Analyzing Fault Reactivation Potential of CO2 Storage

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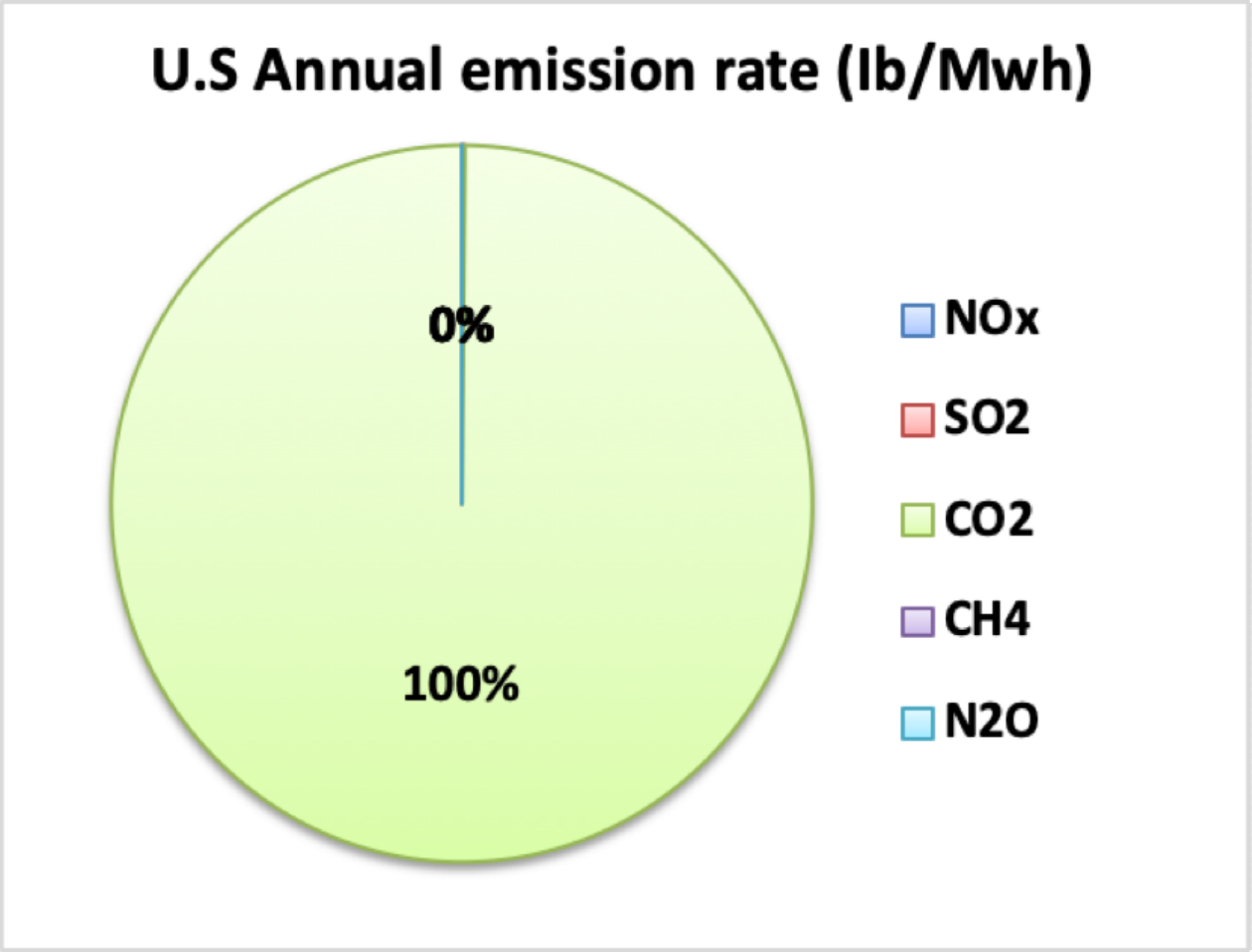
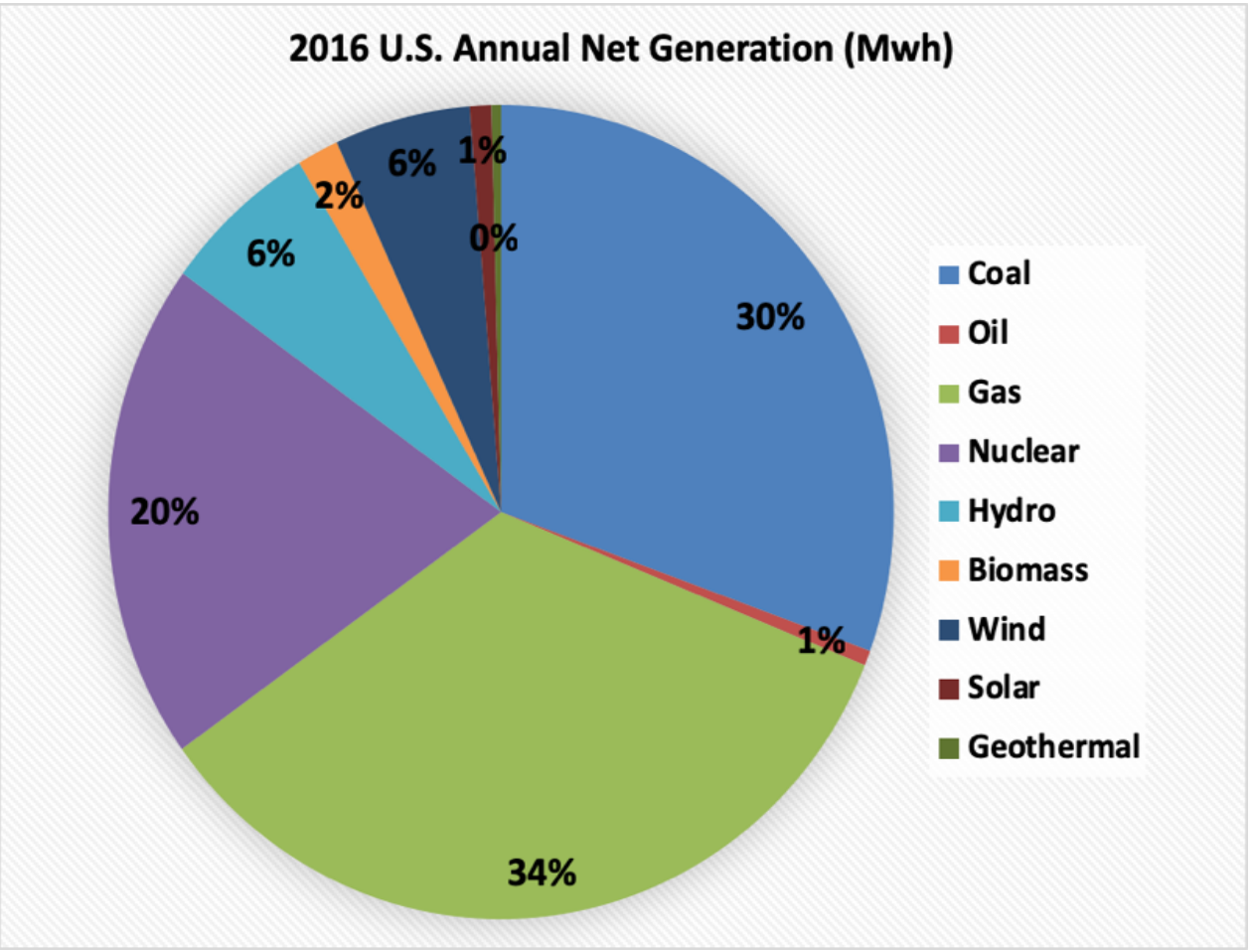
Introduction





