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Seismic interpretation of the upper Paleozoic in the central part of the North Sea
Southern Farsund Basin

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Abstract:

The investigated area located in the North Sea and covers an area of ca. 1000 km2 between the Stavanger platform and the Norwegian-Danish basin. Farsund basin is an underexplored basin and here, we will examine the basin and focusing on exploration the upper Paleozoic. In order to give better understanding for the area and explain the evolution system in upper Paleozoic time using seismic well data and well logs to map the formations in this area. The main result of this thesis is to map the upper Paleozoic using 2D and 3D seismic data. Concluding the tectonic activity in the different groups in the study area.

Acknowledgement:

I would like to express my deepest gratitude to my supervisor Dora Luz Marin Restrepo for her kind supervision, numerous discussions and patience. I would like also to thank my family and my friends for their support.

Table of content:

1. Introduction:

The North Sea has become a mature petroleum province, with a numerous geological data generated during the last 50 years (Coward et al., 2003).

The North Sea hydrocarbons province comprises two parts. The southern North Sea characterized by Carboniferous coals as source rock. The central and northern North Sea have the Jurassic rocks as main source rock, but the potential of the upper Paleozoic source rock is not understood in this area (Coward et al., 2003).

Furthermore, the upper Paleozoic is a successful play concept in the southern part of the North Sea, where giant fields such as Groningen have been discovered. However, in the Norwegian sector of the North Sea this has been under-explored and there is a lack of understanding of the late Paleozoic geological evolution.

During the Carboniferous-Permian there was a major rifting with volcanism and deposition of reddish eolian and fluvial sandstones which forms the Rotliegend Group (Philips et al., 2018). In addition, during the upper Permian thick evaporate sequences included in the Zechstein Group were deposited (Philips et al., 2018). The salt had been forced to move upwards by the buoyancy force of the overlaying younger sediments (Vejbæk, 1990). Salt movement and Mesozoic and Cenozoic tectonic activity created different structures which are important to form hydrocarbons traps (NPD, 2021). Moreover, salt can work as a seal and acting as a heat conductor, thus it is important to understand its distribution and lateral variation (Hudec and Jackson, 2007).

The Farsund Basin has penetrated the upper Paleozoic (Kalani et al., 2020; NPD, 2021), but it has not been properly studied using 3D seismic data. The aim of this study is to improve the geological evolution of the upper Paleozoic in the Farsund Basin (Figure 1), focusing on the salt distribution and tectonics and sedimentation from the Pre-Rotliegend to the Zechstein Group.

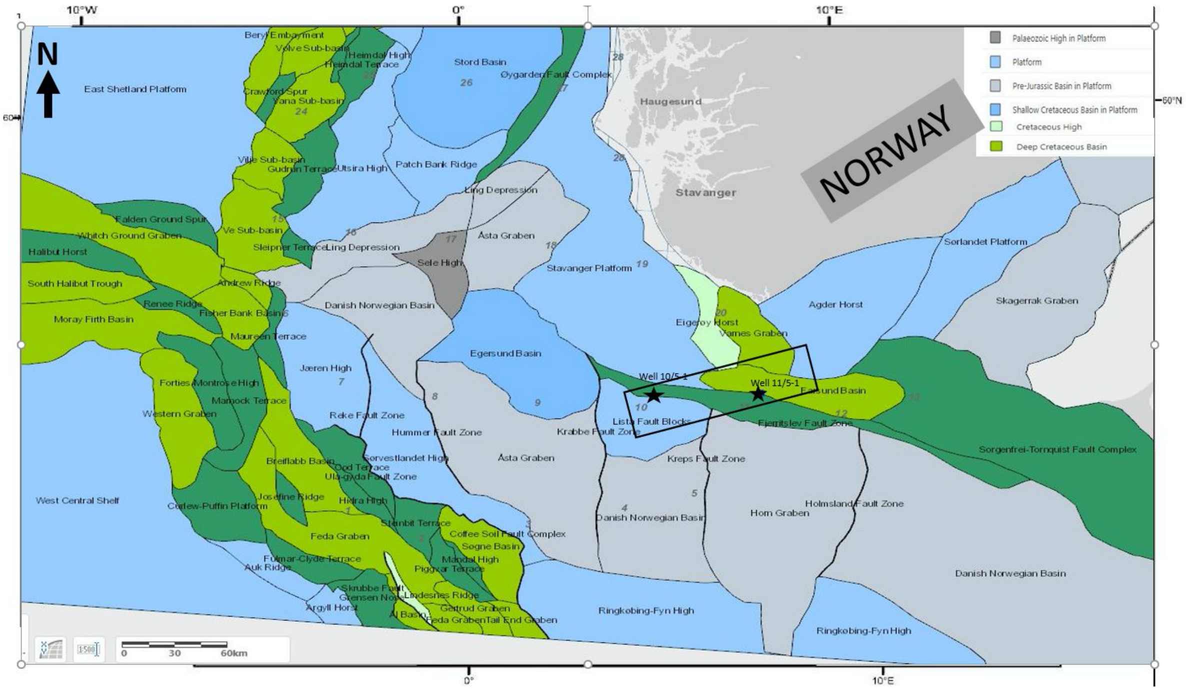


Figure 1: Location of the study area (black polygon) along the Farsund Basin and the Fjerritslev Fault Zone (NPD, 2021).

2.0 Objectives:

The main objective of this study is to improve the understanding of the late Paleozoic geological evolution of the Farsund Basin and to discuss the potential hydrocarbons traps in the Farsund Basin area in the Permian-Carboniferous succession. 2D and 3D seismic data and well logs are used in order to achieve this goal, and the following steps were performed:

- Study the well log data in order to understand the lateral and vertical variation of the studied formations in the area.
- Make the seismic interpretation of the upper Paleozoic succession (Basement Top, Rotliegend GP base and top, and the Zechstein Group top) in the southern part of the Farsund Basin. To interpret seismic termination and seismic facies, and to interpret the main faults in order to understand the late Paleozoic geological evolution of the area and if there was an impact of the tectonics in sedimentation.

3.0 Geological setting:

In this study an area of approximately 1000 km2 offshore southern Norway is investigated (Figures 1 and 2). The southern Farsund Basin has an E-trending shape. It is located to the north of the Norwegian-Danish basin and to the south of Eigerøy horst. The horst has a N-trending shape, and bordered the Varnes Graben and Agder horst, from west to east, respectively (Figure 1) (Christensen and Korstgård, 1994; Liboriussen et al., 1987). Farsund basin bordered the Stavanger platform from the west (Phillips et al., 2018).

