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GEOLOGICAL CONDITIONS OF DEPLETED GAS FIELDS IN THE TRANSYLVANIAN BASIN FOR CO_2 STORAGE ASSESSMENT

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ABSTRACT

Depleted gas reservoirs have attracted increasing interest as potential candidates for geological CO_2 storage, particularly in mature gas provinces where subsurface conditions are well constrained by long-term exploration and production activities. The Transylvanian Basin represents such a setting, hosting numerous gas accumulations developed mainly within suprasalt systems and characterized by a long production history. This paper presents a screening-level geological assessment of depleted gas reservoirs in the Transylvanian Basin. It focuses on geological conditions relevant to containment in the context of potential CO_2 storage.

The assessment is based on an integrated analysis of the basin-scale geological framework, including tectonic evolution, structural configuration, reservoir characteristics, and sealing conditions associated with the widespread Badenian salt. Particular emphasis is placed on the role of salt as a regional seal, the structural and stratigraphic compartmentalization of reservoirs, and the proven ability of these systems to retain gas over geological time. These aspects are considered essential for evaluating containment potential from a geological perspective. As a representative case example, the DepoMures underground gas storage facility, developed within a former gas reservoir, is discussed to illustrate how these geological conditions manifest at site scale and to highlight its relevance as an analogue for CO_2 storage.

The results indicate that selected depleted gas reservoirs in the Transylvanian Basin exhibit several favourable geological features, including effective sealing conditions, well-defined structural traps, and documented gas retention, which support their consideration as potential candidates for CO_2 storage. This study is intentionally limited to geological screening of containment-related factors and does not assess storage capacity, injectivity, pressure build-up/management, or geochemical and geomechanical behaviour. The results therefore provide a preliminary geological basis for selecting candidates for subsequent site-specific characterization and quantitative feasibility studies.

Keywords: depleted gas reservoirs, Transylvanian Basin, geological framework, suprasalt gas system, underground gas storage, CO_2 geological storage

INTRODUCTION

The identification of suitable geological settings for long-term CO_2 storage has become an important topic in the context of reducing greenhouse gas emissions, particularly through the reuse of existing subsurface infrastructures. Depleted gas reservoirs are increasingly considered potential candidates for this purpose, as they represent well-characterized geological systems with a proven capacity to retain fluids over geological time [3],[8],[14],[17]. In mature gas provinces, such reservoirs benefit from extensive geological, geophysical, and production data, which significantly reduces subsurface uncertainty compared to undeveloped formations [8],[13],[14].

The Transylvanian Basin is one of the oldest and most thoroughly explored gas-producing regions in Central and Eastern Europe [4-6]. Natural gas accumulations have been exploited here for more than a century, mainly from suprasalt reservoirs lying on the widespread Badenian salt [6-9],[14]. The basin has a complex tectono-stratigraphic evolution and is strongly compartmentalized. It contains several trap types that controlled the formation and preservation of gas accumulations [6],[9],[11-13]. These characteristics make the Transylvanian Basin a relevant setting for assessing the geological conditions that may support future CO_2 storage concepts.

From a geological perspective, several factors control the suitability of depleted gas reservoirs for CO_2 storage. These include the effectiveness of sealing formations, the integrity of structural traps, reservoir continuity and compartmentalization, and the behaviour of reservoirs during and after depletion. In suprasalt systems, salt plays a particularly important role influencing both trap formation and long-term containment [7],[8],[10],[14]. Understanding how these elements interact at basin and reservoir scale is essential for any preliminary assessment of storage potential.

In the Transylvanian Basin, some former gas reservoirs have already been repurposed as underground gas storage facilities, providing valuable insight into reservoir performance under cyclic injection and withdrawal conditions [2],[4],[5]. Although underground gas storage and CO_2 storage differ in operational objectives and physical behaviour, both rely fundamentally on the same geological controls. As such, existing gas storage facilities developed within former gas reservoirs represent useful analogues for evaluating geological suitability at a screening level.

This manuscript presents a screening-level geological assessment of depleted gas reservoirs in the Transylvanian Basin as potential candidates for CO_2 storage. The analysis is restricted to geological containment elements (regional/local sealing, trap integrity, reservoir architecture, and evidence of long-term gas retention). It does not evaluate storage capacity, injectivity, pressure management, wellbore integrity, or quantitative risk. In addition, no geochemical (CO_2–brine–rock reactions) or geomechanical (stress changes, fault reactivation, fracturing) assessment is performed. These topics require site-specific datasets and dedicated modelling and are therefore beyond the scope of the present study.

GEOLOGICAL SETTING OF THE TRANSYLVANIAN BASIN

The Transylvanian Basin is a large intramontane sedimentary basin located in the central part of Romania, surrounded by the Carpathian orogenic belt. Its geological evolution is closely linked to the Alpine–Carpathian tectonic framework, which controlled basin subsidence, sedimentation patterns, and the development of structural elements that later influenced hydrocarbon accumulation. The basin represents a relatively closed geological system (Figure 1), whose Neogene evolution resulted in a thick sedimentary infill and a distinctive petroleum system dominated by natural gas accumulations [1],[6],[8],[9],[14],[21].

