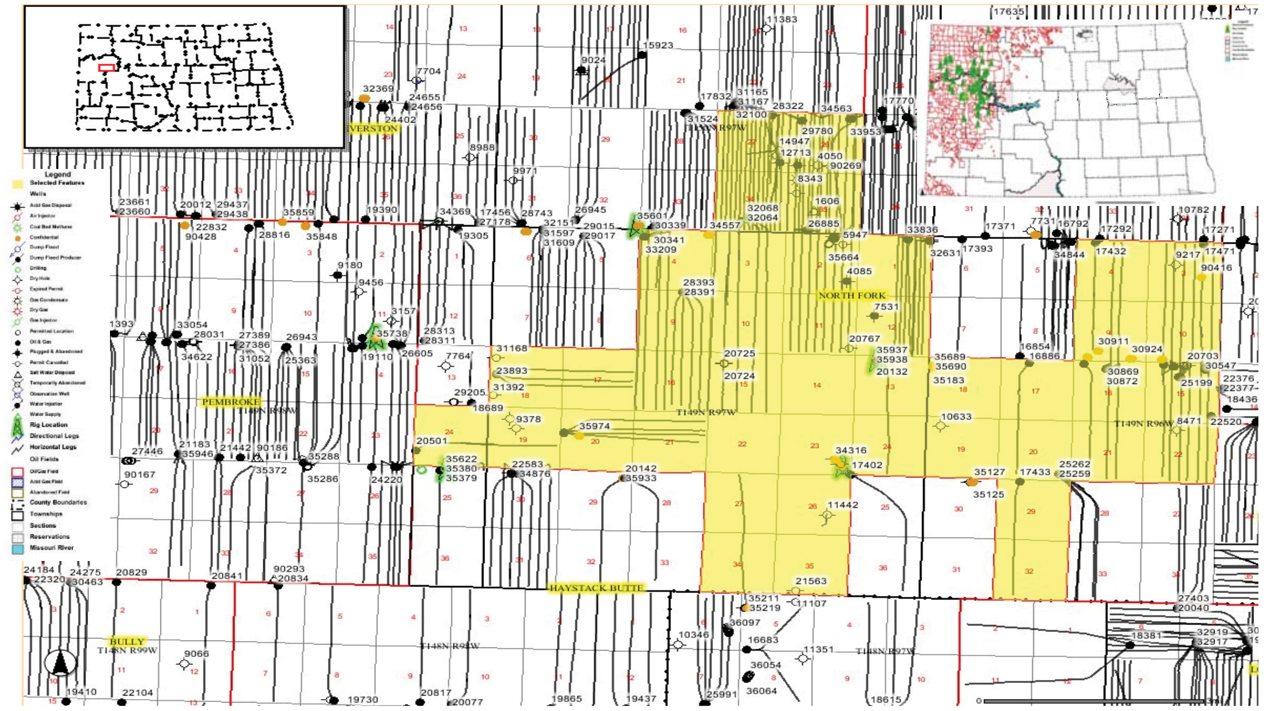
Carbon sequestration and enhanced oil recovery has attracted a lot of concerns in the unconventional shale resources in the past few years. The use of fossil fuel in the past century has drastically increased $CO_2$ emission into the atmosphere. About 80% of global primary energy is from fossil fuel, and the demand for fossil fuel is on the increase to satisfy the basic human needs. A total of about 22x10$^9$ tonnes $CO_2$/year is currently been emitted into the atmosphere globally. According to the EPA eGRID2016 database, as of 2016, U.S. emits about 2x10$^9$ tonnes $CO_2$/year as shown below. Out of that North Dakota has about 37 x 10$^6$ tonnes $CO_2$ /year net generation of $CO_2$.