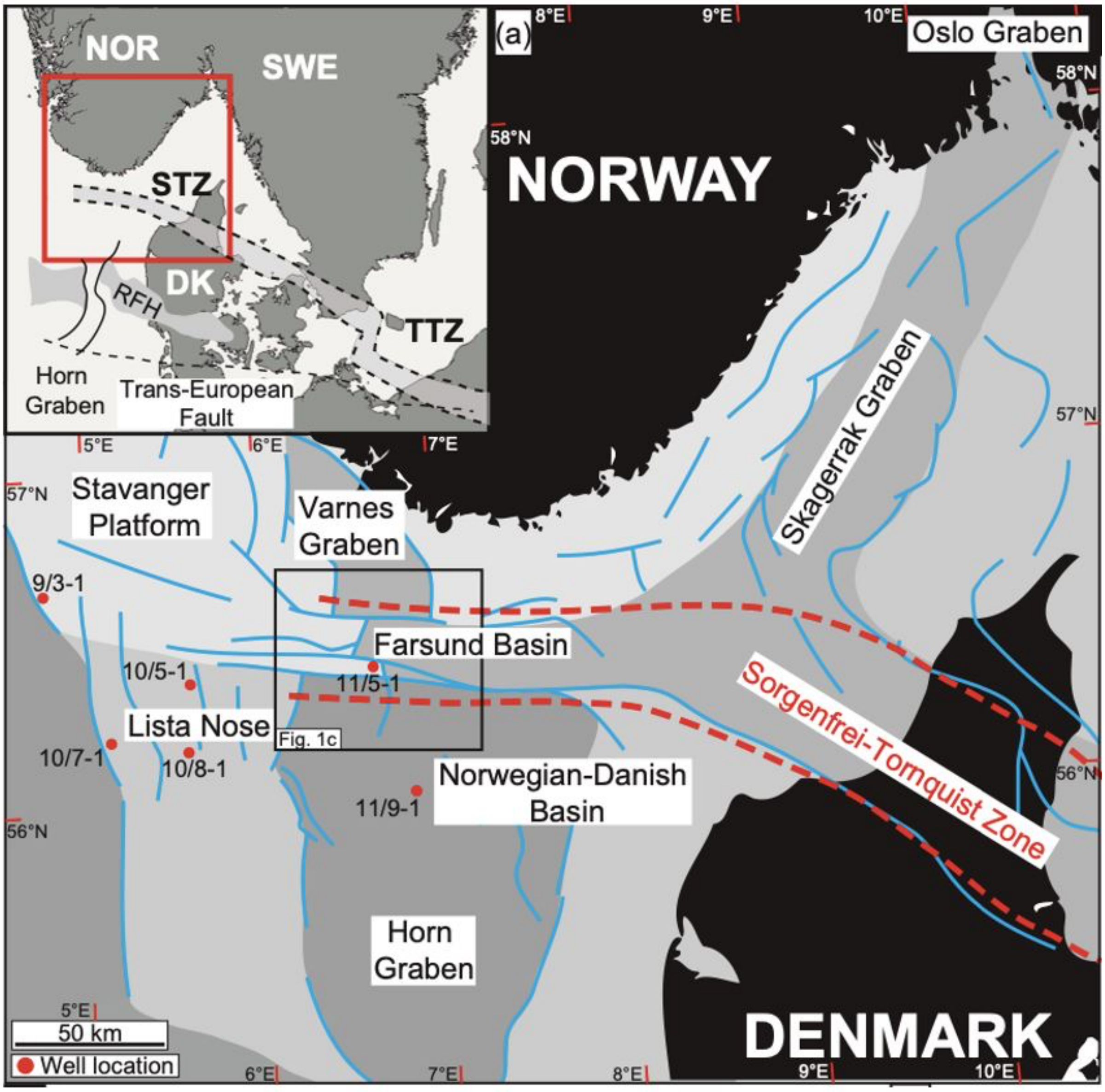


Figure 2: Regional map that showing the relation to the major structural elements and fault networks (Phillips et al, 2018).

N-dipping Fjerritslev Fault system defines the southern margin of the Farsund Basin, and this fault system consists of two parts, the Fjerritslev North Faults and the Fjerritslev South Faults (Red lines in figure 2). The northern margin of the Farsund basin is defined by E-W striking fault. In addition, across the southern margin of the basin presents a series of N-S striking faults (Figure 2).

N-S striking faults absents at shallower stratigraphic levels. Only E-W striking Fjerritslev north and South controlled the basin morphology (Philips et al., 2020).

3.1 Tectonic setting:

Carboniferous-Permian:

The North Sea area was tectonically active during Carboniferous-Permian, experiencing continental extension (Deeks and Thomas, 1995; Mogensen and Korstgård, 2003, Pedersen et al., 2018). Structural elements with N to S- strikes in the area such as Varnes and Skagerrak grabens were formed due to this Carboniferous-Permian extension. This event also affected the Norwegian-Danish and Egersund Basins (Figure 2) (Heermans et al., 2004; Lassen and Thybo, 2012; Philips et al., 2020).
The dominated strike system has a W to E-trending that was as a result of the Variscan orogenesis due to rift activity and voluminous magmatism (Malehmir et al., 2018).

Triassic:

The most important event during this period was the breakup of Pangaea (Bell et al., 2014). Thereby, occurred an E-W continental extension, leaded to the formation of a predominately N-S trending structures across the North Sea that were initiated during the late Permian (Bell et al., 2014; Færseth, 1996). During the Triassic the rifting event reached the Norwegian-Danish basin causing N-S striking normal faults (Philiips et al., 2018).

Late Jurassic-Early Cretaceous:

E-W striking normal faults occurred during this period due to a regional rift phase across the North Sea (Ziegler 1992; Færseth, 1996; Coward et al., 2003). One example of the faults developed in this event is the Farsund North Fault that define the present morphology of the basin (Figure 2) (Morgensen & Jensen 1994; Phillips et al. 2018).

Cretaceous:

The Alpine orogeny caused a horizontal shortening, thus several basins in the North Sea were inverted during Cretaceous (Biddle and Rudolph, 1998; Cartwright, 1989). This inversion was amplified along the upper-crustal expression of the Sorgenfrei-Tornquist Zone (STZ) (Thybo, 2000). The regional uplift affected the basins as well (Japsen et al., 2002; Jensen and Schmidt, 1993).

3.2 Regional stratigraphy:

Many studies describe part of the Permian succession as deposited in a non-marine environment across a big part of the North Sea (McMie & Williams 2009). Apart from Zechstein that deposited in a marine environment (McMie and Williams 2009). Below, a summary description of the upper Paleozoic stratigraphy of the area is provided (Figure 3).

