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A Survey of the Various Geologic Formations Suitable for CO₂ Storage: A Focus on Structure, Capacity, and Long-term Containment Potential

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ABSTRACT

As the world faces increasing challenges from climate change, the need for effective strategies to reduce carbon dioxide (CO_2) emissions has become more urgent. One promising solution is geological storage, where CO_2 is captured and securely stored underground to prevent its release into the atmosphere. This paper explores the various geologic formations suitable for CO_2 storage, focusing on their structure, capacity, and long-term containment potential. It highlights three main types: deep saline aquifers, depleted oil and gas reservoirs, and unmineable coal seams. Each of these formations offers distinct advantages based on their porosity, permeability, depth, and the presence of sealing layers like caprocks that prevent gas escape. The paper also discusses the scientific principles behind CO_2 storage, such as how CO_2 behaves under pressure and temperature conditions in the subsurface, and what makes a site viable for long-term storage. It also reflects on the importance of proper site selection, monitoring, and risk management to ensure safe and sustainable use of geological formations for CO_2 storage. The study emphasises that with careful geological assessment and engineering practices, underground CO_2 storage can play a key role in reducing global emissions and supporting climate change mitigation efforts.

Keywords*:* Survey, geologic formations, co_2 storage*,* structure, capacity, long-term containment potential**,** geological assessment, carbon dioxide (co_2), emission.

INTRODUCTION

In recent decades, the global rise in carbon dioxide (CO_2) emissions has become a major driver of climate change. This increase is largely due to the burning of fossil fuels for energy and industrial activities, leading to an accumulation of greenhouse gases in the atmosphere. The consequences—rising global temperatures, melting ice caps, and extreme weather events—pose significant threats to environmental and human systems worldwide (IPCC, 2014). And as part of the response to this challenge, Carbon Capture and Storage (CCS) has emerged as a critical strategy. CCS involves capturing CO_2 emissions at their source, such as power plants or industrial facilities, and transporting the gas to a secure location for long-term storage underground. In petroleum geology, CCS not only helps reduce atmospheric emissions but also offers opportunities to repurpose existing geological knowledge and infrastructure, particularly in areas with oil and gas reservoirs. This makes petroleum geologists key players in identifying and developing suitable storage sites.

The process of CO_2 storage relies on understanding the physical and chemical behaviour of CO_2 in the subsurface. Once injected, CO_2 is stored in porous rock formations beneath impermeable layers that act as seals, preventing its upward migration. Over time, the gas can dissolve in groundwater, react with minerals to form solid carbonates, or remain trapped in pore spaces, offering multiple mechanisms for secure containment (Metz et al., 2005).

This paper aims to examine the key geologic formations that are suitable for CO_2 storage, focusing on their characteristics, selection criteria, and potential to safely hold carbon dioxide over long periods. It also highlights the importance of proper site evaluation and monitoring in ensuring the effectiveness and safety of this method as part of a broader climate change mitigation strategy.

Statement of the Problem

The escalating level of CO_2 in the atmosphere, primarily driven by fossil fuel combustion, industrial processes, and land-use changes, pose a significant threat to global climate stability, exacerbating extreme weather events, sea-level rise, and ecosystem disruption. Carbon capture and storage (CCS) has emerged as a critical technology for reducing CO_2 emission from large-scale industrial sources, yet its widespread implementation is hindered by the lack of comprehensive understanding of suitable geologic formation for CO2 storage.

Specifically, there is a pressing need to identify and characterize geologic formations with the requisite structure, capacity, and long-term containment potential to safely store CO2, ensuring the effectiveness and safety of CCS operation, mitigating potential risk to human health and the environment, and supporting global efforts to limit warming to well below 2℃. A thorough assessment of geologic formations, including saline aquifers, depleted oil and gas reservoirs, and coal seams, is essential for determining their CO2 storage potential, informing regulatory frameworks, and facilitating the deployment of CCS technologies in diverse geological setting, including those in Nigeria and other developing nations. Thus, this study is carried out to assess the key geologic formations that are suitable for CO_2 storage, focusing on their characteristics, selection criteria, and potential to safely hold carbon dioxide over long periods.

Aim and Objectives of the Study

The aims of this paper is to examine the key geologic formations that are suitable for CO_2 storage, focusing on their characteristics, selection criteria, and potential to safely hold carbon dioxide over long periods. The specific objectives include:

1. Examine the principle of carbon dioxide (CO_2) in geological storage.
2. Explore the types of geologic formations for carbon dioxide (CO_2) storage.
3. Investigate the geologic criteria for site selection.
4. Assess the risk and challenges associated with geological storage of carbon dioxide (CO_2).

