Containment Evaluation and Reservoir Closure Based on Reflection Seismic – Getica CCS Project

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Summary

As part of the feasibility study carried out within the Getica CCS demonstration project (located in Oltenia region –south-west part of Romania), a containment evaluation and reservoir (saline aquifers formations) closure analysis were performed for two candidate CO_2 storage sites (Zone 1 and Zone 5). The characterization of the reservoir and caprock geometry, as well as the identification of structural discontinuities such as faults and fracture corridors, is based on reflection seismic data.
The reservoir closure analysis focuses on caprock integrity and potential migration pathways, highlighting the limitations of the available data and the need for additional 2D and 3D seismic acquisitions. Zone 5 (figure 1) was identified as the most suitable site for geological CO_2 storage, due to its better injectivity and favorable reservoir characteristics.
The study demonstrates the importance of seismic reflection in reducing geological uncertainties and selecting a secure long-term storage site.
A dynamic risk register and a flexible, phased approach support the upcoming stages of project development. Furthermore, the containment evaluation and clarity of geological closure contribute to increasing public trust in the safety of CO_2 storage

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Introduction

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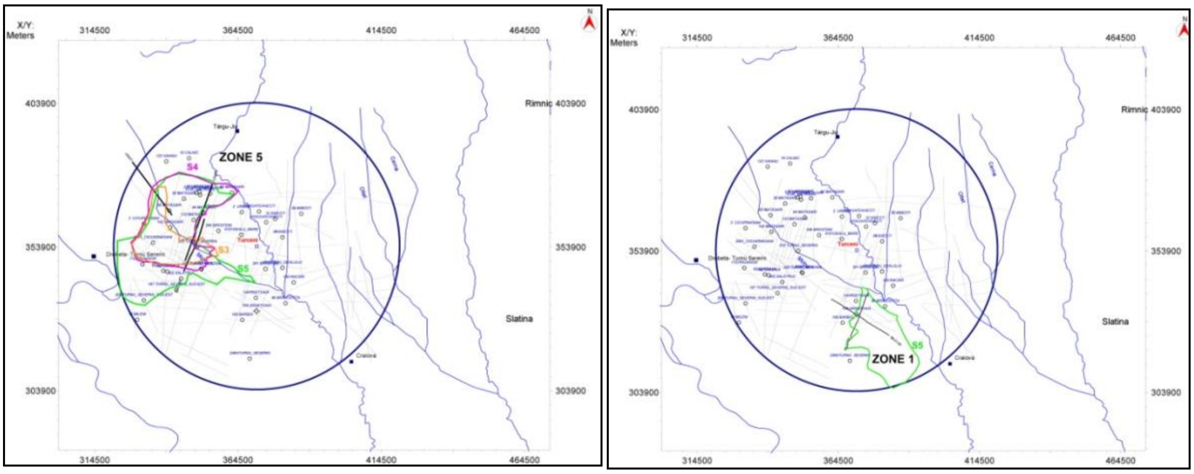

Figure 1 *The location of the Zones no. 1and 5 showing the closure area of the trap and the interpreted seismic lines*

Containment Evaluation and Geological Characteristics of the Reservoir in Zone no. 1

Studying the closure of the reservoir for Zone no. 1 a major characteristic could be observed: the deepening of reservoir sequences from South to North. The shale deposits also appear to be better developed towards North proportionally with the distance from the source sedimentation area.
This means that the reservoir has better properties in the southern part of the investigation zone. The reservoir sequences pinch-out on pre-Tertiary paleo-relief, creating a structural-stratigraphic trap.
The thicknesses maps created for the reservoir sequences Sa7-Sa5 and Sa5-Tertiary base (figure 2) show the reducing of the thicknesses through the West, South and East.
There is a major normal fault system with NE-SW trending affecting the sedimentary sequence from Zone no. 1 (see figure 3).
This fault system is the single fault system which affected in a positive way the Sarmatian reservoir sequences creating both the accumulation basin and the seal.
According with the petro physical analysis and the geological context in Zone no. 1 the layer Sarmatian –Sa7 is the seal for the reservoirs developed in this area.