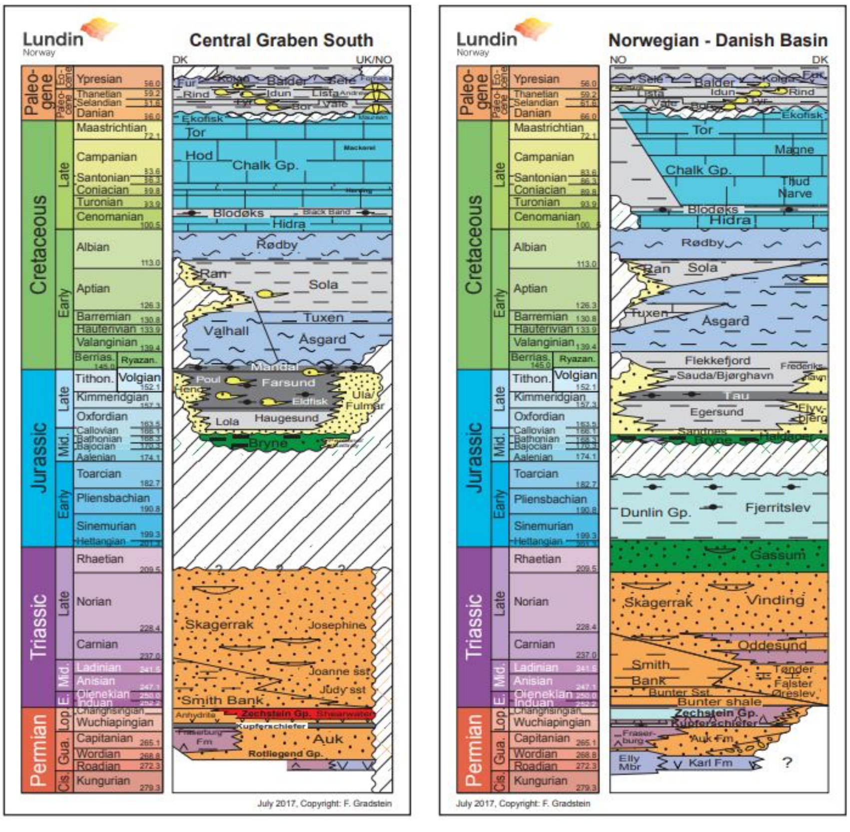


Figure 3: Stratigraphic chart (Gradstein, 2017).

Rotliegend Group- Permian:

During the early Permian time, reactivation of North-South extension and transtensional movement caused a crustal thinning. This movement was parallel to the Teisseyre-Tornquist Line (Gast, 2010). Related to this crustal thinning,

volcanic rocks were widespread formed in the North Sea (Glennie, 2003).
During the deposition of the Rotliegend Group, arid and semi-arid conditions prevailed in the region that has been drifted from southern to northern latitudes (Kombrink and Paruno, 2020). Due to this conditions, local alluvial and fluvial plain-related sand and conglomerates were deposited in the North Sea above the Caledonian mountain ranges (Glennie, 2003) (Figure 4).
Because of lack data from the deeply buried areas in the Northern Permian Basin, the extension of the Rotliegend Group is uncertain (Monaghan et al., 2019). The Permian Basins had not been affected by syntectonic deposition (Ziegler, 1990).

Zechstein Group-Late Permian:
In the late Permian time, marine transgression flooded the restricted Permian Basins (Kombirink and Patruno, 2020). This happened most likely because of melting of the Gondwana ice cap and further regional subsidence (Glennie, 2003). Four to Five evaporates cycles deposited due to periodical marine transgressions, ended to carbonate sequences, halite and anhydrites (Peryt, 2010).

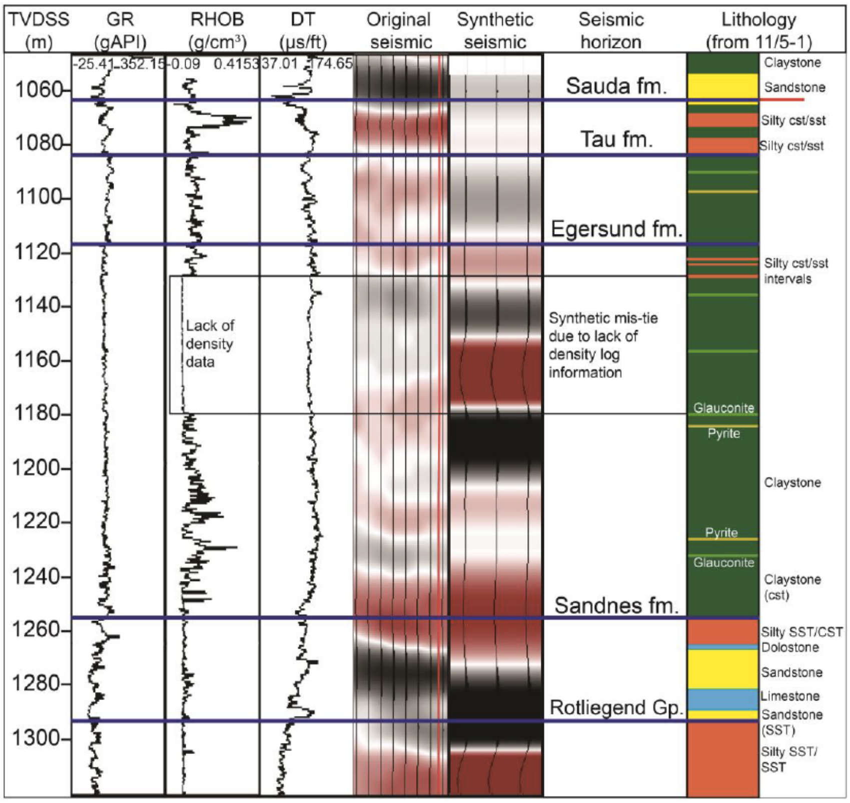


Figure 4: Lithostratigraphy in well 11/5-1 (Phillips et al., 2020).

4.0 DATA AND METHODS:

In this study both 2D and 3D seismic data and well logs from the Norwegian petroleum database Diskos have been used (Figure 5). The 3D seismic survey covers the southern part of the Farsund basin (Figure 5). Two 2D seismic lines covering a more extensive area were selected to have an overview of the main regional structures (Figure 5). Generally, the quality of the seismic data was medium to good for the upper Paleozoic and the top of the basement, the frequencies varies between 10 – 50 Hz. The seismic data has a normal polarity. Well tops from the Norwegian Petroleum Directorate (NPD) were used in this study. Seismic interpretation and map generation was done using Petrel 2020. In order to perform well correlation and generate synthetic seismogram I use 11/5-1 and 10/5-1.

The methodology in this study consists in performing the seismic interpretation of horizons and faults. The horizons that are mapped are the Top of the basement, the top and the base of the Rotliegend Group the top of the Zechstein Group. Thus, four seismic units are interpreted: The basement, the pre-Rotliegend Group, the Rotliegend Group and the Zechstein Group. Seismic-facies and reflection terminations are described for each seismic unit. In addition, four time structural maps, for each mapped horizon, are created to show the upper Paleozoic structural elements. Three time thickness maps are created to determine the variation of the present day thickness and to describe the depocenters within the Pre-Rotliegend Group, Rotliegend Group and the Zechstein Group across the study area. Well logs are used to interpret the lithology, thickness of the packages, and define the depth of the sandstone (Potential reservoir) in the well, and the lateral and vertical variation of the different units.

Three time thickness maps are used to determine the variation of thickness and to describe the depocenters within the Rotliegend GP and the Zechstein Formation across the study area.