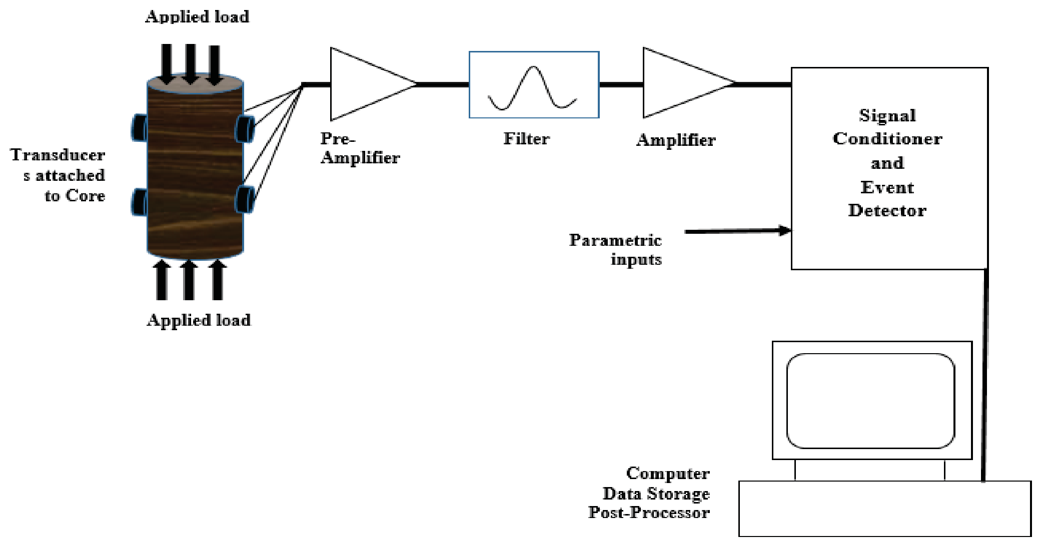




## Location

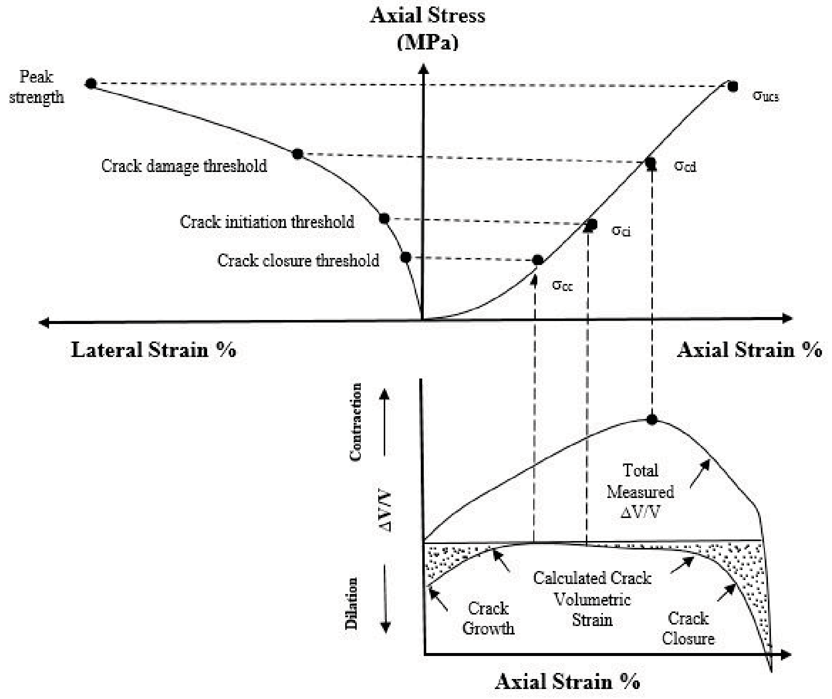
The study site for the $CO_2$ sequestration in North Fork Oil & Gas field in the Western North Dakota shown in the figure below

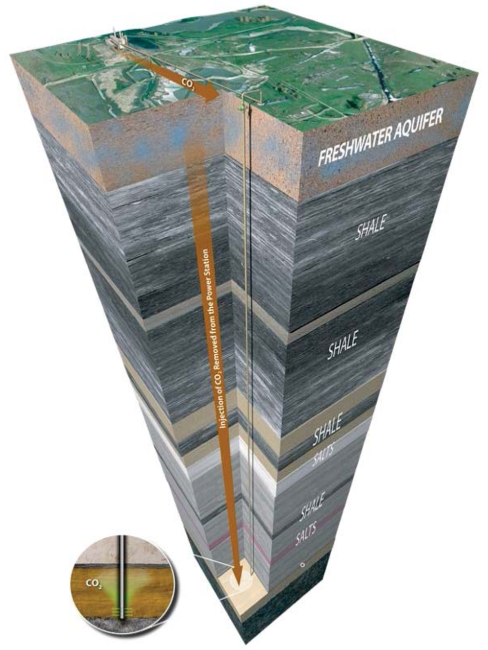


## Method



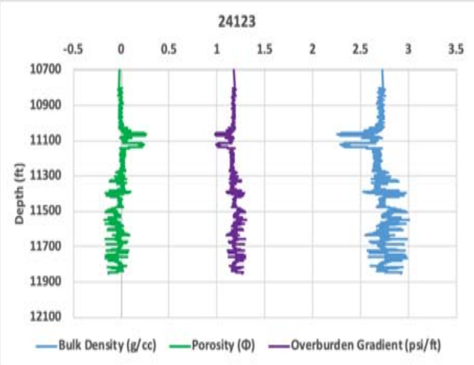

Experimental set up of acoustic emission monitoring, modified from Zhou et al (2018). This equipment will be used to measure V and S waves velocities to know how cracks are propagated on core plugs before and after $CO_2$ exposure, and to study how $CO_2$ sequestration will alter the porosity, permeability and hence the velocity of the rock.