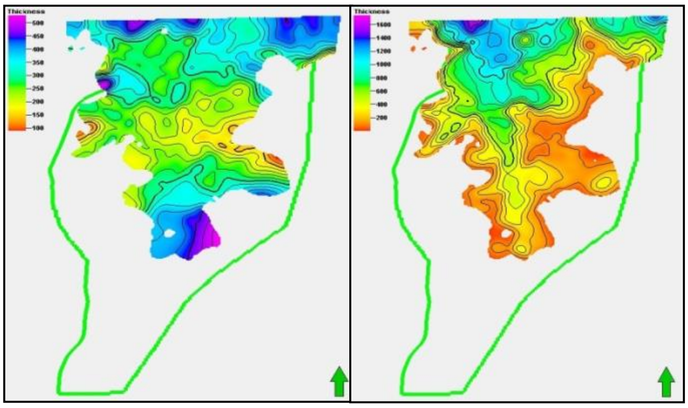

Figure 2 *Reservoir sequences thicknesses map (left – Sa7-Sa5; right – Sa5-Tertiary base)*

No presence of the faults and/or fractures within seal has been identified on the seismic data and logs. This sequence is well developed on the entire area lying above the Sa7. It is characterised by a N/G ratio below 0.3% and has a thickness which varies from 30 m to 1800 m (see figure 4).

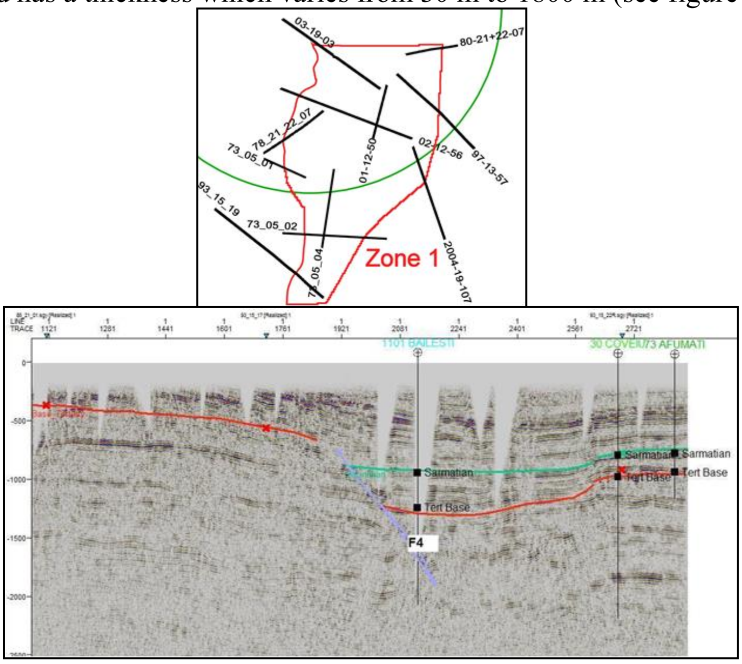

Figure 3 *Interpreted seismic line no 93_15_19 showing the NE-SW fault F4 affecting the sedimentary sequence from Zone no. 1*

The following figure (figure 4), the Sarmatian-Sa7 thickness map, illustrates the distribution of the seal sequence across the entire investigated area. The thickness of this sequence varies significantly, from 30 m to 1800 m, and is characterized by an N/G ratio below 0.3%. This means that the Sarmatian-Sa7 sequence, which acts as a seal for the CO_2 reservoirs, is continuous and intact across the entire investigated area, without being affected by faults or fractures. The absence of faults and fractures within the seal suggests that the seal has good integrity, making it capable of retaining CO_2 in the reservoir without the risk of migration to the surface through geological discontinuities.
Additionally, the variability in the thickness of the Sarmatian-Sa7 sequence (ranging from 30 m to 1800 m) and the N/G ratio (below 0.3%) indicate that the sequence is thick and compact enough to effectively function as a seal, ensuring the long-term safety of CO_2 storage.