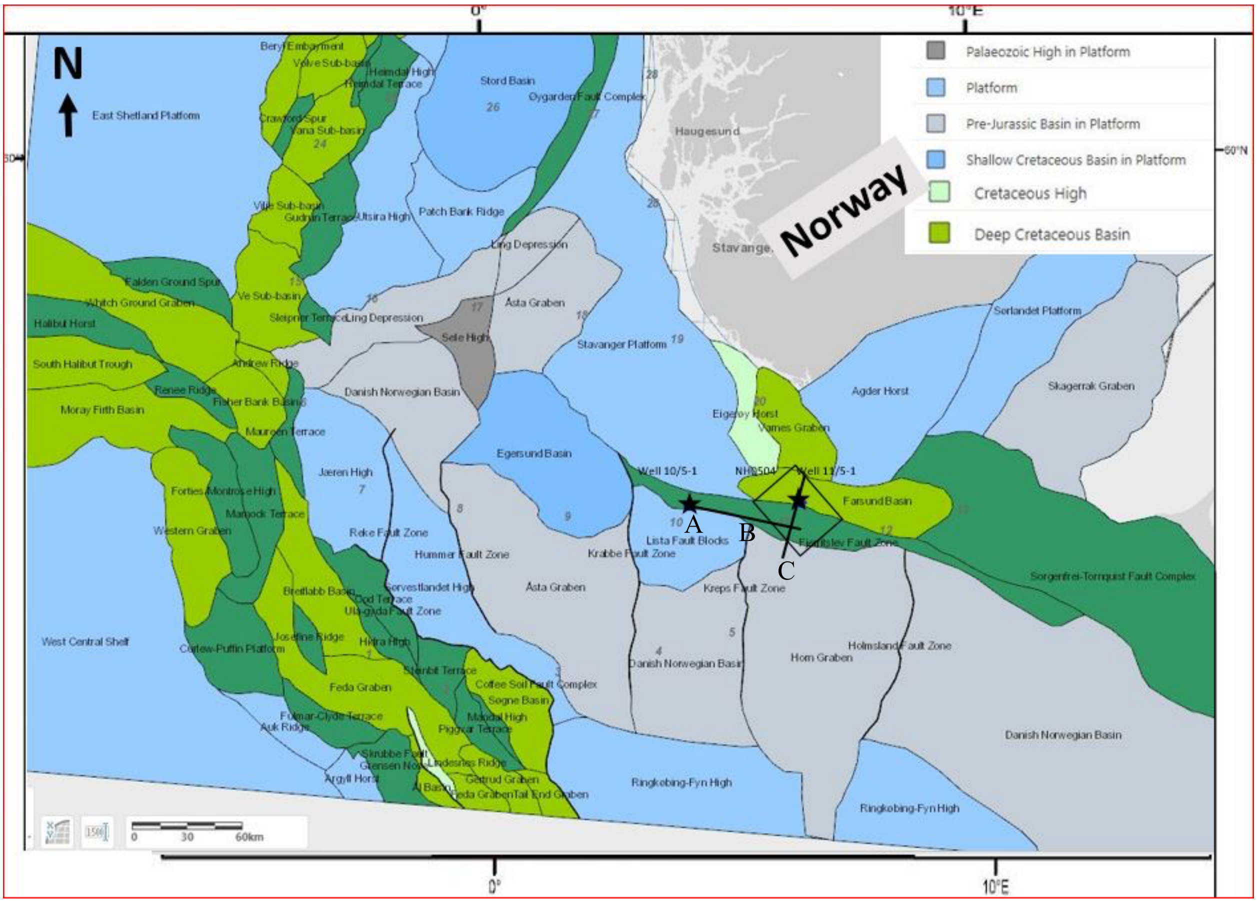


Figure 5: Dataset used in this study. The 3D survey is shown as a black polygon, 2D lines as black lines and wells as black stars (Structural elements from NPD, 2021).

4.1 Seismic resolution:

The target succession is located at depths between 1300 to 4000 TWT. The dominated frequency in the Rotliegend GP was 30 Hz. Thus the seismic resolution at the interval of interest is:

P $\Delta z = \frac{\frac{4154\frac{m}{s}}{30\ Hz}}{4}$ = 34.61 meters for Rotliegend GP.

Top Basement:

The Basement Top represented by a weak trough reflector along the most part of the study area. With some challenges to determine the precise location in some places.

Top Rotliegend Group:

The Rotliegend Group represented by a strong amplitude peak reflector. Generally, the amplitude was strong along the whole area with some exceptions of low to very low amplitude contrasts. The reflector was continuous in most areas of the dataset.

Top of Zechstein Group:

The Zechstein Group represented by a variant amplitude trough reflector. The amplitude of the horizon varies through the study area from weak to strong. The lithology of this group defined to be consisted of salt basically. As a conclusion the movement of the salt can be a reason of a tectonic pulses, differential loading or a combination of both.

4.2 Seismic well Tie:

In order to make the well tie, a synthetic seismogram was generated. The wells available in the study area are 11/5-1 and 10/5-1. And the distance between them about 91 km. No bulk shift was applied to the seismograms. Ricker wavelet was used in both wells (Figures 6 and 7).

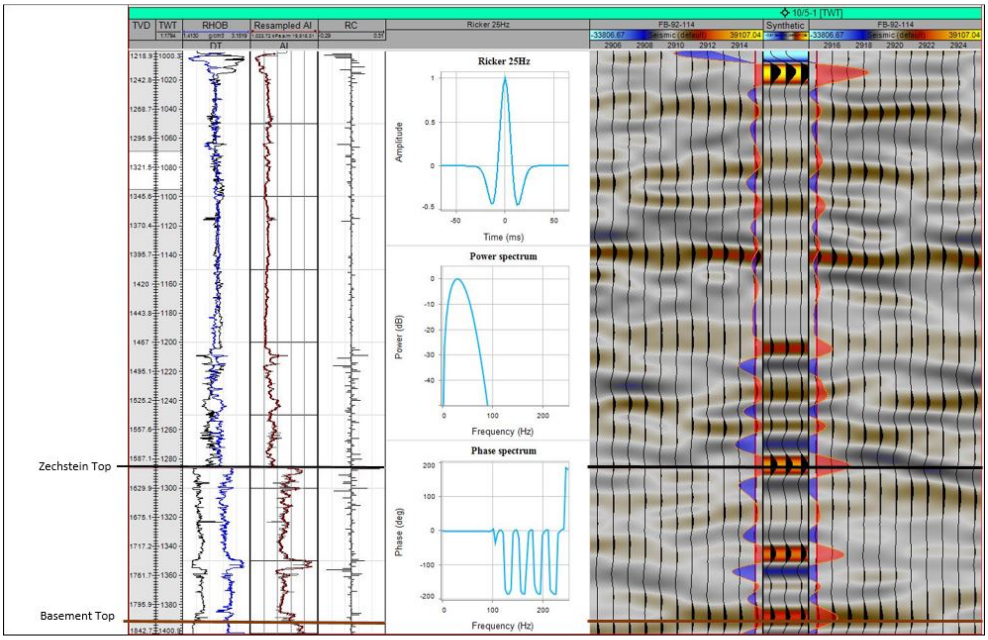


Figure 6: shows the synthetic seismogram and the Ricker wavelet in well 10/5-1.

