Abstract

The Oriskany Sandstone of the Appalachian basin is a widely distributed saline aquifer which has produced large quantities of hydrocarbons. Currently the Oriskany is host to numerous gas storage fields and is a potential target for large-scale geologic storage of CO₂. Published and unpublished data of rock characteristics, pressure, temperature, and formation water geochemistry along with new brine samples were integrated within a geographical information system to better understand the regional-scale hydrogeological regime and its relation to the migration of hydrocarbons and geologic CO₂ sequestration potential. The topographically driven up-dip flow of the Oriskany Sandstone formation waters is generally controlled by outcrops at high elevation to the east and at low elevation to the west. The up-dip flow is opposed by increased salinity induced buoyancy forces down-dip. The flow pattern is substantiated by the salinity distributions, with relatively lower salinity at recharge to the east and discharge to the west due to mixing with fresh meteoric water and higher salinity between the recharge and discharge zones. This flow pattern is also substantiated by the distribution of Oriskany gas fields that occur in the Central Appalachian basin; the major productive gas fields occur at the boundary between lower salinity and are typically absent in areas of higher salinity. It is believed that hydrocarbon distribution is influenced by basinal variations in buoyancy and entrainment by the formation water flow. Improved containment of large-scale CO₂ injection appears to be associated in the Oriskany with convergent flow located in the eastern Appalachian basin.
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As part of the effort by the National Energy Technology Laboratory (NETL) of the Department of Energy and the Regional Carbon Sequestration Partnerships (RCPs), data was assembled to address questions of carbon capture and storage (CCS). Data on sources and potential geologic storage sites were collected and organized for the construction of the Carbon Sequestration Atlas of the United States.

The Appalachian basin is approximately 500 kilometers wide and 1000 km long. It encompasses or is closely linked to the Canadian shield to the north, the Allegheny front to the south, the Appalachian Mountains to the east and the Cincinnati arch to the west (UTBEG, 2008). It represents part of an ancient foreland basin in the eastern United States that contains complex geology formed by a series of continental plate collisions. This deformation resulted in the formation of the Appalachian Mountains and large areas of stretched, faulted, and deformed ridges and valleys (USGS, 2008; Bruner and Smosna, 2008). The axis of the Appalachian basin is underlain by a succession of continental deposits that have been deformed from west to east by the collision of the North American plate with the passive margin of the continental shelf to the east and the passive margin of the continental shelf to the west. The up-dip flow is opposed by increased salinity induced buoyancy force. This interaction forces down-dip. The flow pattern is substantiated by the salinity distributions, with relative lower salinity at recharge to the east and discharge to the west due to mixing with fresh meteoric water and higher salinity located at the discharge and drainage zones. This flow pattern is also substantiated by the distribution of Oriskany gas fields that occur in the Central Appalachian basin, the major production of gas fields occur at the boundary between lower salinity and are typically absent in areas of higher salinity. It is believed that hydrocarbon distribution is influenced by local variations in buoyancy and entrainment by the formation water flow. Improved containment of large-scale CO₂ injection appears to be associated in the Oriskany with convergent flow located in the eastern Appalachian basin.

Super-Critical CO₂

Saline formations are natural sub-surface formations which have the potential to act as a CO₂ storage site. They are depleted gas fields that are no longer producing oil and gas. CO₂ from stationary sources can be separated from the atmosphere or power plants and injected into these depleted formations. Once injected, CO₂ resides in a liquid or supercritical phase. This allows CO₂ to remain stored for thousands of years. In addition, CO₂ injection can increase oil and gas production from these depleted reservoirs. CO₂ can also act as a solvent to dissolve minerals and stimulate oil and gas production.

There are two types of carbon dioxide (CO₂) emission sources: stationary and non-stationary sources. Non-stationary source emissions include CO₂ emissions from the transportation sector. Stationary source emissions come from a particular identifiable, localized source, such as a power plant. CO₂ from stationary sources can be separated from stack gas emissions and subsequently transported to a geological storage injection site. The “North American CO₂ Source” map displays the location and relative magnitude of a variety of CO₂ stationary sources.

According to the EPA, in 2008, U.S. GHG emissions were estimated at 6,150 million metric tons CO₂ equivalent. This estimate includes CO₂ emissions as well as other GHG such as methane (CH₄), nitrous oxide (N₂O), and hydrofluorocarbons (HFCs). Annual GHG emissions have increased nearly 40% since 1990 (EPA, 2010). The concentration of CO₂ in the atmosphere has increased from 280 parts per million (ppm) in 1800 to almost 390 ppm in 2009. The concentration of major CO₂ sources in the Appalachian basin is one of the best monitored in the United States. The Midwest Regional Carbon Sequestration Partnership has estimated that the area must reduce CO₂ emissions by almost 20 percent of our country’s electricity, 10 percent of which is from coal.
References


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