According to the EPA eGRID2016 database, as of 2016, U.S. emits about $2x10^9$ tonnes CO_2/year as shown. Out of that North Dakota has about 37×10^6 tonnes CO_2 /year net generation of CO_2.

- Carbon storage and enhanced oil recovery are two methods which gets rocks exposed to CO2
- I'm studying CO2 storage effect on rock matrix, pore structures of the Bakken shale.

Introduction

The study site for the CO2 storage in North Fork Oil & Gas field in the Western North Dakota

- Geology
- Seismic Geomechanics
- Depositional sequence
- In-situ Stress
- Seal rock integrity

• Basin study

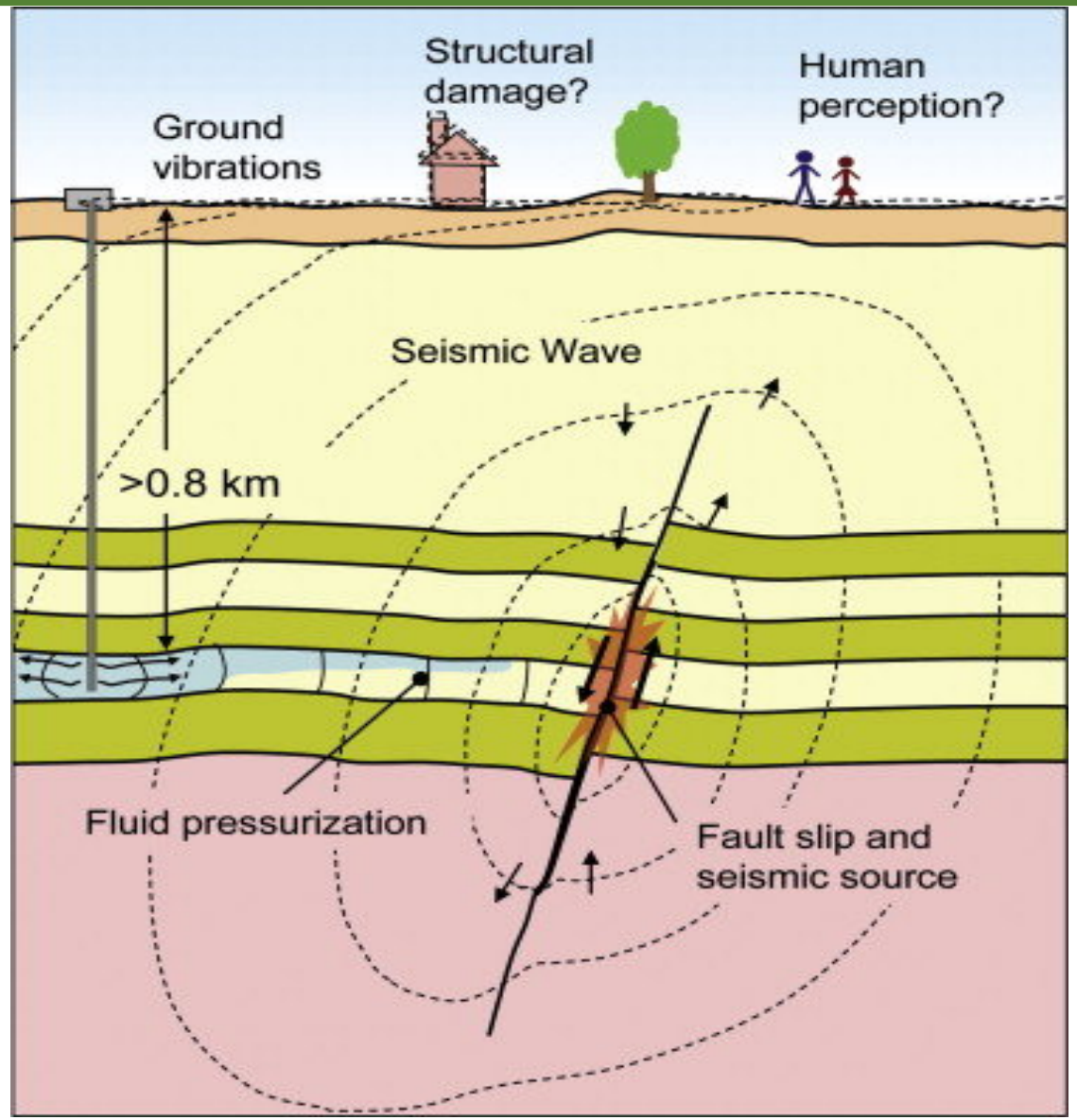
- Core examination
- Pore network
- Saturation capacity
- Nanoindentation analysis
- Core flooding
- Gas adsorption
- Fracture network
- Geomechanical evaluation
- Geochemical

