

Supplementary file

Carbon dioxide storage in saline aquifers: A comprehensive review

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Appendix A: Methodology

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021) to ensure transparency and reproducibility throughout the review process.

To enhance the transparency and reproducibility of the literature retrieval, screening, and synthesis, this study was conducted a systematic review in accordance with the PRISMA 2020 statement (Page et al., 2021). The literature search and subsequent updates were conducted between September 2025 and June 2026, focusing primarily on assessments of caprock-reservoir system suitability for geological CO₂ storage in deep saline aquifers, storage capacity estimation, CO₂-brine-rock interactions, and caprock integrity evaluation.

Search Strategy

A systematic literature search was conducted using Web of Science, Google Scholar, and Scopus. To maintain a focused search strategy while adequately covering the core themes of geological CO₂ storage in saline aquifers, namely caprock-reservoir suitability assessment, storage-capacity estimation, CO₂-brine-rock interactions, and caprock-integrity evaluation, eight search keywords were selected: “CO₂ sequestration”, “saline aquifer”, “caprock integrity”, “mineral trapping”, “residual trapping”, “injectivity”, “pressure buildup”, and “geochemical reaction”. The initial search yielded approximately 6,840 records from Web of Science, 5,753 from Google Scholar, and 9,121 from Scopus. Publications from the past five years accounted for approximately 38.6% to 47.3% of these records, reflecting the rapid development of the field in the context of carbon neutrality goals. Targeted searches of representative sedimentary basins, such as the Ordos Basin, the Superior Basin, and the Beaufort-Mackenzie Basin,

retrieved 2,154, 1,985, 3,204, and 1,467 relevant publications, respectively; these basins are supported by relatively comprehensive geological datasets (Table S1).

Table S1. Databases, search strategies, and search records used in this review.

Search source	Search fields	Records	Purpose of use	Search string or search approach
Google Scholar	Title, abstract, keywords, and full text	5,753	Used to broaden search coverage and identify studies not indexed, or incompletely indexed, in Web of Science.	("CO ₂ sequestration" OR "carbon storage" OR "geological storage") AND ("saline aquifer" OR "deep saline formation" OR "saline reservoir") AND ("caprock integrity" OR "mineral trapping" OR "residual trapping" OR "dissolution trapping")
Web of Science	Title, abstract, keywords, and full text	6,840	Used as the primary database to identify studies on CO ₂ storage in saline aquifers, covering reservoir suitability, storage capacity, CO ₂ -brine-rock reactions, caprock integrity, and long-term trapping security.	("CO ₂ sequestration" OR "carbon storage" OR "geological storage") AND ("saline aquifer" OR "deep saline formation" OR "saline reservoir") AND ("caprock integrity" OR "mineral trapping" OR "residual trapping" OR "dissolution trapping")
Science Direct	Title, abstract, keywords, and full text	512	Used to supplement studies on reservoir-caprock characterization, CO ₂ trapping mechanisms, injection-induced geochemical responses.	("saline aquifer" OR "deep saline formation") AND ("CO ₂ injection" OR "geological storage") AND ("reservoir quality" OR "caprock integrity") AND ("mineral trapping" OR "residual trapping" OR "dissolution trapping")
Scopus	Title, abstract, keywords, and full text	9,121	Used as a supplementary verification database to cross-check the Web of Science results and to identify potentially missed English-language studies.	("carbon storage" OR "geological storage") AND ("saline aquifer" OR "deep saline formation") AND ("reservoir heterogeneity" OR "pore structure") AND ("caprock integrity" OR "mineral trapping")

Literature Screening and Inclusion Criteria

Two authors independently screened titles and abstracts for relevance. Disagreements were resolved through discussion or consultation with a third author. Full texts of potentially eligible studies were then assessed against the following inclusion criteria: (i) Focus on one or more storage mechanisms (structural, residual, dissolution, or mineral trapping); (ii) report on controlling factors (caprock integrity, wettability, salinity, temperature, or CO₂ purity); (iii) propose or apply a method for assessing storage potential; (iv) present field or laboratory data from saline aquifer projects; or (v) discuss risks, monitoring, or future directions. Studies were excluded if they addressed only enhanced oil recovery without storage implications or lacked quantitative or qualitative data on storage performance.