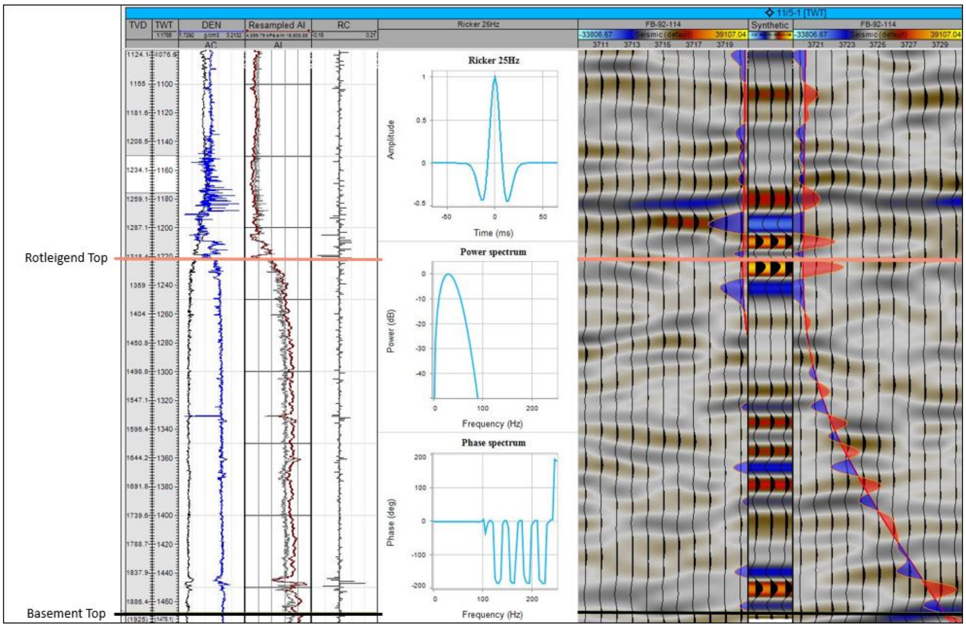


Figure 7: shows the synthetic seismogram and the Ricker wavelet in well 11/5-1.

5.0 Results:

5.1 Well correlation:

Observations:

The well log correlation was done for two wells 11/5-1 and 10/5-1 (location in Figure 1). Well 11/5-1 is located within the 3D seismic survey, well 10/5-1 crosses one of the 2D seismic lines. Well 11/5-1 penetrated the basement at 1920 m, followed by the Paleozoic Rotliegend Group at 1322 m and Callovian Sandstones Formation. The well did not penetrated the Pre-Rotliegend succession nor the Zechstein Group (Figure 8). Well 10/5-1 penetrated the Basement at 1818 m, followed by the Zechstein Group at 1597. This did not penetrate the Pre.Rotliegend succession nor the Rotliegend Group (NPD, 2021).

The penetrated part of the Basement in well 11/5-1 is about 20 m. While in well 10/5-1 the penetrated part of the basement is more than 40 m. GR values varies between the wells indicating deferent components for the Basement in the wells (Figure 8).
The Rotliegend Group in well 11/5-1 has different values of GR, there are five packages with low GR values indicating bell cylinder shapes sandstones (light yellow intervals in Figure 8), and the rest of the Group has a heterolithic character indicating thin intervals of shales.

In well 10/5-1 the Rotliegend Group is absent. In this well the Zechstein Group overlays the basement. The lowest part of the Zechstein Group has high GR values. The rest of Zechstein Group has a relatively low GR values, but the GR values can have some variations.
The thickness of the Permian succession (Rotliegend Group in well 11/5-1 & Zechstein Group in well 10/5-1) in well 11/5-1 is about 590 m, but in the well 10/5-1 it is only 210 m.

Interpretation:
The big contrast in the components of the two wells and the different groups that form the Permian succession can be a result of the big distance between the wells (about 91 km). The heterolytic character of the GR log in the Rotliegend Group indicates a heterolithic succession, with some packages of cleaner sandstone (Figure 8). The high GR values at the base of the Zechstein Group, could indicate that the organic-rich Kupferschiefer Formation is present in this well, although it has not been reported by the NPD. The variation in the GR values within Zechstein Group, cloud indicate a variation in the lithology and that it is not only composed of halite, the normally has low GR values (Ziegler, 1992).

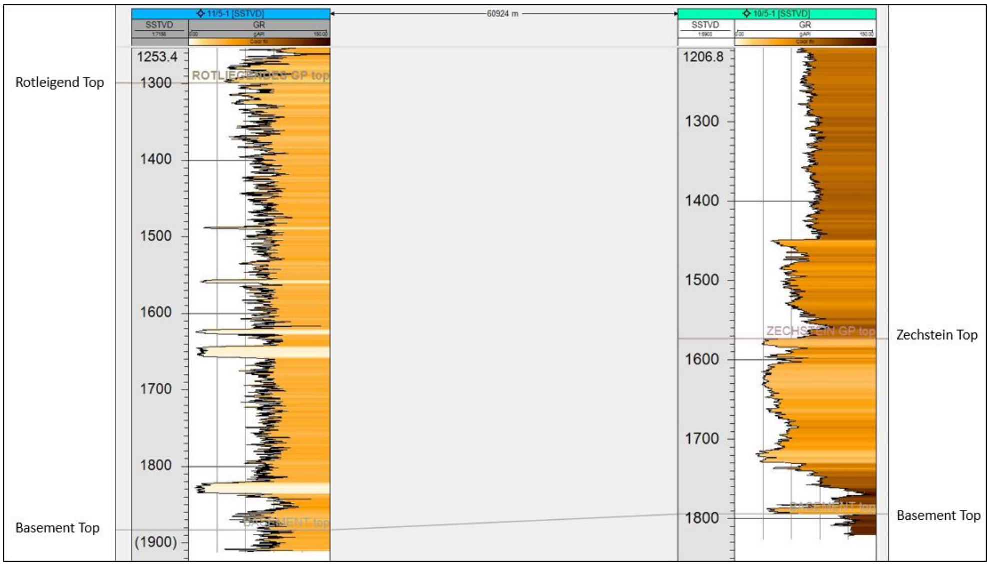


Figure 8: GR logs for the wells in the study area.

5.2 Seismic Interpretation:

General structure of the Farsund Basin:

The seismic line in figure 9 to 18 shows the structure of the study area. The top of the Basement marked in green, the base of the Rotliegend marked in red, the Rotliegend Top marked in blue, and the Zechstein top marked in yellow.
The Zechstein Group absence in well 11/5-1, due to erosion and uplift in the Farsund basin. And the Rotliegend Group absence in well 10/5-1 due to uplift in the area.

5.2.1 The Basement:

Seismic character:

The top of the Basement is a low amplitude reflector. The seismic facies observed are subparallel reflectors with low amplitude.