Stress-strain diagram showing the stages of crack development. Modified from Eberhardt et al 1999. This graph will help to study the crack propagation, its threshold when axial load is applied to measure the core plug strength before and after $CO_2$ exposure. And $CO_2$ sequestration model to understand the underground formation (Adopted from EERC 2018). Failure of rock occurs when internal micro-cracks are initiated, expanded and eventually developed into macro-crack, which releases a strain energy as elastic waves known as the stress waves or acoustic emission. Acoustic emission is used to study the damage mechanics of rocks caused by crack initiation and propagation of cracks under an induced stress leading to sudden release of strain energy of the rock material.

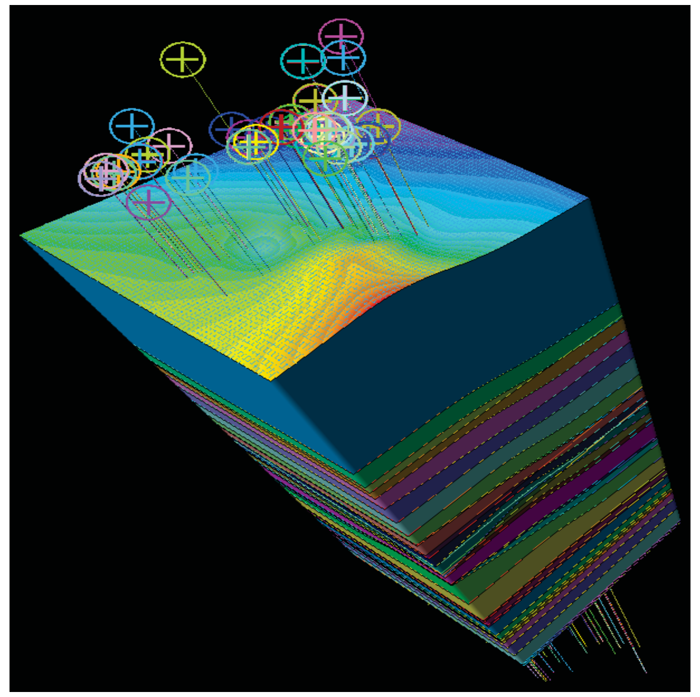
## Results

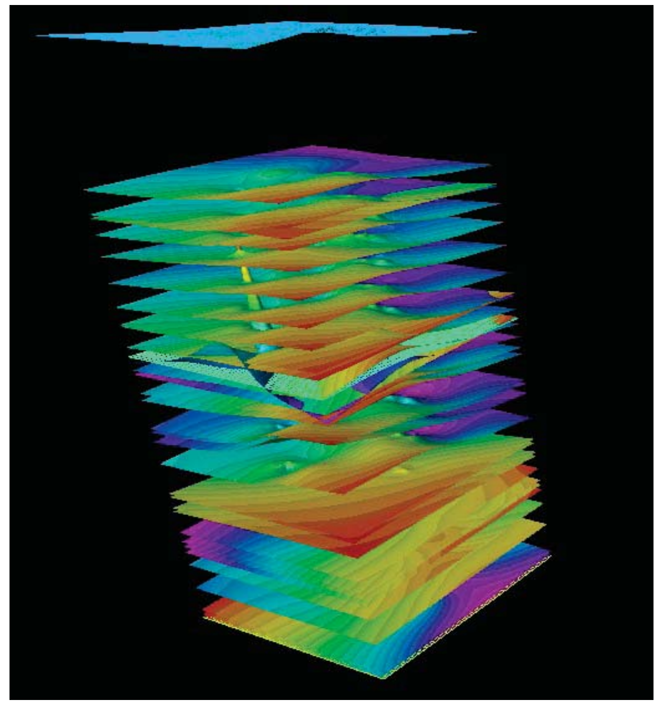




Bulk density plot of Well NO 24123 on blue from the NDIC database before $CO_2$ exposure, this information will be used to determine the best Formation, pressure, temperature for sequestration to mimic the formation properties at the laboratory.

## Current and future work





Build and geological model of the field with all the formation properties. Run a simulation of $CO_2$ sequestration in the geological model to determine its injectivity, capacity, caprock integrity and potential for fault reactivation in the basin.

## Acknowledgments

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