The initial search yielded 21,714 records: 6,840 from Web of Science, 5,753 from Google Scholar, and 9,121 from Scopus. After 6,512 duplicates were removed, 15,202 records were screened by title and abstract, resulting in the exclusion of 14,310 records (mainly off-topic studies on enhanced oil recovery or general CCUS reviews not specific to saline aquifers). The remaining 892 full-text articles were assessed for eligibility; 562 were excluded for reasons including a lack of original data ($n = 216$), a focus on non-saline aquifers ($n = 78$), or insufficient methodological detail ($n = 36$). Ultimately, 181 studies were included in this review (Fig. S1).

Quality assessment and data extraction

A quality-assessment framework based on levels of evidence was used to evaluate the relevance and reliability of the included studies. Each study was rated as high (meeting ≥ 4 of 5 criteria), medium (3 criteria), or low (≤ 2 criteria) quality. Studies rated as low quality were considered only when assessing broad trends and were excluded from quantitative comparisons.

Two reviewers independently performed the quality assessment; inter-rater agreement was 89%, with discrepancies resolved by consensus.

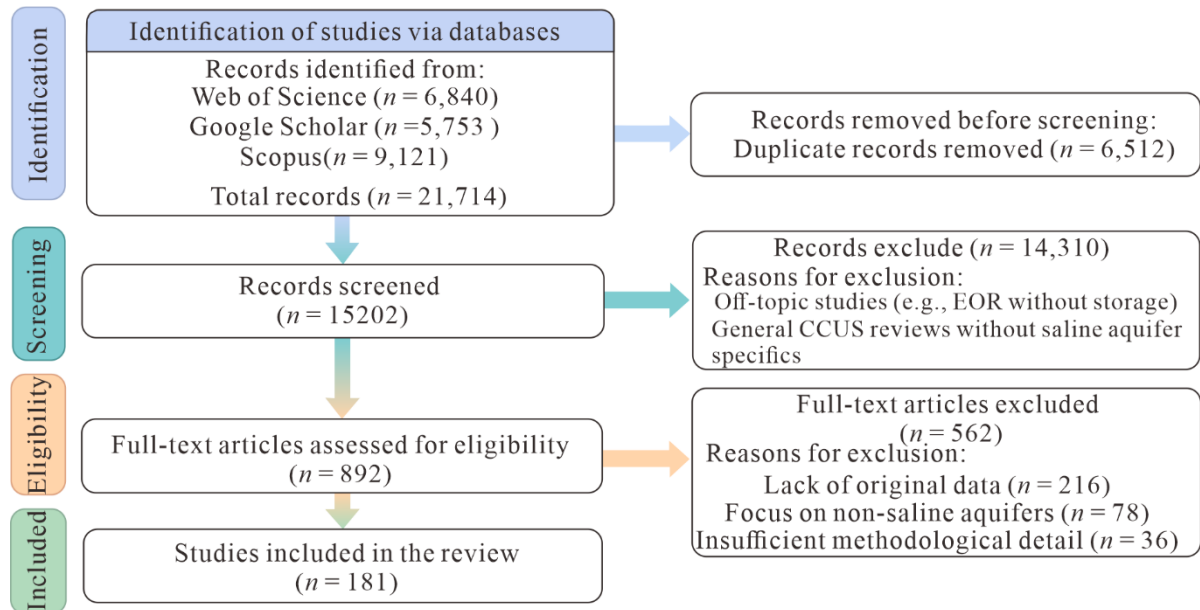


Fig. S1. PRISMA 2020 flow diagram for systematic reviews: showing the process of literature identification, screening, eligibility assessment, and inclusion in this review (Based on Page et al. (2021)).

Data Synthesis and Framework Construction

This study combined thematic synthesis with comparative analysis. The included studies were organized into several themes, including storage mechanisms; multimethod estimation of storage capacity; geochemical mechanisms of CO₂-brine-rock interactions; residual- and dissolution-trapping efficiency; and caprock sealing capacity and mechanical integrity. A unified framework was used to compare representative sedimentary-basin case studies (e.g., the Sleipner, Quest, Gorgon, Ordos, and Snøhvit projects). The framework considered geological structure and reservoir characteristics, injection operating parameters, monitoring technologies and data quality, numerical-simulation assumptions, storage-safety evaluation indicators, and

economic-feasibility constraints.

References

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