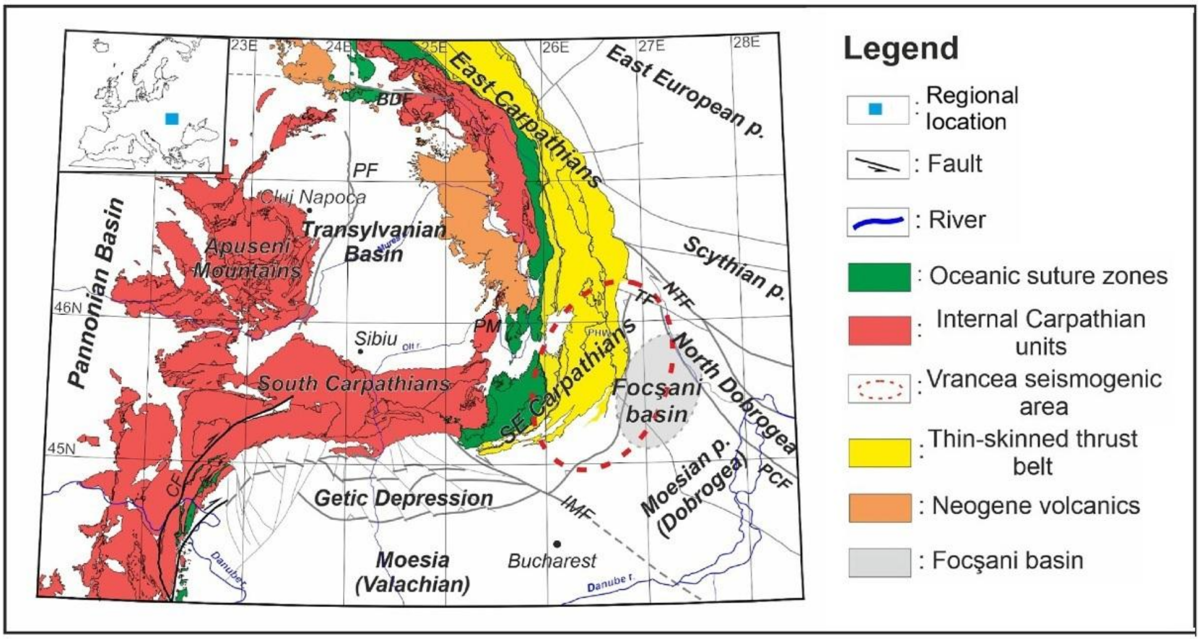

Figure 1. Schematic geological map of the Transylvanian Basin and surrounding tectonic elements. The map provides the regional structural context for suprasalt reservoirs and highlights basin-scale fault systems relevant to trap configuration and potential compartmentalization, which are key screening factors for CO_2 containment. [1].

From a regional tectonic perspective, the Transylvanian Basin developed as a post-orogenic basin, characterized by moderate deformation compared to adjacent orogenic domains. Subsidence was spatially variable, leading to the formation of several depocenters separated by structural highs. Faulting and gentle folding affected the sedimentary succession, contributing to the development of structural traps and to reservoir compartmentalization at different scales [6],[9],[11-13]. Although tectonic deformation is generally less intense than in classical fold and thrust belts, its role in shaping reservoir geometry and trap integrity is significant.

The stratigraphic architecture of the Transylvanian Basin is dominated by Miocene deposits, with Badenian, Sarmatian, and Pannonian units representing the most relevant intervals from a petroleum geology perspective. Among these, the Badenian stage plays a key role due to the widespread development of evaporitic formations, predominantly halite, deposited under restricted marine conditions [7],[10],[11]. These evaporites form a regional sealing horizon across large areas of the basin, exerting a first order control on hydrocarbon accumulation and preservation.

The Badenian salt exhibits variable thickness and lateral continuity, reflecting differences in accommodation space, depositional environment, and post depositional deformation. In many parts of the basin, the salt acts as an effective regional sealing horizon (vertical barrier), separating underlying and overlying sedimentary units and limiting cross-formational vertical

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fluid migration [7],[10]. This sealing capacity is a defining characteristic of the suprasalt petroleum systems of the Transylvanian Basin and has been instrumental in the long term retention of gas accumulations [8],[14],[27].

