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Controlling Role of Salt Tectonics on the Architecture of a Mid-Depth Geothermal Reservoir Based on 3D Seismic Interpretation in the North German Basin

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INTRODUCTION

Decarbonizing the heating sector is a key challenge of Germany's energy transition. The ArtemIS project contributes to this goal by improving the national geothermal database and supporting sustainable subsurface heat use through the Geothermal Information System (GeotIS). Within this context, the calcarenites of the Upper Maastrichtian Reitbrook Formation in the North German Basin are investigated as a promising but still poorly constrained mid-depth geothermal reservoir.

These strata were previously used for wastewater injection in the oil and gas industry, indicating favorable transmissivity (Kinzel, 2021; Fahrion, 1984). However, reservoir properties, spatial distribution, and geological controls remain insufficiently understood. Borehole-based basin-scale mapping reveals pronounced lateral variations in thickness, preservation, and burial depth of the arenitic intervals, indicating a highly heterogeneous distribution of potential reservoir bodies across the basin (Fig. 1). The mapping is based on the correlation and interpretation of borehole log data following the lithostratigraphic framework summarized in Fig. 2.

This heterogeneity is closely related to salt-tectonic dynamics that shaped the basin through differential subsidence, minibasin formation, and structural deformation, affecting both sediment distribution and reservoir architecture. To better resolve these relationships, a legacy 3D seismic dataset was reinterpreted using advanced workflows in OpendTect (dGB Earth Sciences, 2025) and calibrated with borehole data. The integrated analysis improves the understanding of salt structures, stratigraphic variability, and reservoir architecture, supporting more reliable predictions of geothermal potential in the North German Basin.

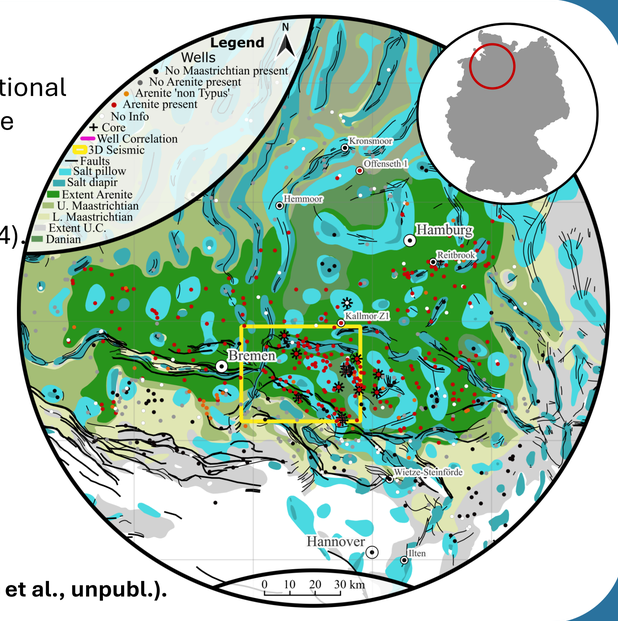
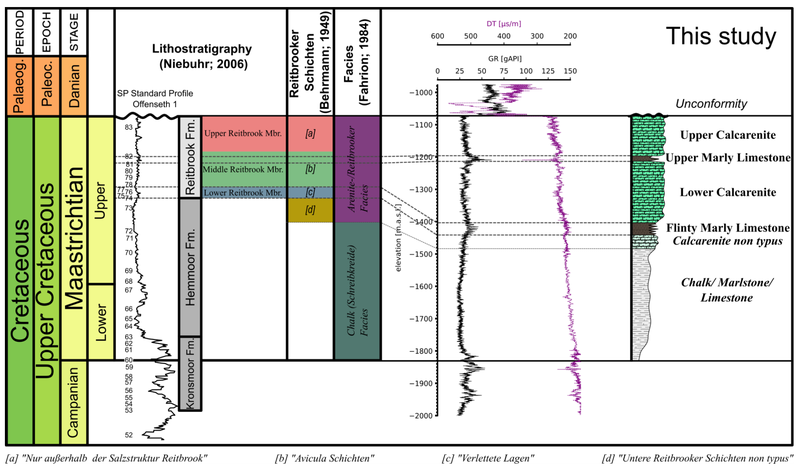


Figure 1: Calcarenite distribution from 712 boreholes with the 3D seismic (Erb et al., unpubl.).

