Abstract

Preliminary assessment of saline aquifers potentially suitable for carbon dioxide (CO₂) sequestration in North Carolina’s Coastal Plain (Dare, Tyrrell, and Hyde counties) was undertaken on Lower and Upper Cretaceous strata from -3,000 feet to -6,100 feet below sea level. National assessment criteria by the USGS, USEPA, and the USDOE for CO₂ injection into geologic formations are a depth greater than -3,000 feet, and formation waters with over 10,000 ppm dissolved solids.

The prime target area, Dare Co., is near several large industrial CO₂ emitters. The sparsely populated area has extensive federally-owned lands including the Navy-Air Force electronic bombing range and qualification range (Dare Bombing Range).

About 153 line miles of 1970’s-era 2D seismic data along with paper geophysical logs from 19 oil exploration wells and sub-surface structural maps (circa 1980’s) were converted from paper to digital formats (.sgy, .las, and .shp) respectively for geographic information system (GIS) and modern seismic software.

Analysis indicates a potentially continuous 150- to 200-foot-thick sand at a depth of -4,500 to -6,600 feet along a coast parallel strike line for ~35 miles. This sand is above the crystalline basement. An overlying stratigraphic sequence has sand units beginning at a depth of about -3,500 feet extending downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-6600 sand (depositional unit #1 of Almy 1987a, b) of Lower Cretaceous age underlies most of Dare Co. at a depth of -3,000 feet or
more and has estimated salinities that are close to the 10,000-ppm total dissolved solids (TDS) criterion, and in many cases exceed that value. There are well-to-well variations in the estimated salinity content. The spontaneous potential (SP) salinity estimates of formation water resistivity used to determine TDS tend to be more saline (NaCl) than those determined by the induction log method supplemented by a few resistivity logs.

The M2-3950 sand in depositional unit #2 (Almy 1987a, b), is shallower and in the northern half of Dare Co. where it appears to be too shallow (e.g., above -3,000 feet) for CO₂ sequestration. Continuity of sand units is somewhat less clear; however, the seismic-stratigraphy approach of Coffey and Sunde (2009) provides clarity on the sand distribution.

Estimated salinities are generally well above the 10,000-ppm TDS criterion; there are well-to-well variations in the estimated salinity content. The SP salinity estimates tend to be more saline than those determined by the induction log method.
Preliminary carbon dioxide (CO₂) Sequestration
Characterization: Dare, Tyrrell and Hyde counties, North Carolina - PART 1 of 2

Jeffrey C. Reid, Elizabeth A. DeFoy, and Farrell B. Taylor
Center for Geoenvironmental Science and Engineering, University of North Carolina at Chapel Hill
direct@unitedstatesgeo.org	farrell@unitedstatesgeo.org

ABSTRACT
A preliminary assessment of saline aquifers potentially suitable for carbon dioxide (CO₂) sequestration in North Carolina’s Coastal Plain (Dare, Tyrrell, and Hyde counties) was undertaken on Lower and Upper Cretaceous shales from ~3,000 to ~6,100 feet below sea level. The lower Cretaceous shales are the main targets for CO₂ sequestration, particularly those within the uppermost ~3,600 feet of the Cretaceous section below sea level. Analysis includes a potentially continuous 150- to 200-foot-thick sand extending downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-3950 sand in depositional unit #2 (Almy 1987a,b) is shallow and in the northern part of Dare Co. where it appears to be too shallow (e.g., above ~3,000 feet) for CO₂ sequestration. About 153 line miles of 2D seismic data along with well logs from the 1970’s were digitized and integrated with the new digital drill hole logs below. The seismic lines, contributed by Cities Service Oil Co., are 12- to 15-second line intervals. The seismic lines came to the North Carolina Geological Survey (NCGS) in 1996. The lines are non-proprietary and can be shared for the study of CO₂ sequestration. The seismic data were used as an independent check on the identification of potential CO₂ storage targets and to establish structural closure.