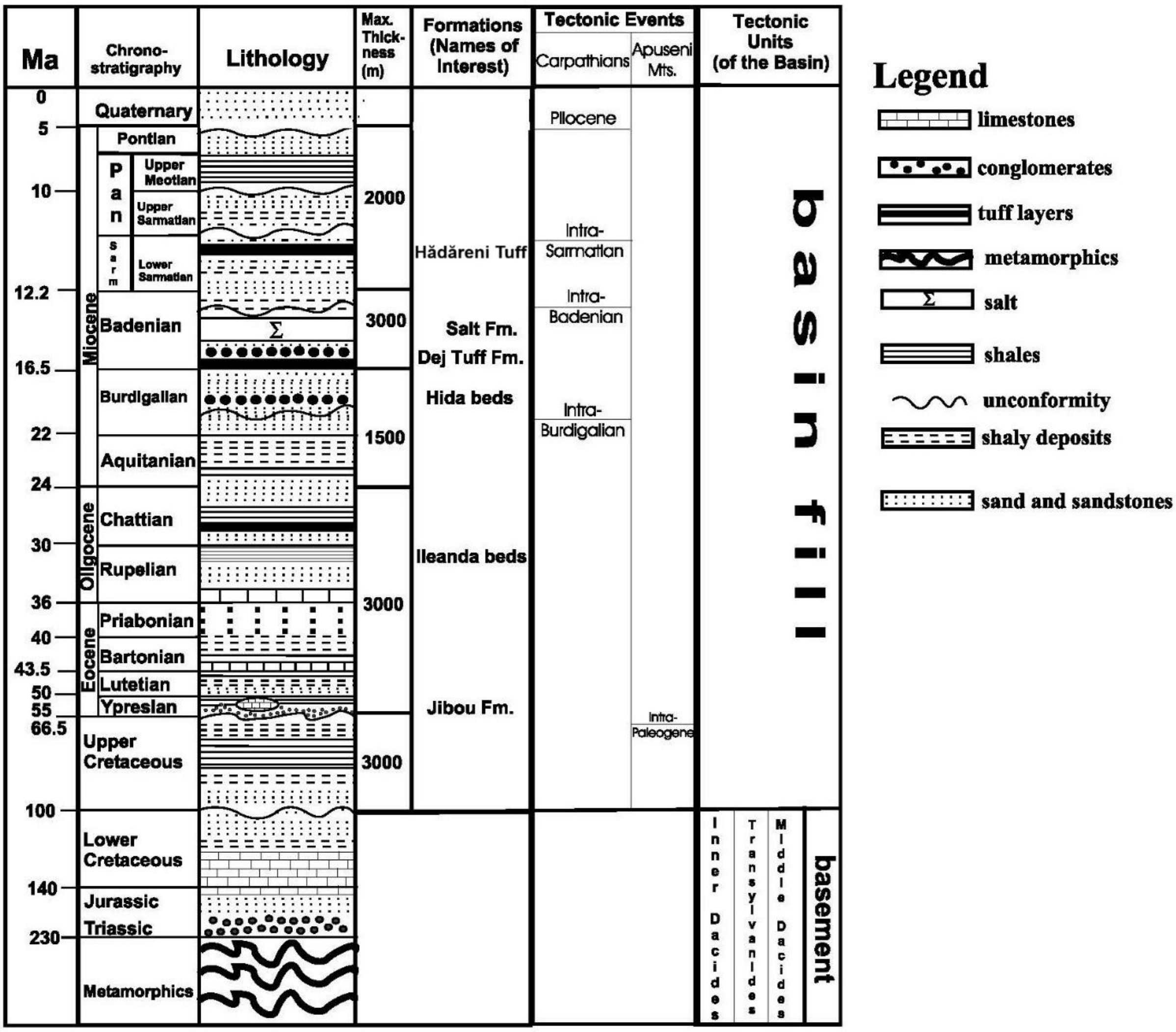

***Figure 2**. Simplified stratigraphic column of the Transylvanian Basin highlighting the Badenian salt (regional seal) and the overlying Sarmatian–Pannonian clastic intervals hosting suprasalt reservoirs. The figure shows the vertical arrangement of reservoir–seal pairs relevant to geological screening for CO_2 storage* [22].

Above the Badenian evaporites, Sarmatian and Pannonian deposits consist mainly of clastic successions, including sandstones, siltstones, and shales deposited in shallow marine, deltaic, and continental environments (see Figure 2) [11-13],[16],[22]. These units host the majority of the known gas reservoirs in the basin. Reservoir sandstones are characterized by variable porosity and permeability, influenced by depositional facies, grain size, and diagenetic processes. Lateral and vertical heterogeneity within these clastic sequences has led to significant reservoir compartmentalization, which is an important aspect when evaluating storage behaviour and containment potential [15],[18],[20].

The petroleum system of the Transylvanian Basin is distinctive due to the predominance of biogenic gas generation. Organic rich sediments deposited during the Neogene (see Figure 3) provided favourable conditions for microbial methane generation, resulting in gas accumulations that are typically located close to their source intervals [8],[13],[14],[22-26]. Migration distances are generally short, and accumulation efficiency is high, owing to the close spatial relationship between source rocks, reservoirs, and effective sealing formations. This configuration has contributed to the widespread distribution of gas accumulations throughout the basin.