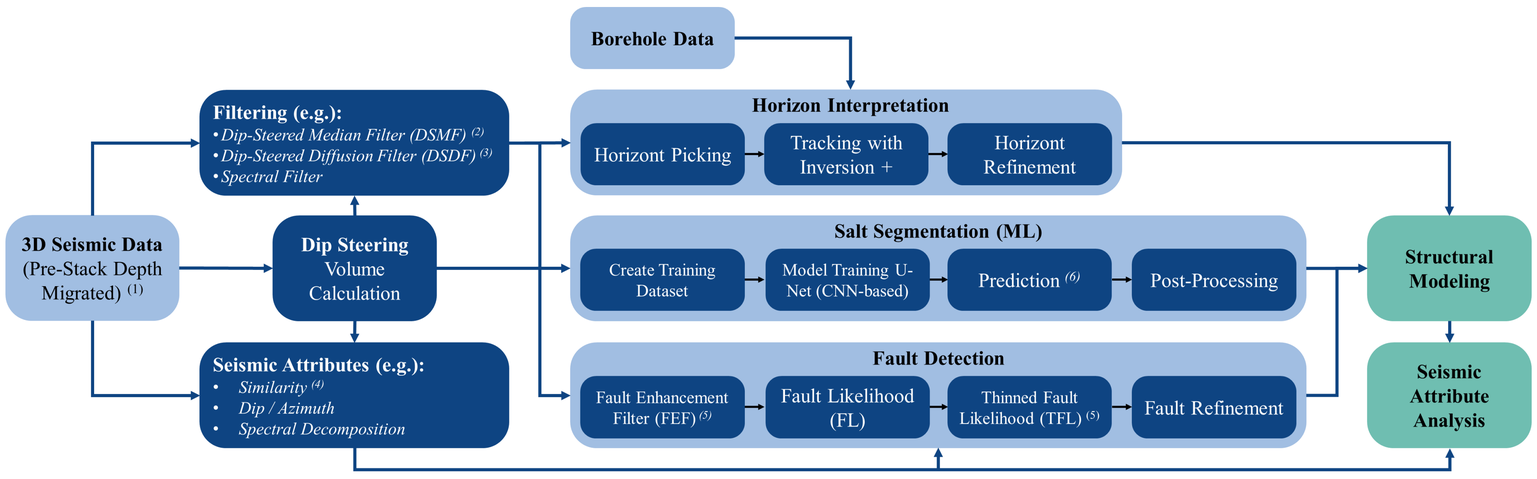
METHODS



[a] "Nur außerhalb der Salzstruktur Reitbrook" [b] "Avicula Schichten" [c] "Verlettete Lagen" [d] "Untere Reitbrooker Schichten non typus"

Figure 2 : Lithostratigraphy and nomenclature used in this study. (Erb et al., unpubl.).

SEISMIC INTERPRETATION WORKFLOW*



*within *OpendTect* (dGB Earth Sciences, 2025)

RESULTS

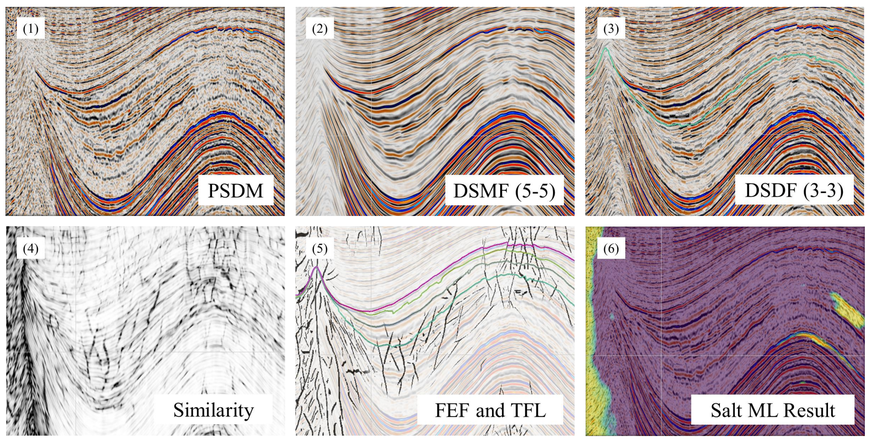


Figure 3 (left): Subsection of seismic inline IL 5000 (see Fig. 5) showing (1) pre-stack depth migrated data, (2) dip-steered median filter, (3) dip-steered diffusion filter, (4) similarity attribute, (5) fault enhancement filter with thinned fault likelihood and horizon interpretation, and (6) convolutional neural network (CNN) based salt segmentation. Processing and visualization were performed in OpendTect (dGB Earth Sciences, 2025). The fault likelihood still requires manual refinement, and the salt segmentation, though successfully detecting major salt bodies, shows minor misclassifications. Overall, the workflow demonstrates promising potential for further optimization.