Research Questions

The study is guided by the following research questions

1. What are the principles of carbon dioxide (CO_2) in geological storage?
2. What are the types of geologic formations for carbon dioxide (CO_2) storage?
3. What are the criteria for geologic site selection?
4. What are the risk and challenges associated with geological storage of carbon dioxide (CO_2)?

Significance of the Study

This study is significant because it aims to identify and characterize geologic formations suitable for CO2 storage, contributing to the development of carbon capture and storage (CCS) technologies. The findings will:

1. Inform policy and regulatory frameworks for CCS deployment in Nigeria and globally.
2. Support the reduction of CO2 emissions from industrial sources, mitigating climate change impacts.
3. Enhance understanding of CO2 storage potential in diverse geological settings.
4. Guide future research and investment in CCS technologies.

Scope and Limitations of the Study

Scope

The study focuses on the key geologic formations that are suitable for CO_2 storage. Specifically, the study covers areas such as:

1. The principle of carbon dioxide (CO_2) in geological storage.
2. The types of geologic formations for carbon dioxide (CO_2) storage.
3. Criteria for the selection of geologic site.
4. The risk and challenges associated with geological storage of carbon dioxide (CO_2).

Limitations

The study is limited by:

1. Lack of site-specific data for some geologic formations
2. Focus on technical aspect of CO2 storage, with limited consideration of socio-economic and policy factors.
3. Rapidly evolving CCS technologies and regulatory frameworks.
4. Geographic focus on Nigeria, with potential limitations for global applicability.

Literature Review

Principles of CO2 Geological Storage

To understand how carbon dioxide (CO_2) can be safely stored underground, it is important to know the basic principles that guide geological storage. This method is often referred to as Carbon Capture and Storage (CCS), which involves collecting CO_2 from industrial sources and injecting it into deep underground rock formations, where it can be contained permanently (Celia & Nordbotten, 2009).

Basic Requirements for CO_2 Storage

1. **Porosity:** Porosity refers to the amount of empty space within a rock. Rocks with high porosity, such as sandstone, have enough space to store large volumes of CO_2. The more porous the rock, the more CO_2 it can hold (Chilingarian et al., 1992).
2. **Permeability:** This is the ability of fluids to flow through rock pores. High permeability allows CO_2 to move easily during injection and spread throughout the formation. Without this, the injection process could be inefficient or even dangerous due to pressure buildup (Cengel & Cimbala, 2018).
3. **Sealing or Caprock:** Above the porous rock must be a sealing layer—often made of shale or salt—that is impermeable. This caprock acts as a barrier to prevent the upward escape of CO_2 (Mohitpour et al., 2016).
4. **Depth:** CO_2 must be injected at depths greater than 800 meters. At this depth, pressure and temperature conditions turn CO_2 into a **supercritical fluid**, which is denser and easier to control underground (IPCC, 2005).

Behaviour of CO_2 Underground

1. **Supercritical State:** In deep conditions, CO_2 becomes supercritical, having both gas-like and liquid-like properties. This makes it easier to inject and store in compact spaces (Moran & Shapiro, 2008).
2. **Buoyancy:** CO_2 is lighter than water, so it tends to rise within the rock formation. This is why a reliable caprock is essential to trap it and prevent leaks (Ahmed, 2016).
3. **Solubility:** Over time, some of the CO_2 dissolves into formation water, reducing the risk of escape. This is called dissolution trapping (Munson et al., 2013).
4. **Mineral Trapping:** In the long term, CO_2 can react with minerals in the rock to form solid carbonates. This is the most secure form of storage, though it happens over thousands of years (Turgut et al., 2000).

These principles ensure that CO_2 can be stored safely and effectively for long periods. Understanding them is the first step in evaluating which geologic formations are best suited for permanent storage.

Types of Geologic Formations for co_2 Storage

Geologic storage of CO_2 depends on the use of underground formations that can securely trap and isolate carbon dioxide for long periods, ideally thousands of years. These formations vary widely in their characteristics, offering different levels of effectiveness, safety, and practicality. Understanding the nature and behavior of each type is essential for selecting the most suitable option for long-term carbon containment.