• Laboratory testing

- Carbon capture
- Injection
- Sequestration

• Field test

Introduction



- CO_2 operations involve the injection and pressurization of reservoirs that usually results in changes to the state of in-situ stresses that may destabilize fractures.
- Instability can lead to slippage along pre-existing fracture systems.
- Fractures are conduits for fluid seepages and may raise reservoir pressures.

Introduction

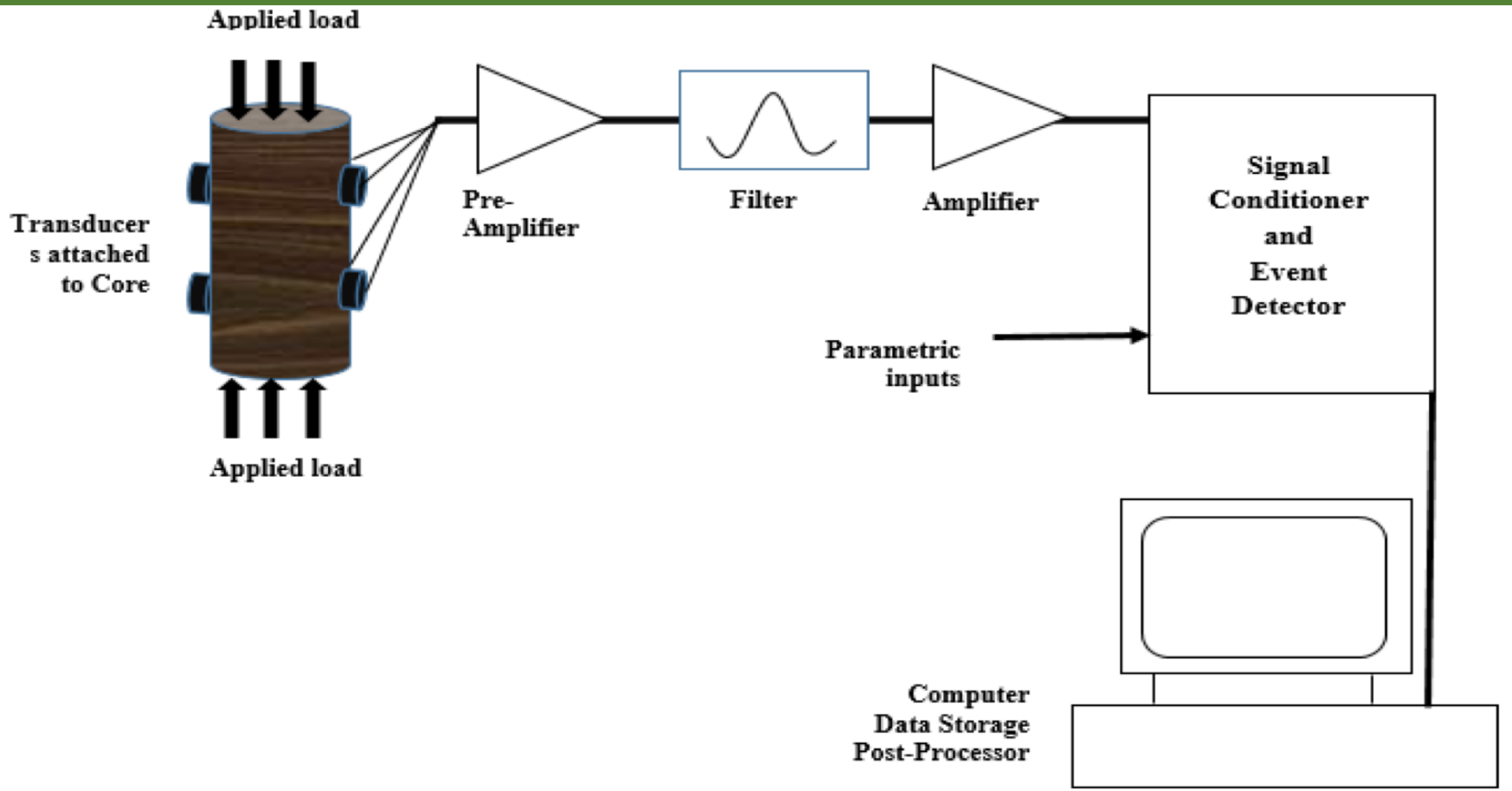
- $H_2O + CO_2 \leftrightarrow H_2CO_3$ (1)