Structural elements:

The upper boundary of the Basement is deepening from west to east in the Farsund Basin (Figure 24). The faults that affected the Basement are normal faults. In the inline cross section (Figure 17) we can observe a horst in the central part of the section. In the east part of the study area the Basement shallower than the western part.

5.2.2 Pre-Rotliegend succession:

Seismic character:

The top of the Pre-Rotliegend is a low to medium reflector. The main seismic facies observed within this unit are wedges (Figure 15). The rest of the study area has subparallel medium amplitude reflectors (Figure 9, 11 and 13). There is not well control for this succession in the area, but based on the regional geology and seismic character it is possible that this succession is composed of Carboniferous/Devonian? Sedimentary rocks (Rodriguez, 2020).

Structural elements:

The upper boundary of the Pre-Rotliegend is deepening toward the northeast part of the study area affected by normal faults (Figure 23). This unit absence in the wells in the study area. This absence and the thickness variation (Figure 27) in this unit indicates fault activity. The depositional environment in this unit is marine environment. An example of the absence in this unit can be recognized in figure 15. Generally, the thickness increases towards the east part of the study area.

5.2.3 Rotliegend Group:

Seismic character:

The top of Rotliegend has medium to high amplitude and the internal character of this group consists of subparallel reflector with low amplitude. Onlaps presented adjacent the well 11/5-1 in east part (Figure 17).

Structural elements:

The upper boundary of the Rotliegend Group is deepening toward the east part of the study area (Figure 22). The Rotliegend Group is present in the entire study area, and relatively constant thickness was observed. Minor variations were observed at (Figure 26). Indicating a continental depositional environment. Relatively constant thickness indicate a tectonic quiescent period during the deposition of this Group.

5.2.4 Zechstein Group:

Seismic character:

The top of Zechstein Group is characterized by a low to medium amplitude reflector. The main seismic facies observed within this group is wedges and diapirs (Figure 17). The rest of the study area has subparallel reflectors with high to medium amplitude.

Structural elements:

The upper boundary of the Zechstein Group is deepening toward the east part of the study area (Figure 21). The Zechstein Group presented in a wide part of the study area. With absence in deposition in the central part of the study area and in the position of well 11/5-1 (Figure 16 and 18). We can observe that the Zechstein Group has diapir in the east part of the study area indicates the salt continent, while in the west part of the study area the group characterized in relatively constant values in thickness with some anomalies (Figure 9, 11 and 13). The big values in thickness variation can be either due to fault activity during the deposition time, or due to the variation in the components of this group, or due to the compaction of the upper units on this group. This indicate that the group deposited in a marine environment and during an active tectonic period.

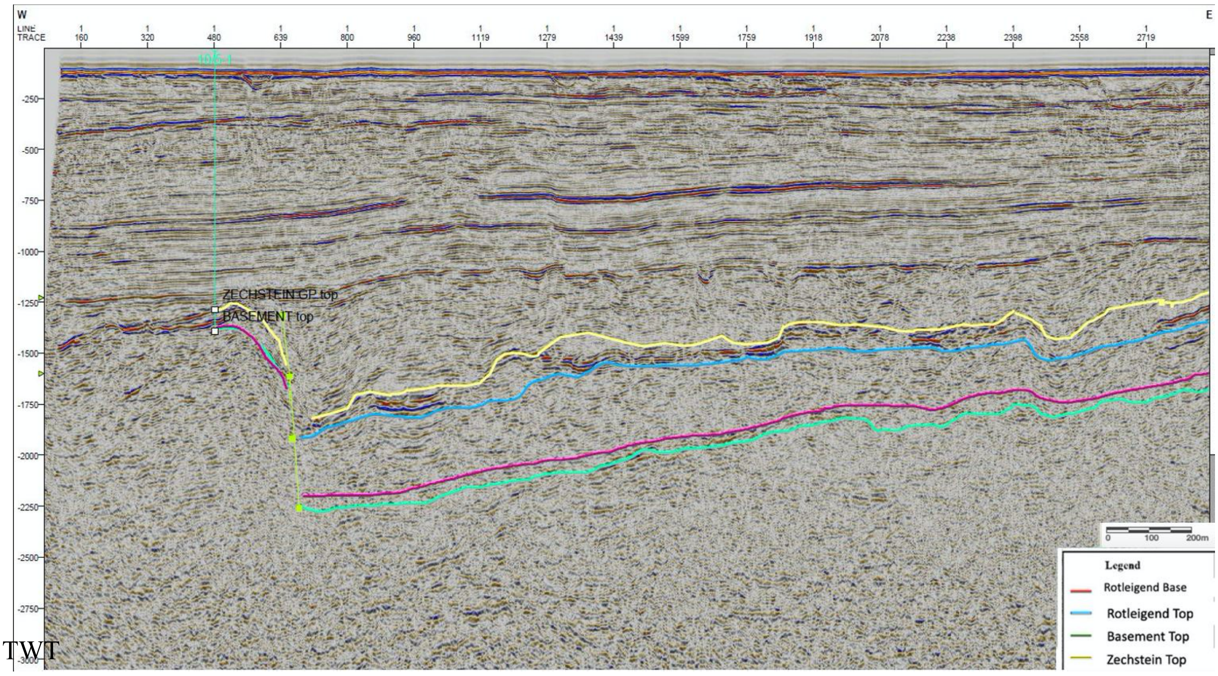


Figure 9 shows the first part of the study area (AA´) that had been covered by the 2D studies. (Location in figure 5)