1. Depleted Oil and Gas Reservoirs

Depleted oil and gas reservoirs are among the most studied and utilized formations for CO_2 storage. These are underground structures that have already held hydrocarbons for millions of years, proving their capacity to trap fluids under pressure.

One major advantage of using these reservoirs is **the availability of detailed subsurface data.** Since oil and gas fields have been extensively explored and developed, we already know a lot about their geology, pressure conditions, porosity, and sealing properties (Bachu, 2008). This reduces the uncertainty and cost of site evaluation.

Another benefit is the **presence of existing infrastructure**, such as wells, pipelines, and surface facilities, which can be repurposed for CO_2 injection and monitoring. This saves both time and capital (IEA, 2013).

Also, injecting CO_2 into these reservoirs can enable **Enhanced Oil Recovery (CO_2-EOR)**. In this process, CO_2 is used to push out remaining oil that was previously too difficult to extract, improving oil recovery while simultaneously storing CO_2 (Lake et al., 2014).

However, there are also **risks and challenges**. Older wells may not have been designed to handle CO_2 injection and could become leakage pathways if not properly sealed. Also, the variability in pressure conditions after depletion can complicate CO_2 injection planning (Celia & Nordbotten, 2009).

2. Deep Saline Aquifers

Deep saline aquifers represent the largest global potential for CO_2 storage (IPCC, 2005). These formations are layers of porous rock filled with salty water (brine) located deep underground and often more than 800 meters below the surface.

One reason for their vast potential is their **widespread availability**. Unlike oil and gas reservoirs, saline aquifers exist in many sedimentary basins around the world, including places without a history of oil or gas production (Benson & Cole, 2008).

In terms of characteristics, these formations typically have **high porosity and permeability**, making them ideal for injecting and storing large volumes of CO_2. They are also overlain by **impermeable caprocks**, such as shale or mudstone, which act as a seal to trap the CO_2 beneath the surface (IPCC, 2005).

Chemical interactions between CO_2 and the brine or rock over time can lead to **dissolution and mineral trapping**, which further stabilizes the CO_2 in the long term. However, managing and monitoring such deep formations is technically complex.

To ensure safety, **monitoring strategies** like pressure sensors, seismic surveys, and tracer injections are used to track the movement and behavior of CO_2 underground (Bachu, 2008). These measures help detect early signs of leakage or unexpected migration.

3. Unmineable Coal Seams

Unmineable coal seams are coal layers that are too deep, too thin, or of poor quality for economic mining. These formations offer another option for CO_2 storage, primarily because of their ability to **adsorb CO_2 onto the surface of the coal**.

The unique property of coal to adsorb gases makes it an effective medium for trapping CO_2. In fact, CO_2 tends to adsorb more strongly than methane, which allows it to displace methane that is still trapped in the coal. This process, known as **Enhanced Coal Bed Methane (ECBM) recovery**, can release methane gas as a useful energy source while storing CO_2 (White et al., 2005).

However, not all coal seams are suitable. To be effective, the seam must have enough **permeability** for CO_2 to flow through it and enough pressure to keep the gas stable. Depth also matters—shallower seams may not maintain the CO_2 in a dense state, increasing the risk of leakage (IEA, 2013).

Moreover, coal can swell when it absorbs CO_2, which may reduce its permeability and limit further injection. This makes long-term storage efficiency in coal seams more uncertain compared to other formations.

4. Basalt Formations

Though less commonly used, basalt formations—igneous rocks formed from cooled lava—are gaining attention due to their potential for **CO_2 mineralization**. Unlike sedimentary rocks, basalts contain large amounts of reactive minerals like calcium, magnesium, and iron, which can chemically react with CO_2 to form solid carbonates.

This process, called **mineral trapping**, is considered the most permanent form of CO_2 storage, as the gas is converted into stable rock. One of the most notable projects demonstrating this potential is **Iceland's CarbFix project**, where CO_2 was successfully injected into basalt and mineralized in just two years (Matter et al., 2016).

Despite its promise, the use of basalt is still in early stages. Most suitable basalt formations are found in volcanic regions, and the infrastructure and knowledge base around them is less developed compared to traditional sedimentary formations. Nevertheless, they remain a promising option for the future.

In essence, each of these geologic formations plays a distinct role in CO_2 storage efforts. While depleted oil and gas reservoirs offer immediate practicality due to existing infrastructure and data, deep saline aquifers present the greatest long-term storage capacity. Unmineable coal seams add value through methane recovery, and basalts offer the strongest chemical stability, albeit with limited current usage. Understanding their properties helps in making informed decisions about where and how to store CO_2 most safely and effectively.