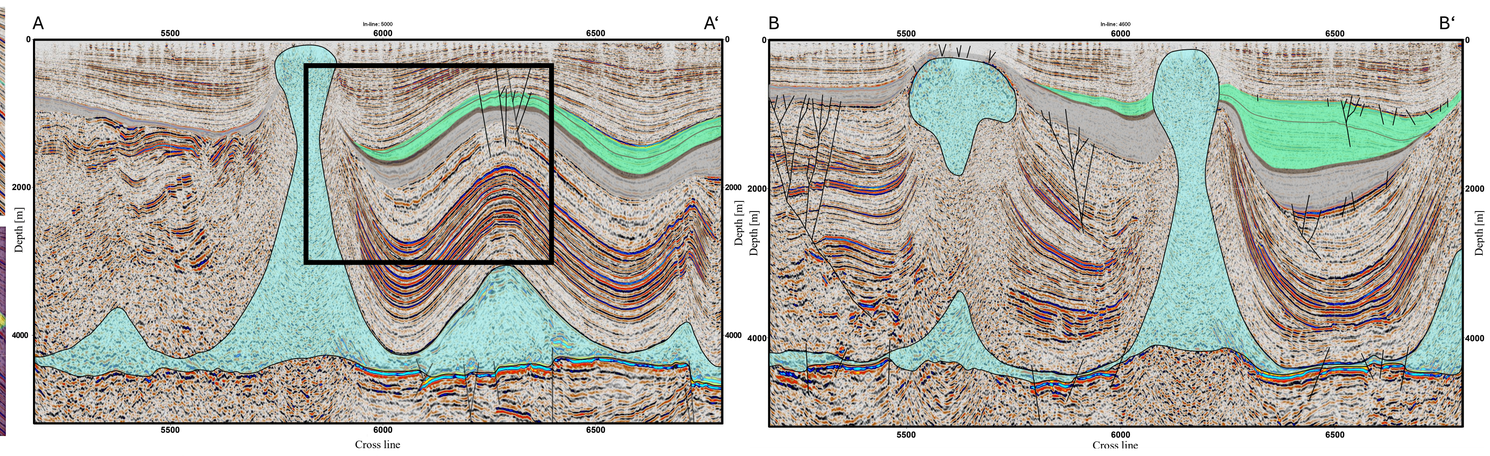


Figure 4 (middle): Seismic inline 5000 with interpreted salt bodies, processed in OpendTect (dGB Earth Sciences, 2025). Colour scheme of the Maastrichtian deposits, see Fig. 1. The position of the inline is shown in Figure 7 (data source: KW-FIS; (Erb et al., unpubl.).

Figure 5 (right): Seismic inline 4600 with interpreted salt bodies, processed in *OpendTect (dGB Earth Sciences, 2025)*. Colour scheme of the Maastrichtian deposits, see Fig. 1. The position of the inline is shown in Figure 7 (data source: KW-FIS; Erb et al., unpubl.).