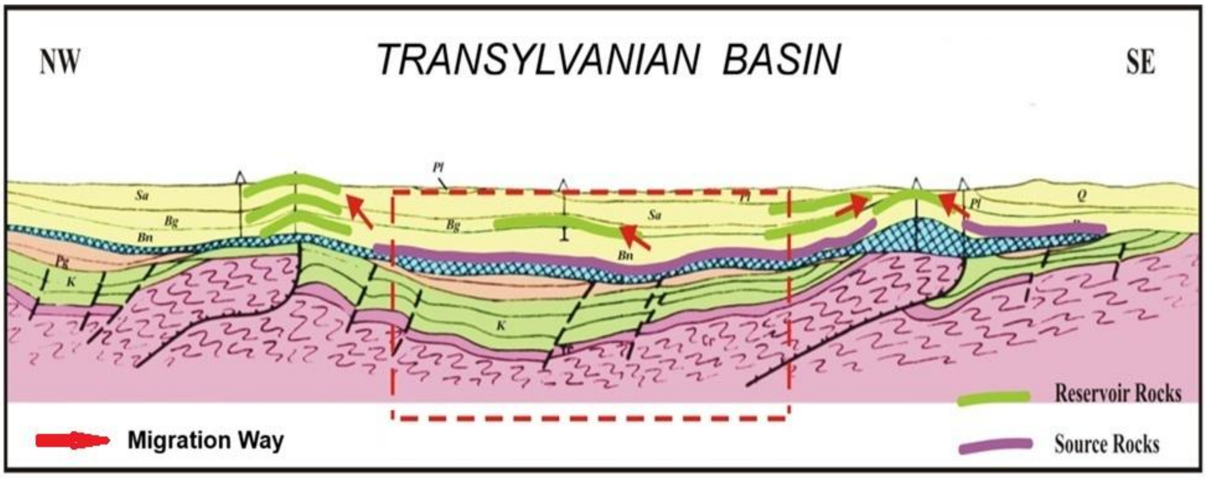

Figure 3*. Regional cross-section showing source–reservoir–seal relationships and migration style. For CO_2 storage screening, the figure illustrates the established containment architecture (regional salt seal and overlying fine-grained seals) and the short migration distances associated with the basin petroleum system* [23].

Structural traps within the Transylvanian Basin are mainly associated with gentle folds, fault related closures, and stratigraphic pinch-outs developed within the suprasalt succession. Salt related deformation, although not as pronounced as in classical salt basins, locally influenced trap geometry and enhanced sealing efficiency. The interaction between salt movement, sediment loading, and tectonic stresses resulted in subtle structural features that played an important role in hydrocarbon entrapment [7],[10],[21-26]. These characteristics are particularly relevant for assessing the long-term containment of injected fluids in a geological storage context.

An important aspect of the basin is the demonstrated ability of its geological system to retain gas over extended geological time periods. Numerous gas accumulations have remained stable prior to exploitation, indicating effective sealing and favourable reservoir trap relationships. This historical performance provides valuable insight into the containment behaviour of the subsurface and constitutes a key argument for considering depleted gas reservoirs in the basin as potential candidates for geological storage applications.

The Transylvanian Basin is also characterized by a mature stage of exploration and production, which has resulted in the acquisition of extensive geological, geophysical, and production datasets [25],[26],[29]. These data allow for a detailed understanding of reservoir geometry, pressure regimes, and fluid behaviour, significantly reducing subsurface uncertainty compared to less explored basins [32]. From a geological perspective, such data availability is essential for any screening level assessment of storage potential, as it supports informed evaluations based on documented subsurface behaviour rather than speculative assumptions.

In summary, the Transylvanian Basin exhibits a complex but well constrained geological framework, shaped by Neogene tectonic evolution, widespread Badenian evaporites, and suprasalt clastic reservoirs. The interplay between tectonics, stratigraphy, and sealing mechanisms has led to the formation and long term preservation of numerous gas accumulations. These geological characteristics provide a solid basis for evaluating depleted gas reservoirs in the basin as potential candidates for CO_2 storage within a preliminary, geological screening context.

DEPLETED GAS RESERVOIRS AND SUPRASALT SYSTEMS

Depleted gas reservoirs represent a specific category of geological systems that have undergone extensive production but retain many of the characteristics that govern hydrocarbon accumulation and preservation prior to depletion. In mature basins, such reservoirs are particularly well understood, as their geological framework, pressure evolution, and fluid behaviour have been documented over long periods of exploration and exploitation. From a geological perspective, the relevance of depleted gas reservoirs for subsurface storage applications lies in their proven capacity to trap and retain buoyant fluids within well-defined structural and stratigraphic configurations.

In the Transylvanian Basin, most gas accumulations occur in the suprasalt reservoir system, where suprasalt reservoirs overlie the Badenian evaporites (see Figure 4). Containment in suprasalt reservoirs is primarily provided by overlying fine-grained caprocks within the suprasalt succession, while the Badenian salt acts mainly as a regional sealing horizon (vertical barrier) separating suprasalt units from deeper stratigraphy; locally it may also contribute to lateral sealing where reservoirs pinch out against salt or are juxtaposed along faults.