Geologic Criteria for Site Selection

Selecting a suitable site for CO_2 storage is not simply about finding available underground space. It requires a careful examination of specific geologic criteria that ensure safety, stability, and long-term effectiveness. These factors are essential in preventing leakage, promoting secure containment, and maintaining environmental integrity over time.

1. **Structural Integrity:** One of the first considerations in site selection is the structural soundness of the formation. The presence of faults, fractures, or any form of structural weakness can compromise the seal and create pathways for CO_2 to escape. Ideally, the formation should be overlain by an impermeable caprock, such as shale or claystone, that acts as a natural seal, preventing upward migration of the stored gas (Bachu, 2008). Sealing formations must be continuous and laterally extensive to provide reliable containment.
2. **Depth and Pressure Conditions:** Depth plays a significant role in determining whether CO_2 will behave as a dense fluid suitable for storage. CO_2 becomes supercritical at depths greater than approximately 800 meters, where it exhibits both gas-like and liquid-like properties. In this state, it is denser and more stable, making it easier to store in large quantities (IPCC, 2005). The surrounding pressure must be sufficient to maintain CO_2 in its supercritical form, while not being so high that it threatens the integrity of the formation or equipment.
3. **Rock Properties: Porosity, Permeability, and Capillary Entry Pressure:** Effective CO_2 storage also depends on the physical properties of the host rock. High porosity ensures there is enough space within the rock to accommodate injected CO_2. However, porosity alone is not enough. Permeability, which measures how easily fluids can flow through the rock, is equally important. High permeability allows CO_2 to spread evenly throughout the formation, reducing pressure buildup and improving storage efficiency (Benson & Cole, 2008).

   Another important factor is **capillary entry pressure**, which refers to the pressure required for CO_2 to enter the pores of the sealing rock. A high capillary entry pressure in the caprock ensures that the CO_2 remains trapped below and does not breach the seal. This interplay between reservoir and seal properties forms the backbone of a successful storage system.
4. **Geochemical Compatibility with CO_2:** Beyond physical characteristics, chemical interactions between CO_2, formation water, and rock minerals must be considered. When CO_2 is injected, it dissolves in the formation water and forms carbonic acid, which can react with the surrounding rock. These reactions can either enhance or degrade the storage site. For instance, in some formations, reactions with minerals may lead to the precipitation of stable carbonate minerals, effectively locking CO_2 in solid form—an ideal long-term outcome (Xu et al., 2003). On the other hand, unfavorable reactions may dissolve cementing minerals, increasing porosity and possibly reducing caprock integrity.

Risks and Challenges

While the geological storage of CO_2 holds promise for long-term climate change mitigation, it is not without its risks and uncertainties (IPCC, 2005). These concerns, if not properly addressed, could compromise both the safety and effectiveness of carbon capture and storage (CCS) projects. Understanding the key challenges associated with CO_2 storage, namely leakage, induced seismicity, and long-term site monitoring is critical for the selection, design, and management of storage sites.

1. Leakage Pathways

One of the most pressing risks in geologic CO_2 storage is the potential for leakage. CO_2 stored underground can escape through several pathways, including faults, fractures, improperly sealed wells, or degraded caprocks. If CO_2 migrates beyond the intended storage formation, it could contaminate shallow groundwater or return to the atmosphere, negating the climate benefits of storage (IPCC, 2005).

Historical oil and gas operations provide real-world examples of how poorly maintained wells can act as conduits for upward gas migration. Therefore, assessing the integrity of both natural and man-made seals is essential before site selection. Modern CCS projects rely heavily on detailed subsurface modeling and pressure management to minimize such leakage risks (Zoback & Gorelick, 2012).

2. Induced Seismicity

Another concern is the possibility of induced seismic activity ie earthquakes triggered by the injection of CO_2 into deep geologic formations. Injecting large volumes of fluid into the subsurface can increase pore pressure, which may destabilize nearby faults, especially in tectonically active regions. Although most induced seismic events associated with CCS are small and not destructive, they can raise public concern and regulatory scrutiny (Verdon et al., 2013).

To reduce this risk, storage operations must be preceded by thorough geomechanical assessments. This includes identifying fault zones, understanding in-situ stress fields, and limiting injection rates and pressures. Continuous seismic monitoring during and after injection is also crucial for early detection and response.