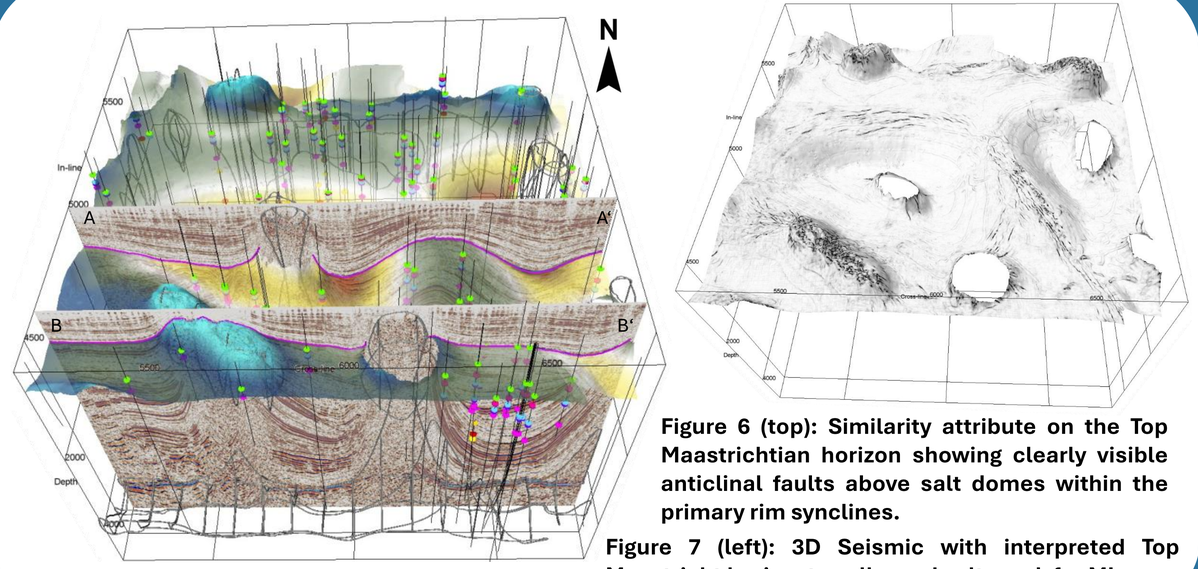


Figure 6 (top): Similarity attribute on the Top Maastrichtian horizon showing clearly visible anticlinal faults above salt domes within the primary rim synclines.

Figure 7 (left): 3D Seismic with interpreted Top Maastricht horizont, wells, and salt mask for ML.

DISCUSSION & CONCLUSION

- Seismic data reveal complex salt-related features (walls, diapirs, domes) and faults.
- Synsedimentary salt movement formed multiple minibasins with distinct geometries and evolutions.
- Reitbrook Formation with calcarenite distribution show strong thickness and subsidence variations.

→ very komplex reservoir architecture.

FUTURE WORK

- Refinement of CNN approach from first promising results.
- Building of a complete 3D reservoir model.
- Reservoir properties with seismic attributes and ML.
- Analysis of minibasins with a tectonostratigraphic approach as interpretive method (Figure 8).

Next Step → Minibasin Tectonostratigraphic Succession (MTS) analysis

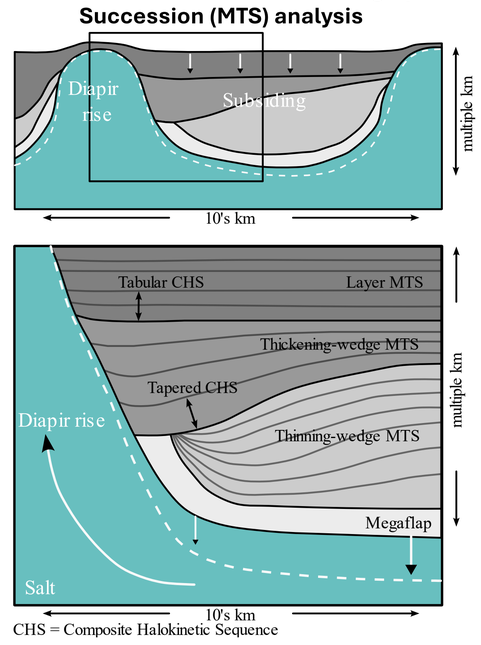


Figure 8: Conceptual scheme of minibasin subsidence and internal stratigraphy above rising salt diapirs, illustrating long-wavelength differential deformation (modified after Rowan & Giles, 2023).

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Literature

- Fahrion, H. (1984). Comments on Distribution and Fades of the Maastrichtian in NW Germany. *Zeitschrift der Deutschen Geologischen Gesellschaft*, *135*(2)
- Kinzel, M. (2021). Neue Chancen für Tiefengeothermie-Projekte in Niedersachsen (p. 9). Presented at the Der Geothermiekongress DGK 2021, 30.November - 2.Dezember 2021, Celle.
- LBEG. (2022.). Kohlenwasserstoff-Fachinformationssystem (KW-FIS). - Landesamt für Bergbau, Energie und Geologie (LBEG), Hannover.
- Niebuhr B (2006) Multistratigraphische Gliederung der norddeutschen Schreibkreide (Coniac bis Maastricht), Korrelation von Aufschlüssen und Bohrungen. Z Dtsch Ges Für Geowiss 157:245–261.
- dGB Earth Sciences (2025). OpendTect 7.0 [Seismic interpretation software]. Enschede, The Netherlands.
- Rowan MG, Giles KA (2023) Different scales of salt–sediment interaction during passive diapirism. AAPG Bull 107:7–22.