Overall, these observations suggest that the area is suitable for geological CO_2 storage, with a high-quality seal that reduces the risks of CO_2 migration and contributes to the safety of the project.

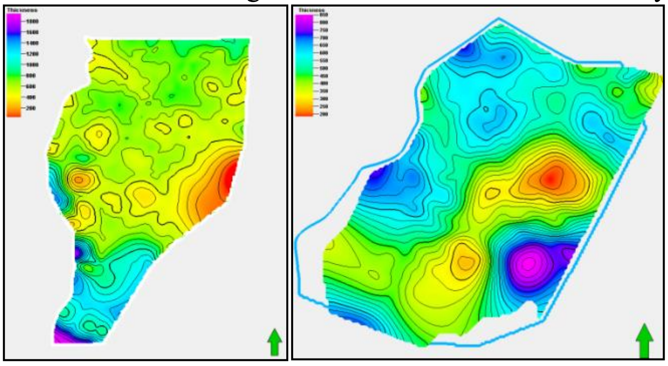

Figure 4 *Sarmatian-Sa7 and Sarmatian –Sa5 thickness maps*

The definition of the storage site and storage complex has currently been narrowed down to the level of an investigation area. However, it is anticipated at this point that the 3D boundaries of the storage site and storage complex will be contained within a "target geological volume" as defined below: it vertically extends from the base of Tertiary up to the top of Sarmatian (therefore including the reservoir sequences Sa5 and Sa7 and the caprock formed by the overlaying Sarmatian sequences). These stratigraphic boundaries will be revised after drilling the appraisal wells, when the lithology of this local area is better characterized. Its lateral boundaries are constrained by the most northern bounding fault and the pinch-out of the reservoir formations on the western boundary, by the pinch-out of the reservoir formations on the southern boundary, while the northern and southern boundaries have been arbitrarily drawn.

Containment Evaluation and Geological Characteristics of the Reservoir in Zone no. 5

Studying the closure of the reservoir for Zone no. 5 a major characteristic could be observed: the deepening of reservoir sequences from South to North and from West to East. Associated with this deepening is an increase in shale deposits due to the increasing of the distance from the sedimentary source area to the deposition area (Bachu, 2008). In this area there are two sedimentary source areas located in the southern and in the western parts of the area. From reservoir point of view the deepening of the Tertiary base means a reducing of reservoirs quality in the most north-eastern part of the area (Anghel, 2024). In Zone no. 5 the reservoir sequences Sa5-Sa5a and Sa5a-Sa4, are developed and pinch-out through South and South-East on Pre-Tertiary paleo-relief creating a structural-stratigraphic trap.The thickness maps created for the reservoir sequences Sa5-Sa5a and Sa5a-Sa4. (figure 5) show the reducing of the thicknesses through the West, South and East.

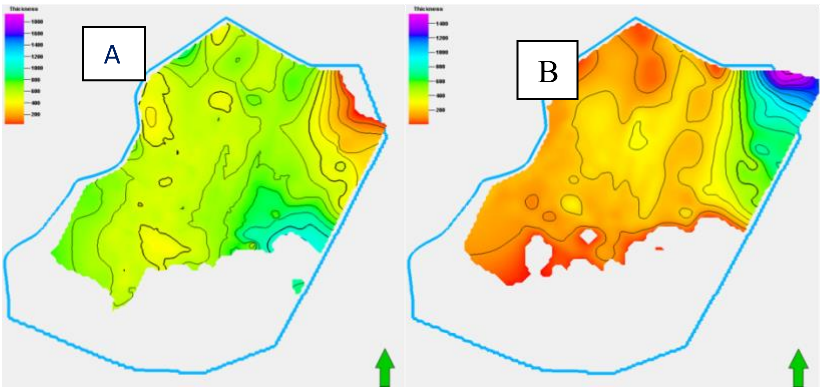

Figure 5 *Thicknesses maps for reservoir sequences (A) Sa5-Sa5a, B) Sa5a-Sa4*

There are two major normal fault systems with NE-SW (F1) and WNW-ESE (F2) trending affecting the sedimentary sequence from Zone no. 5 (Figures 6).