3. Long-term Site Integrity and Monitoring

Even after injection ends, the need for long-term monitoring persists. CO_2 may remain mobile underground for decades or centuries before becoming securely trapped through physical and chemical processes. Ensuring that storage formations retain their integrity over such timeframes requires comprehensive post-injection surveillance.

Monitoring technologies include seismic imaging, pressure and temperature sensors, soil gas measurements, and satellite-based remote sensing (IEA, 2020). These tools help track the movement of CO_2, detect anomalies, and verify that the gas remains contained. Moreover, long-term liability frameworks must be in place to determine who is responsible for site management in the years following closure.

Summary of the Findings

Based on the review of literatures, the findings of the study are summarized as indicated below:

1. The study found out the principles of carbon dioxide (CO_2) in geological storage to include: porosity, permeability, sealing or caprock, and depth. These principles ensure that carbon dioxide (CO_2) can be stored safely and effectively for long periods.

2. The study also revealed the types of geologic formations such as depleted oil and gas reservoirs, deep saline aquifers, unmineable coal seams, and basalt formations offer varying degrees of suitability for long-term CO_2 storage. Each of these formations presents unique advantages, from pre-existing infrastructure in hydrocarbon fields to the vast storage capacities of saline aquifers (Benson & Cole, 2008).

3. However, it was found out that the successful implementation of CO_2 storage projects depends not only on the type of formation chosen but also on a careful assessment of specific geologic criteria. Factors such as structural integrity, adequate depth and pressure conditions, favorable rock properties like porosity and permeability, and geochemical compatibility all play essential roles in ensuring the safety and reliability of storage sites (IEA, 2020). A site that meets these conditions is far more likely to prevent leakage, reduce the risk of induced seismicity, and maintain long-term containment.

4. Conversely, it was discovered from the study that geologic storage is not without its challenges. Potential risks—particularly CO_2 leakage, induced seismic events, and uncertainties surrounding long-term site behavior—demand a robust framework for site selection, monitoring, and regulatory oversight. These concerns must be addressed with detailed scientific understanding, technological investment, and responsible management practices (Zoback & Gorelick, 2012).

CONCLUSION

In conclusion, the survey of geologic formations suitable for CO2 storage highlights the importance of a comprehensive evaluation of structure, capacity, and long-term containment potential. The findings underscore that saline aquifers and depleted oil/gas fields are promising options for CO2 storage, owing to their vast storage capacities and existing infrastructure. However, their viability is contingent upon meticulous site—specific assessments that consider a multitude of factors, including injectivity, pressure management, and containment in saline aquifers, and existing infrastructure, well integrity, and caprock assessment in depleted fields.

The survey's outcomes emphasize the need for advanced modeling and characterization techniques to accurately predict CO2 behaviour, identify potential leakage pathways, and secure long-term containment. Furthermore, the findings highlight the importance of integrating geological, geochemical, and geophysical data to develop a comprehensive understanding of subsurface processes and optimize CO2 storage strategies.

Ultimately, the successful deployment of CO2 storage technologies hinges on the careful selection and characterization of suitable geologic formations. By leveraging the insights gained from this survey, stakeholders can make informed decision, mitigate risks, and unlock the full potential of CO2 storage as a climate change mitigation strategy.

RECOMMENDATIONS

To enhance the safety, effectiveness, and public trust in CO_2 geological storage, several key actions should be prioritized.

1. There is a need to promote more comprehensive and site-specific characterization before any storage activity begins. This includes not only assessing porosity, permeability, and sealing formations but also understanding the site's geological history, stress regimes, and potential fault activities. A well-characterized site significantly reduces the risk of leakage and improves the accuracy of long-term performance predictions.
2. Monitoring should not be treated as an afterthought. Instead, integrated and continuous monitoring technologies—such as seismic surveys, pressure tracking, and geochemical analysis—should be embedded into the design of any CO_2 storage project. These systems enable early detection of anomalies and provide valuable data for improving future storage operations.
3. Countries should invest in local geological research to better understand their domestic storage potential. While global case studies offer valuable insights, each region has unique geologic conditions that require tailored assessment. Supporting national geoscience agencies and research institutions in this area will help identify suitable sites and build technical expertise.
4. Regulatory and legal frameworks need to be developed or strengthened to address liability, long-term stewardship, and public communication. Clear rules on site selection, operational procedures, and post-closure responsibilities are essential to ensure environmental protection and to foster public confidence in the technology.