The geological and physical characteristics are known only at a reconnaissance level. Integrating these characteristics with the new seismic data from the NCGS Open File Report 2011-12 and the new digital well log data should improve the understanding of the potential CO₂ storage targets and the amount of storage capacity.

We are using a continuous section of a 150- to 200-foot-thick sand as a natural gas storage reservoir. This sand is approximately 1,000 feet thick and extends downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-3950 sand in depositional unit #2 (Almy 1987a,b) is shallow and in the northern part of Dare Co. where it appears to be too shallow (e.g., above ~3,000 feet) for CO₂ sequester stores. About 153 line miles of 2D seismic data along with well logs from the 1970’s were digitized and integrated with the new digital drill hole logs below. The seismic lines, contributed by Cities Service Oil Co., are 12- to 15-second line intervals. The seismic lines came to the North Carolina Geological Survey (NCGS) in 1996. The lines are non-proprietary and can be shared for the study of CO₂ sequestration. The seismic data were used as an independent check on the identification of potential CO₂ storage targets and to establish structural closure.

The geological and physical characteristics are known only at a reconnaissance level. Integrating these characteristics with the new seismic data from the NCGS Open File Report 2011-12 and the new digital well log data should improve the understanding of the potential CO₂ storage targets and the amount of storage capacity.

We are using a continuous section of a 150- to 200-foot-thick sand as a natural gas storage reservoir. This sand is approximately 1,000 feet thick and extends downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-3950 sand in depositional unit #2 (Almy 1987a,b) is shallow and in the northern part of Dare Co. where it appears to be too shallow (e.g., above ~3,000 feet) for CO₂ sequester stores. About 153 line miles of 2D seismic data along with well logs from the 1970’s were digitized and integrated with the new digital drill hole logs below. The seismic lines, contributed by Cities Service Oil Co., are 12- to 15-second line intervals. The seismic lines came to the North Carolina Geological Survey (NCGS) in 1996. The lines are non-proprietary and can be shared for the study of CO₂ sequestration. The seismic data were used as an independent check on the identification of potential CO₂ storage targets and to establish structural closure.

The geological and physical characteristics are known only at a reconnaissance level. Integrating these characteristics with the new seismic data from the NCGS Open File Report 2011-12 and the new digital well log data should improve the understanding of the potential CO₂ storage targets and the amount of storage capacity.

We are using a continuous section of a 150- to 200-foot-thick sand as a natural gas storage reservoir. This sand is approximately 1,000 feet thick and extends downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-3950 sand in depositional unit #2 (Almy 1987a,b) is shallow and in the northern part of Dare Co. where it appears to be too shallow (e.g., above ~3,000 feet) for CO₂ sequester stores. About 153 line miles of 2D seismic data along with well logs from the 1970’s were digitized and integrated with the new digital drill hole logs below. The seismic lines, contributed by Cities Service Oil Co., are 12- to 15-second line intervals. The seismic lines came to the North Carolina Geological Survey (NCGS) in 1996. The lines are non-proprietary and can be shared for the study of CO₂ sequestration. The seismic data were used as an independent check on the identification of potential CO₂ storage targets and to establish structural closure.

The geological and physical characteristics are known only at a reconnaissance level. Integrating these characteristics with the new seismic data from the NCGS Open File Report 2011-12 and the new digital well log data should improve the understanding of the potential CO₂ storage targets and the amount of storage capacity.

We are using a continuous section of a 150- to 200-foot-thick sand as a natural gas storage reservoir. This sand is approximately 1,000 feet thick and extends downward to the top of the lower sand. Some structural closure is present and these sands could be a potential natural gas storage reservoir.