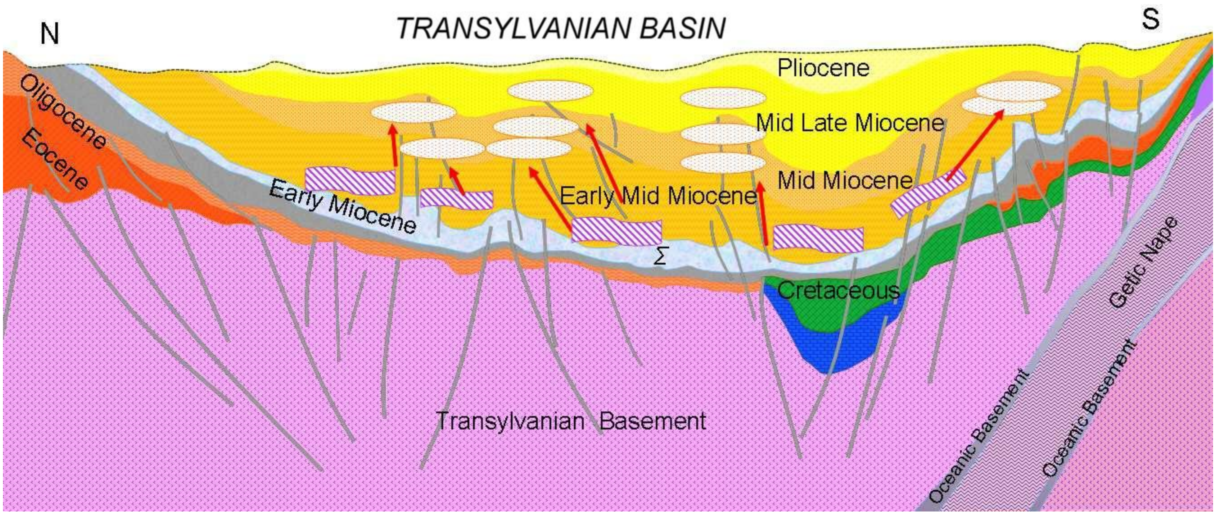

***Figure 4**. Regional cross-section in the Transylvanian Basin showing possible future candidates for CO2 storage* [23].

The suprasalt reservoirs are typically hosted within Sarmatian and Pannonian clastic successions, deposited in shallow marine to continental environments [11-13],[16]. The combination of effective regional sealing by salt and favourable reservoir properties has led to the formation of numerous gas accumulations, many of which have subsequently been depleted through long term production. Reservoirs within suprasalt systems are commonly characterized by significant heterogeneity, both laterally and vertically. Variations in depositional facies, grain size, and diagenetic alteration result in compartmentalized reservoir architectures, where individual sand bodies may be partially or fully isolated from one another [15],[18],[20]. Faults and subtle structural features further contribute to compartmentalization, influencing pressure communication and fluid distribution within the reservoir. These characteristics are critical when assessing the behaviour of reservoirs during depletion and their potential response to subsequent injection processes.

The process of gas depletion induces changes in reservoir pressure and stress conditions, which may affect reservoir and seal integrity. However, in the Transylvanian Basin, the long production history of many gas reservoirs indicates that depletion has generally occurred without major integrity issues, suggesting favourable mechanical behaviour of both reservoirs and sealing formations. The absence of widespread leakage or loss of containment during production provides indirect evidence of the robustness of the geological traps and sealing mechanisms.

An important aspect of suprasalt systems in the Transylvanian Basin is the role of the Badenian salt in maintaining long term containment. Salt formations exhibit very low permeability and, under geological conditions, can behave as ductile seals capable of accommodating deformation without fracturing [7],[10]. This property has contributed to the preservation of gas accumulations over geological time and remains relevant when considering the potential reuse of depleted reservoirs for subsurface storage [32],[33]. Even in areas where salt thickness varies or is locally disrupted, its presence exerts a strong control on vertical fluid migration [7],[8],[14].

Gas accumulations in the Transylvanian Basin are predominantly biogenic in origin, reflecting microbial methane generation within organic rich Neogene sediments [8],[13],[14],[22-26]. As a result, migration pathways are typically short, and gas is accumulated close to its source. This spatial proximity between source rocks, reservoirs, and seals enhances accumulation efficiency and contributes to the widespread distribution of gas fields across the basin. From a geological storage perspective, such configurations are advantageous, as they indicate a history of effective fluid retention within relatively simple migration systems.

The transition from active production to depletion marks a change in the operational status of gas reservoirs but does not fundamentally alter their geological framework. Structural traps, reservoir architecture, and sealing conditions remain largely unchanged after depletion, although pressure regimes are significantly modified. In this context, depleted gas reservoirs can be viewed as pre-tested geological containers, whose capacity to retain fluids has already been demonstrated under natural and production related conditions.

Within the Transylvanian Basin, the existence of underground gas storage facilities developed in former gas reservoirs further illustrates the suitability of suprasalt systems for cyclic injection and withdrawal operations. While the objectives and physical behaviour of underground gas storage differ from those of CO_2 storage, both rely on the same fundamental geological controls, including trap integrity, reservoir continuity, and seal effectiveness. Observations derived from such storage operations therefore provide valuable insights into reservoir performance and containment behaviour under changing pressure conditions.

Overall, depleted gas reservoirs within suprasalt systems of the Transylvanian Basin exhibit a combination of geological characteristics that are favourable for subsurface storage considerations. These include well-defined traps, effective regional and local seals, documented reservoir behaviour during depletion, and extensive geological knowledge derived from long term exploitation. Together, these attributes support the relevance of depleted suprasalt gas reservoirs as candidates for further geological evaluation in the context of CO_2 storage.

CASE STUDY – DEPOMURES UNDERGROUND GAS STORAGE FACILITY

The DepoMures underground gas storage facility represents one of the most relevant examples of subsurface reuse in the Transylvanian Basin, being developed within a former natural gas reservoir that had previously undergone extensive production. Its location in the central part of the basin places it within the characteristic suprasalt geological framework, where gas accumulations are hosted in Neogene clastic reservoirs lying on the Badenian evaporites. The selection of this site for underground gas storage reflects both favourable geological conditions and the availability of detailed subsurface data acquired during the production phase.

From a geological standpoint, the DepoMures storage facility (Figure 5) is associated with reservoirs positioned above the Badenian salt, within Sarmatian and Pannonian sedimentary successions. These reservoirs consist predominantly of clastic lithologies, mainly sandstones interbedded with finer grained deposits, which provide the necessary porosity and permeability for gas storage operations. The presence of the salt at depth plays a key role in the regional geological framework, while overlying low permeability formations contribute to local containment. This configuration is consistent with the general suprasalt petroleum systems described for the Transylvanian Basin.