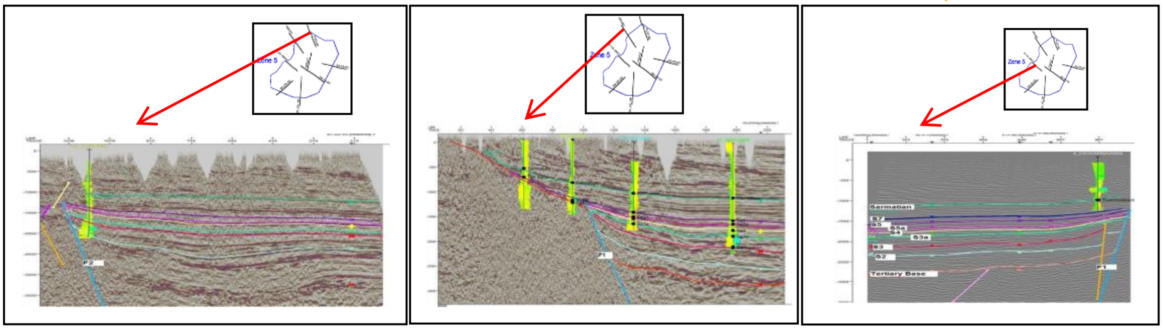

Figure 6 *Interpreted seismic lines no 4-22-87 showing the WNW-ESE fault F2,* no r-05-z-01 *showing the NE-SW fault F1 and no 12-14-1992 showing the NE-SW fault F1 affecting the sedimentary sequence from Zone no. 5*

These two fault systems have positively influenced the Sarmatian reservoir sequences, contributing to both the formation of the accumulation basin and the sealing structure. According to petrophysical analyses and the geological context in Zone no. 5, the Sarmatian–Sa5 interval acts as the primary seal for the reservoirs developed in this area. This sealing sequence is well developed across the entire area above Sa5. It is characterized by a net-to-gross (N/G) ratio below 0.05% and a thickness ranging from 200 to 850 meters (see Figure 4). t is currently anticipated that the 3D boundaries of the storage site and storage complex will be included within a "target geological volume," defined as followsVertically, this volume extends from the top of the Burdigalian to the top of the Sarmatian (thus including the reservoir sequences Sa3a, Sa4, Sa5a, and Sa5, as well as the sealing unit formed by the overlying Sarmatian sequences). These stratigraphic boundaries will be revised after drilling the appraisal wells, when the lithology of this local area is better characterized. Laterally, the boundaries are constrained by the marginal faults to the west and north, by the pinch-out of the reservoir formations in the south, while the eastern boundary has been arbitrarily drawn in the figures below and will be adjusted if necessary (IPCC, 2005).

Conclusions

Zone 5 has been identified as the most suitable location for geological CO_2 storage, due to better injectivity and favorable geological characteristics, including a well-developed caprock and the absence of significant faults or fractures within the seal.
Containment assessments for both zones rely on reflection seismic data, which allowed the identification of the Sarmatian caprock and the presence of structural-stratigraphic traps.
For both zones, the storage site and storage complex boundaries are preliminarily defined as a target geological volume, to be refined after the Appraisal phase based on well data and additional geophysical surveys.Public acceptance and risk management are critical for project success, requiring transparent communication and continuous updates of the dynamic risk register.

Acknowledgements

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