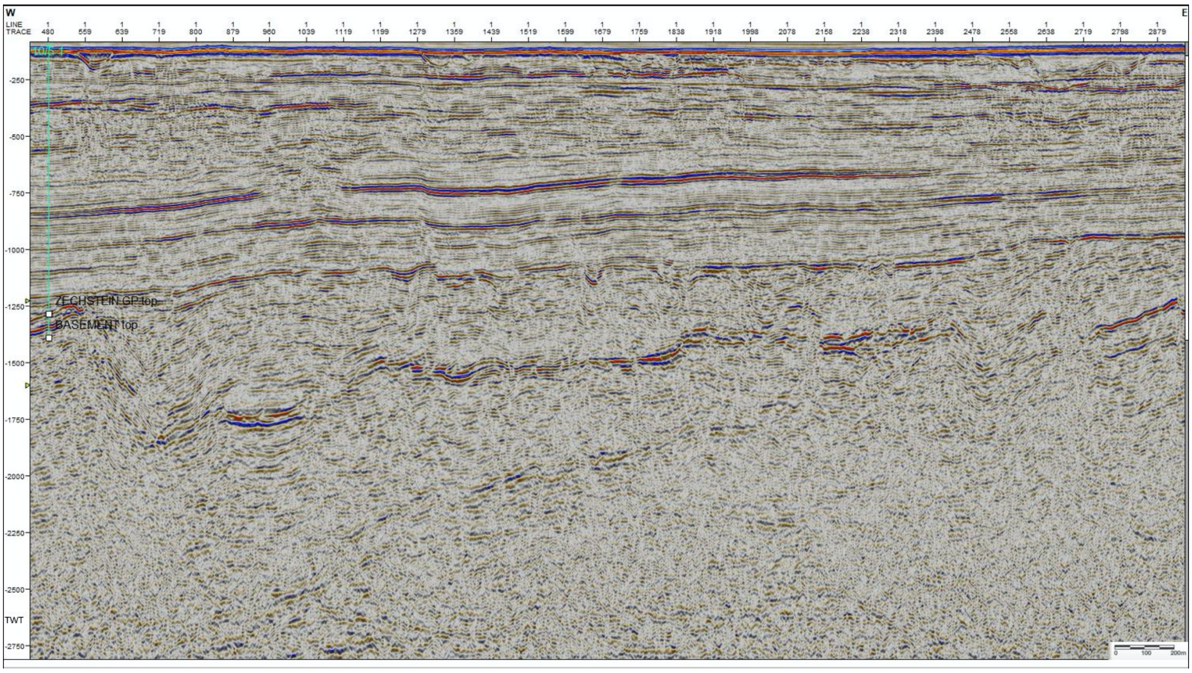


Figure 10 shows the same area in figure 10 without interpreting.

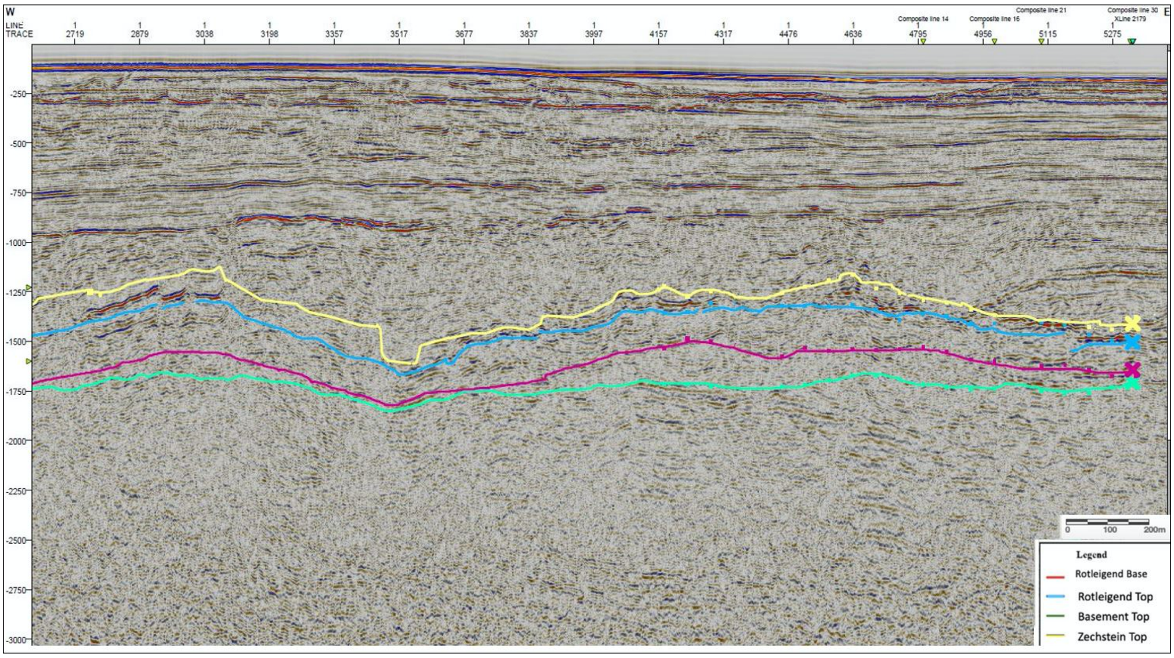


Figure 11 shows the second part of the study area (BB') that had been covered by the 2D studies. (Location in figure 5)

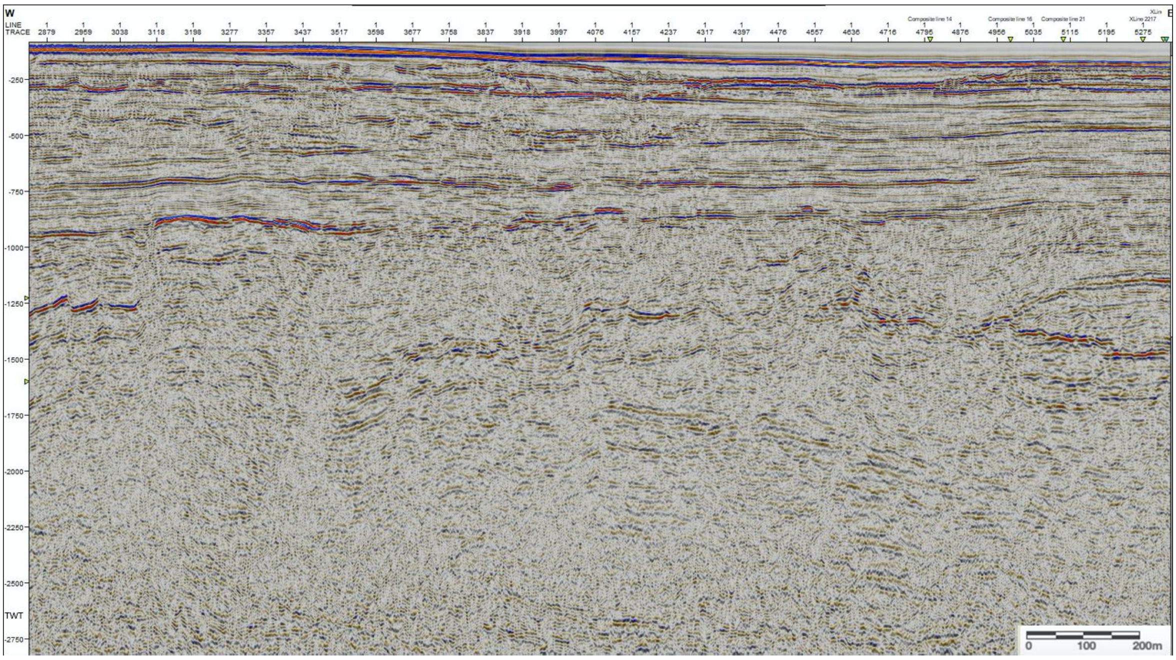


Figure 12 shows the same area in figure 12 without interpreting.