The geological framework of the DepoMures site benefited from a long production history prior to its conversion into a storage facility. During the exploitation phase, reservoir behaviour, pressure evolution, and fluid distribution were extensively monitored, resulting in a high level of confidence regarding reservoir continuity, compartmentalization, and sealing efficiency [29]. Such information is essential for any subsurface storage application, as it reduces uncertainty related to reservoir performance and containment integrity. The absence of significant leakage or integrity issues during production further supports the suitability of the geological setting for subsequent storage use.

The transition from gas production to underground storage did not alter the fundamental geological characteristics of the reservoir. Structural traps, reservoir architecture, and sealing formations remained unchanged, while pressure regimes were modified through controlled injection and withdrawal cycles. These cyclic operations provide valuable insights into reservoir response under varying pressure conditions, including pressure propagation, deliverability, and containment behaviour. Although underground gas storage and CO_2 storage differ in operational objectives and thermodynamic conditions, both rely on the same geological controls, particularly trap integrity and seal effectiveness.

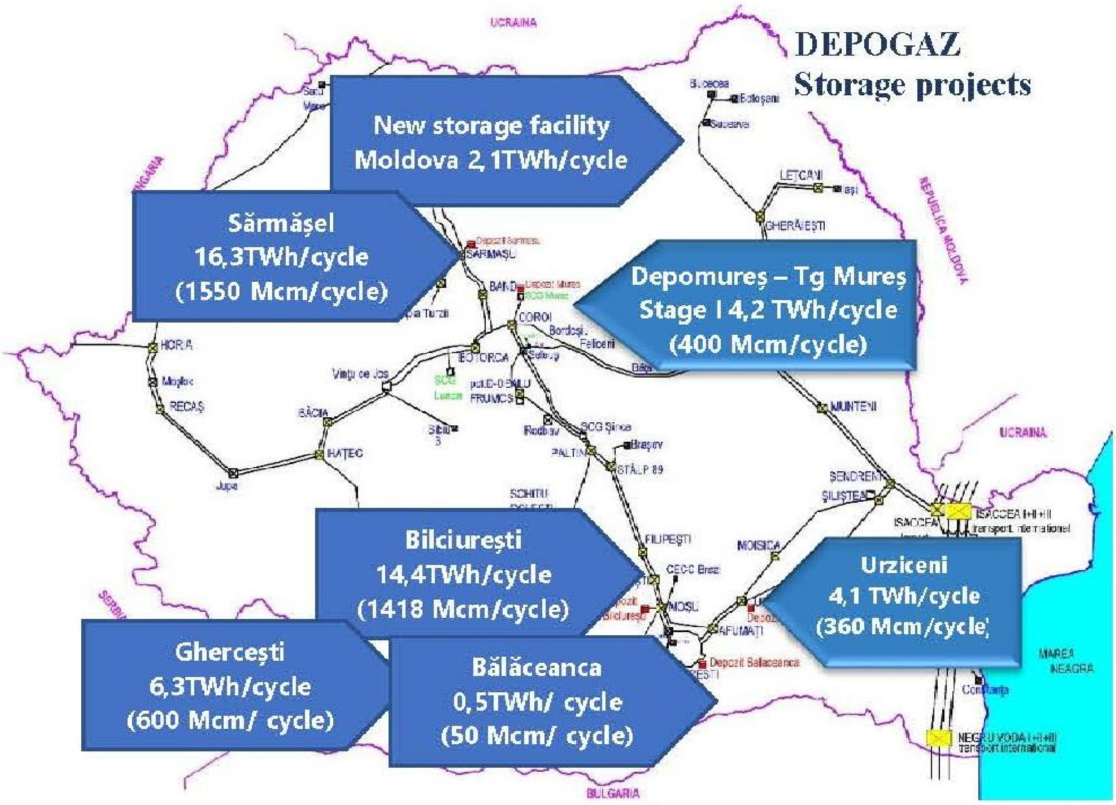

Figure 5. *Major natural gas storage projects of Romania* [28].

From a geological screening perspective, the DepoMures underground gas storage facility serves as a useful analogue for evaluating the potential of depleted gas reservoirs for CO_2 storage. The site demonstrates that suprasalt reservoirs in the Transylvanian Basin can sustain repeated injection and withdrawal without compromising containment, provided that favourable geological conditions are present. The proven performance of the reservoir seal system under operational stress supports the assumption that similar depleted reservoirs may exhibit suitable geological characteristics for further evaluation.

It is important to emphasize that the use of DepoMures as a case example in this study does not imply direct feasibility for CO_2 storage. No assessment of storage capacity, injectivity, or long term geochemical interactions [31] is undertaken. Instead, the example is employed to illustrate how geological conditions identified at basin scale manifest at site scale, and how existing underground gas storage operations can inform preliminary geological screening for CO_2 storage concepts. In this context, DepoMures provides a practical reference point for understanding the behaviour of former gas reservoirs under controlled injection conditions within the geological framework of the Transylvanian Basin.

