In 1958, Charles David Keeling began measuring carbon dioxide concentration levels in atmosphere. The compilation of this research has become known as the famous Keeling Curve, showing a dramatic increase in atmospheric CO₂ concentration over past few decades.

The Physical Analysis of Borehole Core Samples to Assess the Carbon Storage Potential of the Newark Basin

Research Questions

Does the Newark Basin contain layers of porosity suitable for carbon sequestration? If so, what is the carbon storage potential of the suitable layers?

Methods

Measurement of Bulk Density (g/cm³)

1. Dry Weight
   - Dried samples 24+ hours at 100°C
2. Submerged Weight = Volume
   - Archimedes' principle
   - Instantaneous saturation: timed saturation & projected submerged weight

Measurement of Porosity (%)

1. Dry Weight
2. Submerged Weight
3. Saturated Weight
   - Under vacuum 150 hours
   - Instantaneous saturation: Saran wrapped samples and weighed

Calculations & Corrections

Dry Weight
1. String correction: Subtract weight of string
2. Air buoyancy

Submerged Weight
3. Projected weight at time of initial submersion (no saturations)
Storage of CO\textsubscript{2} in geologic formations for long-term isolation from the atmosphere
- Necessities: High permeability and solid caprock
- Utsira Sand, Sleipner field, Norway: effectively sequestering CO\textsubscript{2} in extremely porous sandstone saline aquifer since 1996

Necessities: High permeability and solid caprock
- Sedimentary rift basin covering over 7,000 km\textsuperscript{2}
- Located in close proximity to high-emitting CO\textsubscript{2} states (NJ, NY, PA)
- TriCarb Project currently assessing the basin’s CO\textsubscript{2} injectivity, storage capacity, and sequestration effectiveness

The Newark Basin Online Log Data.

<table>
<thead>
<tr>
<th>Borehole Data</th>
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<tbody>
<tr>
<td>Newark Basin Coring Project</td>
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<tr>
<td>- Geophysical logs of the 7 continuous cores</td>
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<tr>
<td>- Converted bulk density log to porosity log for formation penetrated by a borehole or well</td>
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</tbody>
</table>

Newark Basin Coring Project

- 7 continuous cores |
- Converted bulk density log to porosity log for formation penetrated by a borehole or well |

Quartz Calibration

Calculated Applied to Quartz Measurements to Measure Accuracy and Precision

- Actual Density: 2,648 g/cm\textsuperscript{3}

The Newark Basin Coring Project

- Drilling project from 1989-1994 to recover record of ancient continental climate change and reveal the history of the Newark Basin
- Recovered over 677 m of continuous cores from 7 sites and geophysical borehole logs

Lab Data

- Porosities: 0-5%
- Ideally 20-25%
- Sample 19: 10.6%
- Sample 20: 10.3%

Storage Potential

\[ Q = \frac{p \cdot V}{\rho} = \frac{e \cdot \phi}{c} \]

- Volume (km\textsuperscript{3})
- \( p \): CO\textsubscript{2} density (kg/m\textsuperscript{3})
- \( e \): storage efficiency (%)
- \( \phi \): reservoir porosity (%)

Sample 19: 91,000 MTCO2
Sample 20: 41,000 MTCO2

Results

- Weight of Displaced Fluid ÷ density of water
- Total volume of reservoir (km\textsuperscript{3})

Borehole Log: record of a geologic formation penetrated by a borehole or well
- Correlates depth/thickness of layers with properties (such as bulk density, porosity, etc.)

Newark Basin Coring Project

- Geophysical logs of the 7 continuous cores
- Converted bulk density log to porosity log for Princeton core (450 ft-3000 ft)

Plot samples 19 and 20 to identify depths of porosity layers

Sample 19: 1416-1442 ft (26 ft)
Sample 20: 2072-2084 ft (12 ft)

CO\textsubscript{2} Sequestration preferred around 3,000 ft

Discussion

- CO\textsubscript{2} transitions into a supercritical fluid at ~100 bar and 300 K
- Samples 19 and 20 are located at depths too close to the transition point
- Unsafe/unstable conditions
- Sequestration preferred around 3,000 ft

EPA CO\textsubscript{2} Emissions

- United States Environmental Protection Agency released state-by-state CO\textsubscript{2} emissions from 1990-2010

Conclusion & Future Research

- Proved existence of high porosity layers of Newark Basin
- Broadened knowledge of Newark Basin
- Further investigate depths around high porosity samples
Study at greater depths
Locate low-porosity caprocks

Bibliography