- $CaCO_3 + H_2CO_3 \leftrightarrow Ca(HCO_3)_2$ (2)

- When carbon dioxide is injected into shale reservoir, it dissolves in water and changes the acid-base equilibrium that then triggers the dissolution and precipitation of minerals.

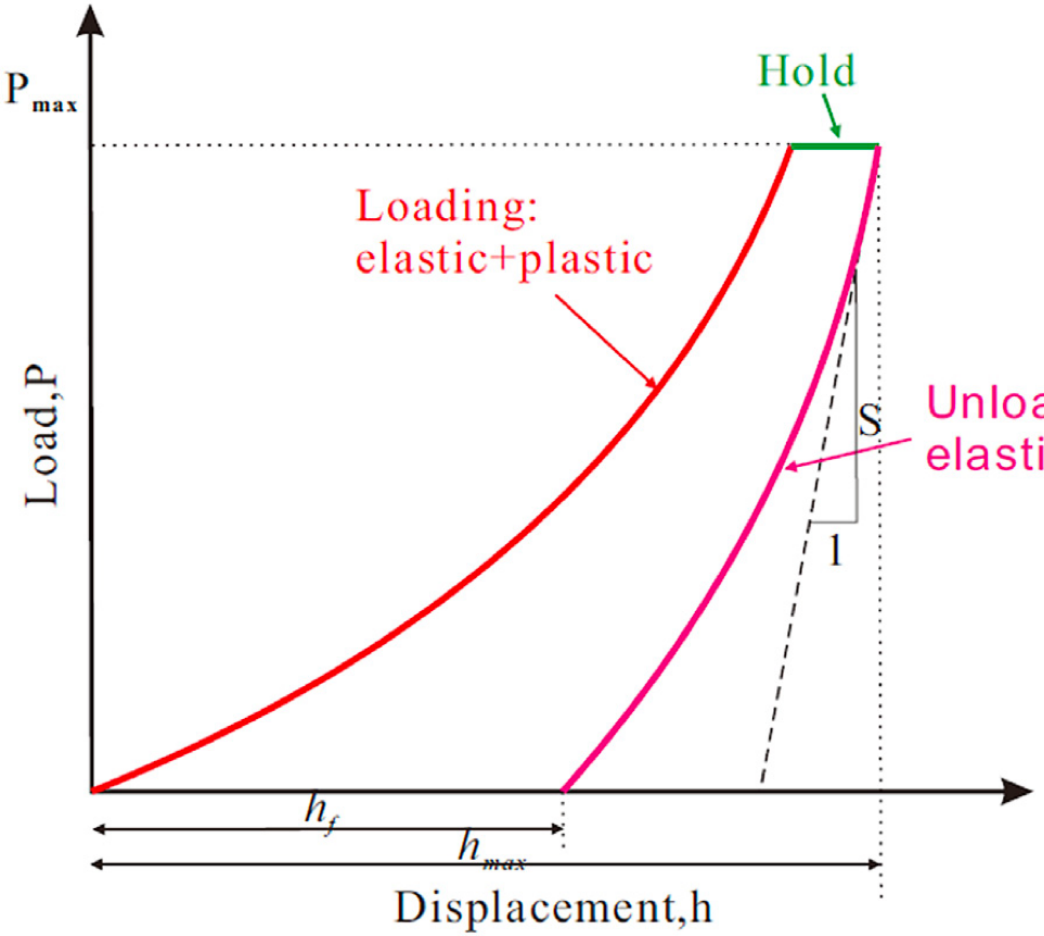
- Carbon dioxide dissolves in water to form bicarbonate (Equation 1) and dissociates to carbonic acid. Carbonic acid dissolved calcites in carbonate rocks (Equation 2).