GEOLOGICAL CONDITIONS RELEVANT FOR CO_2 STORAGE

The suitability of depleted gas reservoirs for geological CO_2 storage is primarily controlled by a set of geological conditions that govern fluid containment and reservoir behaviour (see Figure 6). In a screening level assessment, these conditions are evaluated qualitatively, based on the geological framework, reservoir architecture, and historical performance of the petroleum system, rather than on quantitative modelling or site specific engineering data. Within this context, the Transylvanian Basin provides a relevant example, as its gas reservoirs have developed within a well defined suprasalt system characterized by effective sealing and documented long term gas retention [7],[8],[14],[27].

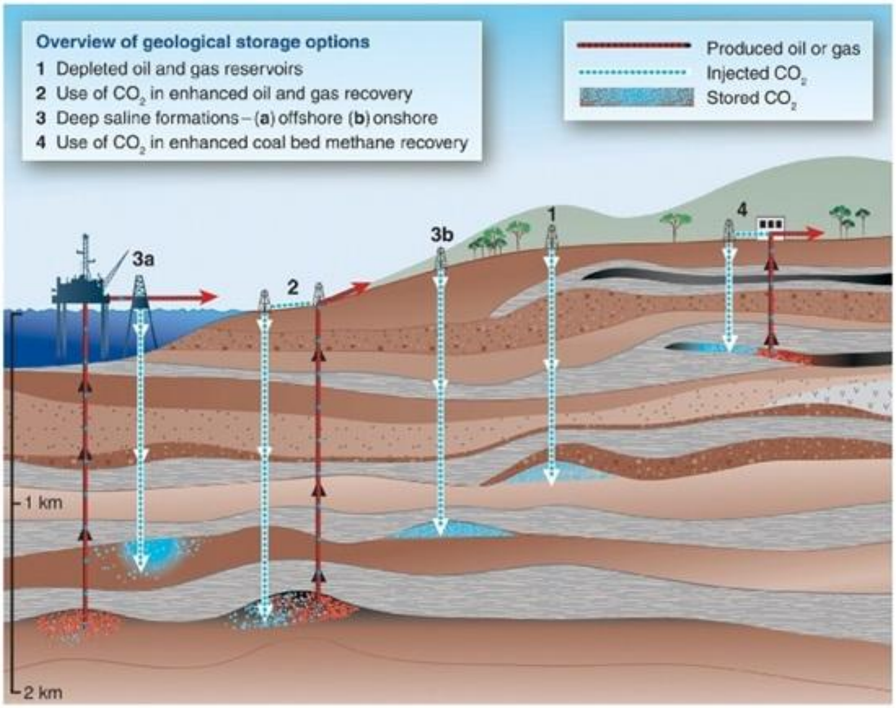

***Figure 6**. Conceptual classification of geological CO_2 storage options (after* [30]*). The diagram is used here only to position depleted gas reservoirs within a broader storage context; it does not imply capacity or injectivity assessment.*

For suprasalt reservoirs, it is important to distinguish between (i) the Badenian salt as a basin-scale sealing horizon that limits vertical migration across the evaporite level, and (ii) the actual caprocks of individual suprasalt reservoirs, which are typically fine-grained intervals within the Sarmatian–Pannonian succession. Depending on local structure and stratigraphic relationships, the salt may additionally act as a lateral seal.

One of the most important geological factors influencing storage potential is the presence of effective sealing formations. In the Transylvanian Basin, the widespread Badenian evaporites represent a regional seal that has played a fundamental role in the accumulation and preservation of natural gas. The very low permeability of salt and its ductile mechanical behaviour under geological conditions limit vertical fluid migration and enhance containment. This sealing capacity has been demonstrated over geological time by the existence of stable gas accumulations and is therefore considered a key prerequisite when assessing depleted reservoirs as potential storage candidates [7],[10].

In addition to regional sealing, local sealing conditions associated with overlying fine grained sediments and stratigraphic configurations contribute to containment at reservoir scale. Suprasalt reservoirs are commonly embedded within heterogeneous clastic successions, where interbedded shales and siltstones provide additional barriers to fluid migration [11-13],[16].

The combined effect of regional and local seals increases the robustness of the reservoir seal system, although variations in seal continuity and thickness must be considered when evaluating individual reservoirs.

Structural configuration and trap integrity represent another critical geological condition. Gas accumulations in the Transylvanian Basin are typically associated with gentle folds, fault related closures, and stratigraphic traps developed within the suprasalt succession [6],[9],[18]. The long term preservation of these accumulations prior to exploitation indicates that structural traps and associated faults have generally acted as effective containment elements rather than leakage pathways [8],[14],[19]. From a storage perspective, this behaviour suggests that trap integrity has been sufficient to retain buoyant fluids under natural conditions.

Reservoir properties and internal architecture also influence storage behaviour. Suprasalt reservoirs are characterized by variable porosity and permeability, controlled by depositional facies and diagenetic processes. Reservoir compartmentalization, resulting from facies heterogeneity and faulting, affects pressure communication and fluid distribution. While such compartmentalization may limit storage efficiency in some cases, it can also contribute to containment by restricting large scale fluid migration. These characteristics must therefore be considered qualitatively when assessing storage potential at a screening level.

The depletion history of gas reservoirs provides additional insight into their geological suitability. Long term production without evidence of widespread leakage or loss of containment suggests that reservoir seal systems have maintained their integrity under changing pressure conditions. In the Transylvanian Basin, this historical performance is further supported by the successful operation of underground gas storage facilities developed in former gas reservoirs, which demonstrate the ability of these systems to accommodate repeated pressure cycles. Although underground gas storage and CO_2 storage involve different fluids and operating conditions, both rely on the same fundamental geological controls.