The M2-3950 sand in depositional unit #2 (Almy 1987a,b) is shallow and in the northern part of Dare Co. where it appears to be too shallow (e.g., above ~3,000 feet) for CO₂ sequester stores. About 153 line miles of 2D seismic data along with well logs from the 1970’s were digitized and integrated with the new digital drill hole logs below. The seismic lines, contributed by Cities Service Oil Co., are 12- to 15-second line intervals. The seismic lines came to the North Carolina Geological Survey (NCGS) in 1996. The lines are non-proprietary and can be shared for the study of CO₂ sequestration. The seismic data were used as an independent check on the identification of potential CO₂ storage targets and to establish structural closure.

The geological and physical characteristics are known only at a reconnaissance level. Integrating these characteristics with the new seismic data from the NCGS Open File Report 2011-12 and the new di...
Preliminary carbon dioxide (CO₂) Sequestration

Characterization: Dare, Tyrrell and Hyde counties, North Carolina - PART 2 of 2

Jeffrey C. Reid, Elizabeth A. DePoy, and Kenneth B. Taylor
N.C. Geologic Survey, 1612 Mail Service Center, Raleigh, 27699-1612,

RESULTS AND DISCUSSION

Depth of formations of interest and salinities

Cenomanian Age (deposition unit 1, Cross Section 1) - Salinity figures from Almy’s (1978b) map are used to describe the area. The 3,000-foot depth contour is lower in the southern part of Dare County, where tidal deposition has modified the Cenomanian coastal deposits. Below 3,000 feet, the salinity is estimated by the induction log method using the log results for wells that have the M2-6600 at a depth of -3,000 feet or greater. The salinity is estimated by the induction log method using the log results for wells that have the M2-6600 at a depth of -3,000 feet or greater.

The following wells have the more conservative deep induction log salinity estimates that include the wells mentioned that have the M2-6600 at a depth of -3,000 feet or greater.

<table>
<thead>
<tr>
<th>Well Name</th>
<th>SP log estimate as ppm NaCl</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR-OT-01-71 Westvaco “A” Stumpy Point</td>
<td>10,000 - 16,000</td>
</tr>
<tr>
<td>DR-OT-01-73 Westvaco #2</td>
<td>6,200 - 10,500</td>
</tr>
<tr>
<td>DR-OT-02-65 State of N.C. #1</td>
<td>29,000 - 38,000</td>
</tr>
<tr>
<td>DR-OT-02-74 First Colony</td>
<td>9,800 - 24,000</td>
</tr>
<tr>
<td>DR-OT-04-65 West VA Pulp &amp; Paper</td>
<td>10,000 - 16,000</td>
</tr>
<tr>
<td>DR-OT-02-65 State of N.C. #2</td>
<td>29,000 - 38,000</td>
</tr>
<tr>
<td>DR-OT-04-65 State of N.C. #1</td>
<td>6,200 - 10,500</td>
</tr>
</tbody>
</table>

The following tables and diagrams provide a summary of the salinity and depth information for the wells mentioned that have the M2-6600 at a depth of -3,000 feet or greater.

CONCLUSIONS

Lower unit M2-6600 sand

The M2-6600 sand of Lower Cretaceous age underlies most of Dare County at a depth below surface of -3,000 feet or more which exceeds the minimum depth requirement. The M2-6600 sand has estimated salinities exceed the 10,000 ppm TOC minimum criterion, with only three exceptions. There are well-to-well variations in the estimated salinity content. The SP salinity estimates tend to be more saline than those determined by the induction log method supplemented by a few resistivity logs.

Upper unit sands

The upper unit (Almy's depositional unit 2, cross section 1) also has sand units but it is shallower and in the northern half of Dare County, it appears to be too shallow (e.g., less than a depth of -3,000 feet). Continuity of sand units is somewhat less clear. However, the seismic-stratigraphy approach of Smith and Coffey may provide clarity on the distribution of sands.

Estimated salinities are generally well above the 10,000 ppm TOC minimum criterion. There are well-to-well variations in the estimated salinity content. The SP salinity estimates tend to be more saline than those determined by the induction log method.

Natural gas storage potential

Substantial additional work would be required to determine if these sands are suited for natural gas storage potential.

REFERENCE CITED