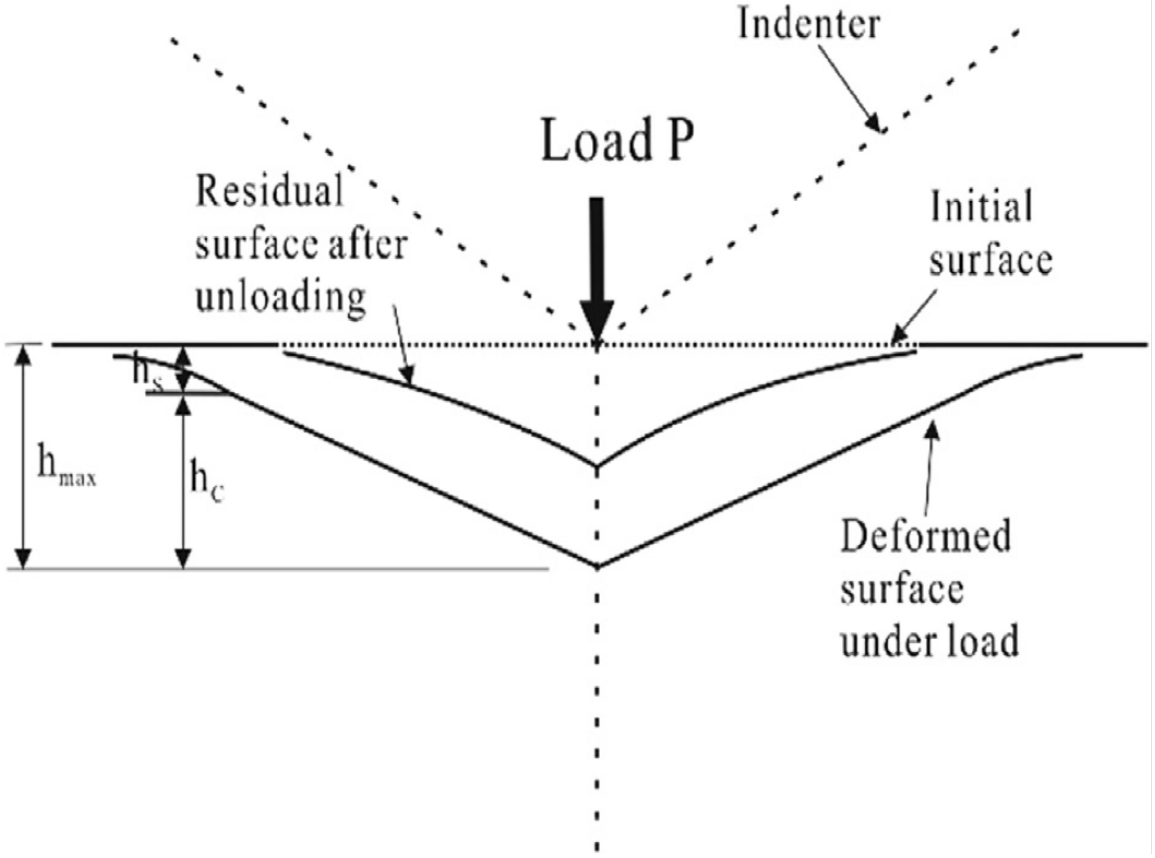
Method



Acoustic Emission method

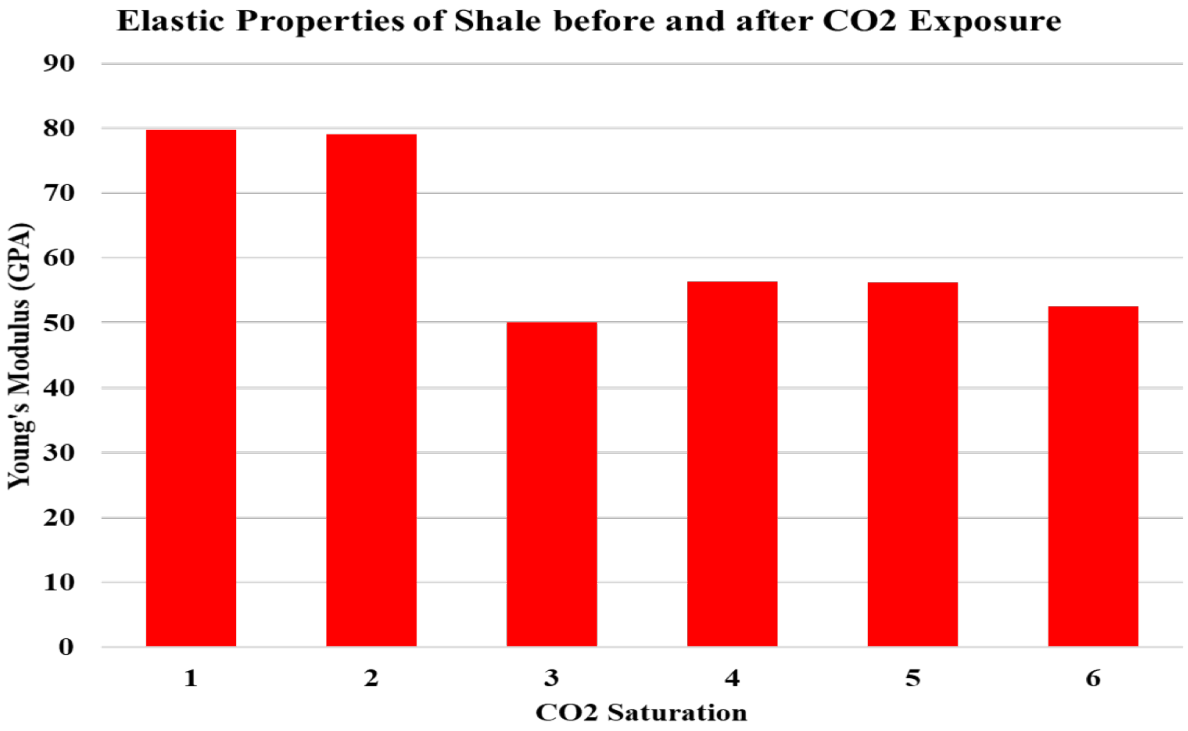
Method

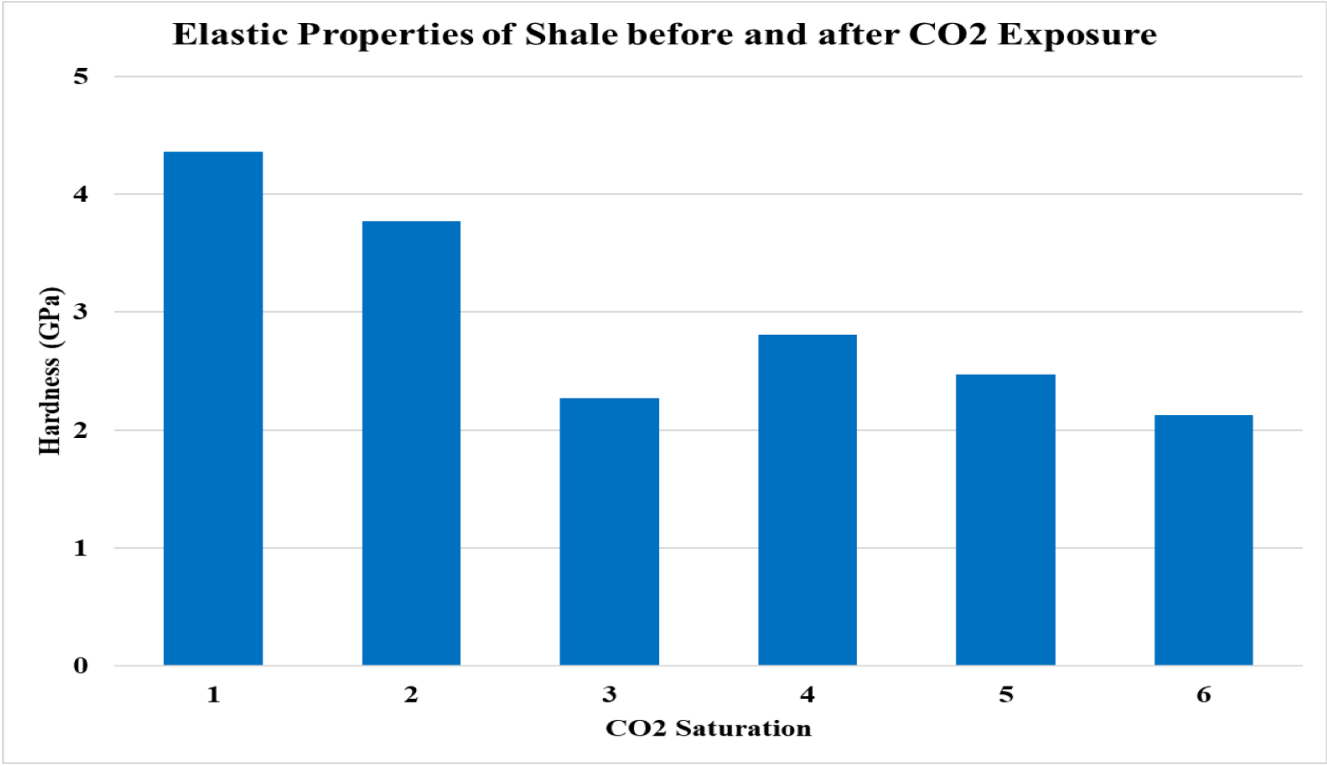




Nanoindentation method

Results



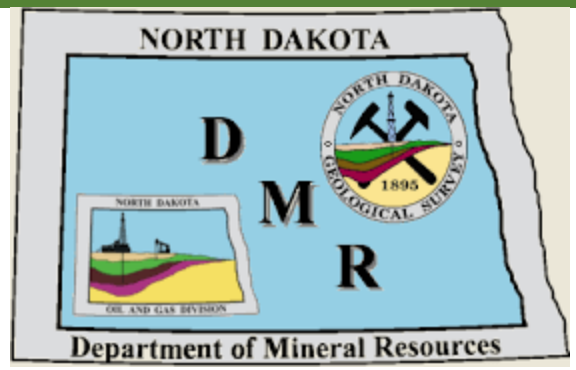


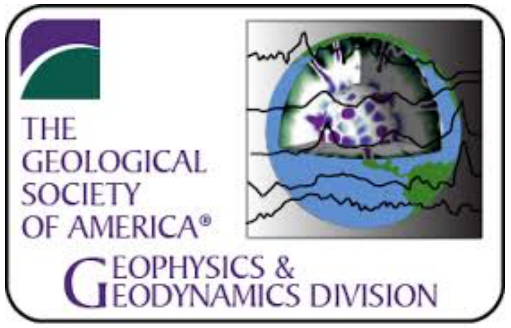
The average Young's modulus and hardness of the shale reservoir was 79.8 and 4.4 G Pa before saturation, 52.6 and 2.1 G Pa after 60 days CO2 saturation.

Discussion and Conclusion

- The Young's modulus declined at 34% after 60 days and the hardness declined at 51% after 60 days.
- Perform X-ray Powder Diffraction (XRD) test to estimate how the mineralogical components of the sample will change with respect to the CO2 exposure.
- Estimate the pore network and the pore connectivity changes using gas adsorption.
- Generate seismic of the core plug to to better understand the pore network and structure in high frequency.
- Determine the crack propagation of the shale reservoir using acoustic emission with overburden load.

Acknowledgments





Question?