Taken together, the geological conditions identified in the Transylvanian Basin including effective regional and local sealing, stable structural traps, favourable reservoir properties, and documented containment performance, support the consideration of selected depleted gas reservoirs as potential candidates for CO_2 storage at a preliminary, geological screening level. It is emphasized that these conditions do not imply technical or economic feasibility, but rather define a geological framework within which more detailed, site specific assessments may be undertaken in future studies.

DISCUSSIONS

The evaluation of depleted gas reservoirs for geological CO_2 storage requires a clear distinction between preliminary geological screening and detailed feasibility assessment. The present study deliberately focuses on the former, using existing geological knowledge from a mature gas province to identify conditions that may support further investigation. In this context, the Transylvanian Basin provides a valuable example, as its geological framework and petroleum system are well documented and characterized by long-term gas retention.

One of the main strengths of the Transylvanian Basin, highlighted in this study, is the presence of a regionally extensive sealing system associated with the Badenian evaporites. The role of salt as an effective seal has been widely documented in relation to hydrocarbon accumulation and preservation [7-10],[14],[26],[31], and this characteristic is equally relevant when considering geological storage concepts. The long-term stability of gas accumulations prior to exploitation suggests that vertical containment has been effective under natural conditions, an observation that is central to any screening-level assessment of storage suitability.

Another important aspect discussed in this paper is the structural and stratigraphic configuration of suprasalt reservoirs. The predominance of gentle structural traps, combined with reservoir compartmentalization, has influenced both gas accumulation and production behaviour in the basin. While compartmentalization may pose challenges for large scale storage efficiency, it can also enhance containment by limiting extensive fluid migration. At a geological screening level, such characteristics should therefore be regarded as site specific factors that require further evaluation rather than as inherent limitations.

The use of the DepoMures underground gas storage facility as a case example illustrates how basin scale geological conditions manifest at site scale. Although underground gas storage and CO_2 storage differ in terms of fluid properties, injection strategies, and long term objectives, both rely fundamentally on the same geological controls, including reservoir integrity, sealing efficiency, and structural stability [31],[33],[34].

Observations derived from underground gas storage operations provide indirect evidence that certain depleted reservoirs in the Transylvanian Basin are capable of sustaining controlled injection and pressure cycling without compromising containment. However, these observations should be interpreted cautiously and should not be equated with direct evidence of suitability for CO_2 storage.

Several limitations of the present study must be acknowledged. The assessment is based exclusively on geological information and does not include quantitative evaluations of storage capacity, injectivity, pressure build-up, or geochemical interactions between CO_2, reservoir fluids, and host rocks. In addition, fault integrity and potential leakage pathways are considered only qualitatively, based on historical reservoir performance, rather than through dedicated geomechanical or flow modelling. As such, the results presented here should be viewed as indicative rather than definitive.

Despite these limitations, the findings of this study are consistent with similar screening-level approaches applied in other mature gas basins, where depleted reservoirs have been identified as potential candidates for further CO_2 storage assessment based on geological criteria. By clearly defining the geological conditions that have supported hydrocarbon accumulation and retention in the Transylvanian Basin, this paper contributes to a structured framework for narrowing down candidate sites prior to more detailed investigations.

Overall, the discussion reinforces the idea that geological screening represents an essential first step in the assessment of subsurface storage options. In the case of the Transylvanian Basin, the combination of effective sealing, stable trapping configurations, and extensive geological knowledge provides a sound basis for considering selected depleted gas reservoirs in future CO_2 storage studies, while recognizing the need for additional, site-specific analyses before any practical implementation.

CONCLUSIONS

This paper provided a geological, screening-level assessment of depleted gas reservoirs in the Transylvanian Basin, with the aim of identifying the main geological conditions that support their consideration as potential candidates for CO_2 storage. The analysis focused on the basin-scale framework and on the characteristics of suprasalt reservoir systems, where the presence of widespread Badenian evaporites plays a key role in regional containment.

The results emphasize the importance of effective sealing conditions, particularly the role of the Badenian salt as a regional seal, complemented by local sealing within heterogeneous clastic successions. In addition, the long-term preservation of gas accumulations and the structural configuration of suprasalt traps indicate that, in selected cases, the geological system has been capable of retaining buoyant fluids over geological time. Reservoir heterogeneity and compartmentalization are shown to be relevant factors that may influence storage behaviour and should therefore be addressed at site scale during subsequent evaluations.

The DepoMures underground gas storage facility, developed within a former gas reservoir, was discussed as a representative case example to illustrate how basin-scale geological conditions manifest at site scale and to underline the relevance of existing subsurface storage operations as analogues in a screening context. This example supports the broader observation that certain reservoirs within the Transylvanian Basin can sustain controlled injection-related pressure changes without compromising containment, provided that favourable geological conditions are present.

This study remains intentionally limited to geological aspects and does not include quantitative assessments of storage capacity, injectivity, pressure evolution, or long-term geochemical and geomechanical behaviour. Consequently, the conclusions should be interpreted as a preliminary geological screening that helps constrain the regional framework and highlights the key criteria for selecting candidate sites. Further work should therefore focus on site-specific characterization and quantitative evaluation to support any future consideration of CO_2 storage within the basin.

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