These recommendations, if implemented consistently, will not only support safer and more effective CO_2 storage but also position geological storage as a trusted tool in the broader climate solution portfolio.

REFERENCES

Ahmed, T. (2016). *Reservoir engineering handbook* (4th ed.). Gulf Professional Publishing.

Bachu, S. (2008). *CO_2 storage in geological media: Role, means, status and barriers to deployment.* Progress in Energy and Combustion Science, 34(2), 254–273.

Benson, S. M., & Cole, D. R. (2008). *CO_2 sequestration in deep sedimentary formations*. Elements, 4(5), 325–331.

Celia, M. A., & Nordbotten, J. M. (2009). *Practical modeling approaches for geological storage of carbon dioxide*. Ground Water, 47(5), 627–638.

Chadwick, A., Arts, R., Eiken, O., & Kirby, G. (2009). *Geophysical monitoring of CO_2 storage*. In B. B. Benson & D. R. Cole (Eds.), *Carbon dioxide capture for storage in deep geologic formations – Results from the CO_2 capture project* (Vol. 2, pp. 1135–1146). Elsevier.

IPCC. (2005). *IPCC Special Report on Carbon Dioxide Capture and Storage*. Prepared by Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press.

IEAGHG. (2011). *Quantification techniques for CO_2 leakage*. IEA Greenhouse Gas R&D Programme, Report 2011/02.

IEAGHG. (2013). *Deployment of CCS in the Cement Industry*. IEA Greenhouse Gas R&D Programme, Report 2013/19.

Lake, L. W., Johns, R. T., Rossen, W. R., & Pope, G. A. (2014). *Fundamentals of enhanced oil recovery*. Society of Petroleum Engineers.

Matt, S. M., Anderson, J. R., & Kneafsey, T. J. (2016). *Monitoring strategies for geologic CO_2 storage: Current practices and research needs*. Lawrence Berkeley National Laboratory.

Metz, B., Davidson, O., de Coninck, H. C., Loos, M., & Meyer, L. A. (Eds.). (2005). *Carbon dioxide capture and storage: Special report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Michael, K., Golab, A., Shulakova, V., Ennis-King, J., Allinson, G., Sharma, S., & Aiken, T. (2010). *Geological storage of CO_2 in saline aquifers—A review of the experience from existing storage operations*. International Journal of Greenhouse Gas Control, 4(4), 659–667.

Mohitpour, M., Golshan, H., & Murray, A. (2016). *Pipeline integrity: Management and risk evaluation*. American Society of Mechanical Engineers (ASME) Press.

Moran, M. J., & Shapiro, H. N. (2008). *Fundamentals of engineering thermodynamics* (6th ed.). Wiley.

Munson, D. E., Hoag, D. L., & Jones, R. L. (2013). *Salt creep and its impact on underground storage*. Sandia National Laboratories.

Turgut, B., Wong, S., & Kovscek, A. R. (2000). Experimental and simulation studies of CO_2 injection into coalbed methane reservoirs. *SPE Western Regional Meeting*.

Verdon, J. P., Kendall, J. M., White, D. J., & Angus, D. A. (2013). Linking microseismic event observations with geomechanical models to minimize the risks of storing CO_2 in geological formations. *Earth and Planetary Science Letters, 368*, 132–142.

White, C. M., Strazisar, B. R., Granite, E. J., Hoffman, J. S., & Pennline, H. W. (2008). Separation and capture of CO_2 from large stationary sources and sequestration in geological formations—Coalbeds and deep saline aquifers. *Journal of the Air & Waste Management Association, 53*(6), 645–715.

Wilson, E. J., Friedmann, S. J., & Pollak, M. F. (2007). *Research for deployment: Incorporating risk, regulation, and liability for carbon capture and sequestration*. Environmental Science & Technology, 41(17), 5945–595.

Xu, T., Apps, J. A., & Pruess, K. (2003). Reactive geochemical transport simulation to study mineral trapping for CO_2 disposal in deep arenaceous formations. *Journal of Geophysical Research: Solid Earth*, *108*(B2).

Zoback, M. D., & Gorelick, S. M. (2012). *Earthquake triggering and large-scale geologic storage of carbon dioxide*. Proceedings of the National Academy of Sciences, 109(26), 10164–10168.