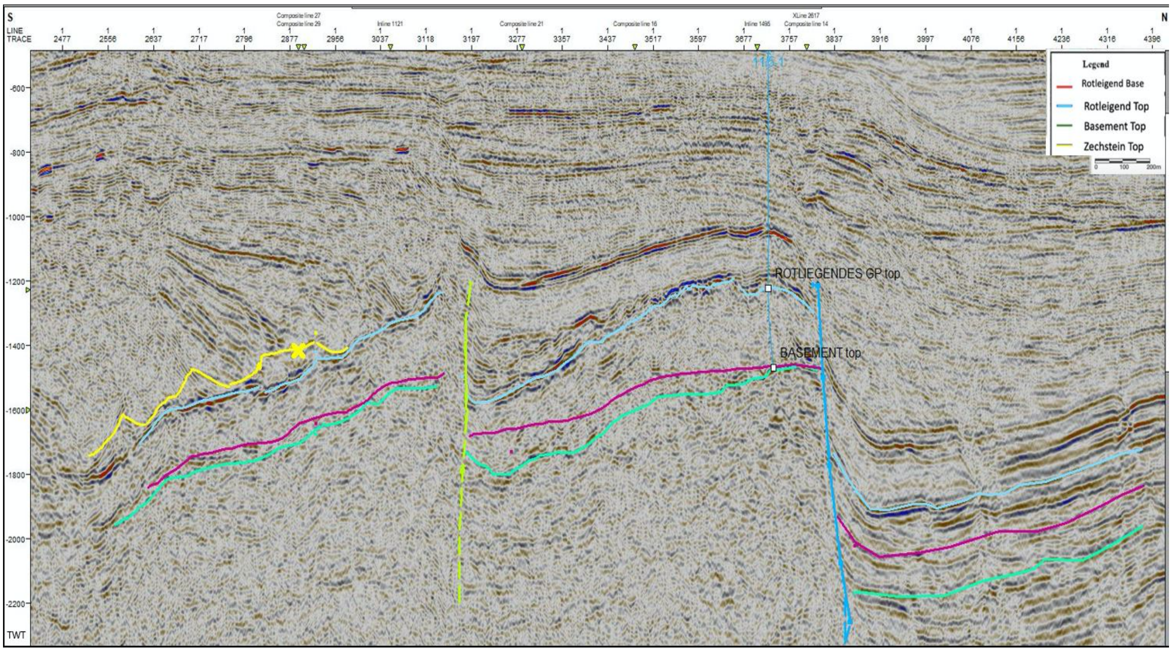


Figure 13 Shows the third part of the study area (CC') that had been covered by the 2D studies. (Location in figure 5)

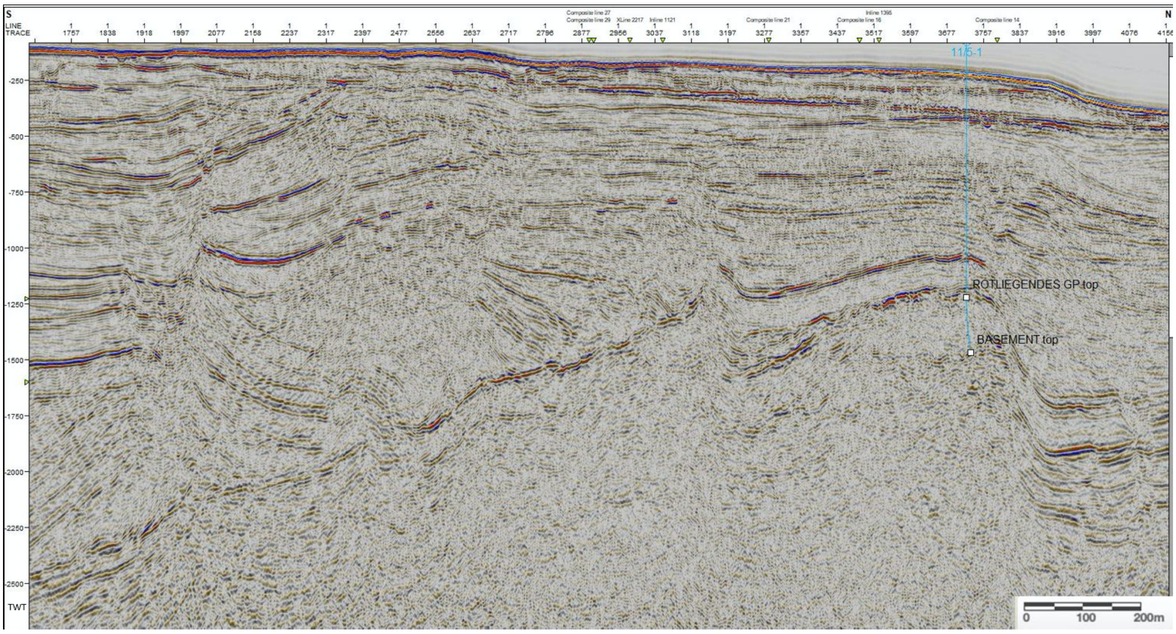


Figure 14 shows the same area in figure 14 without interpreting.

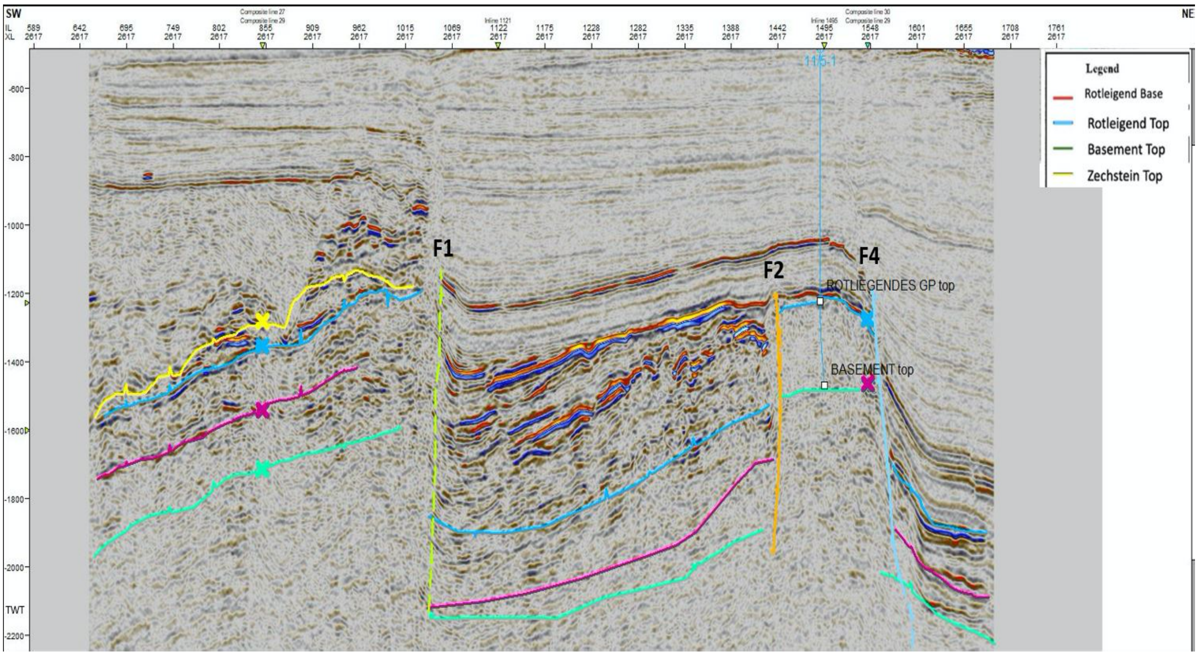


Figure 15 shows a structural map crossing the well 11/5-1 by the 3D survey in the study area. (Location in figure 5).

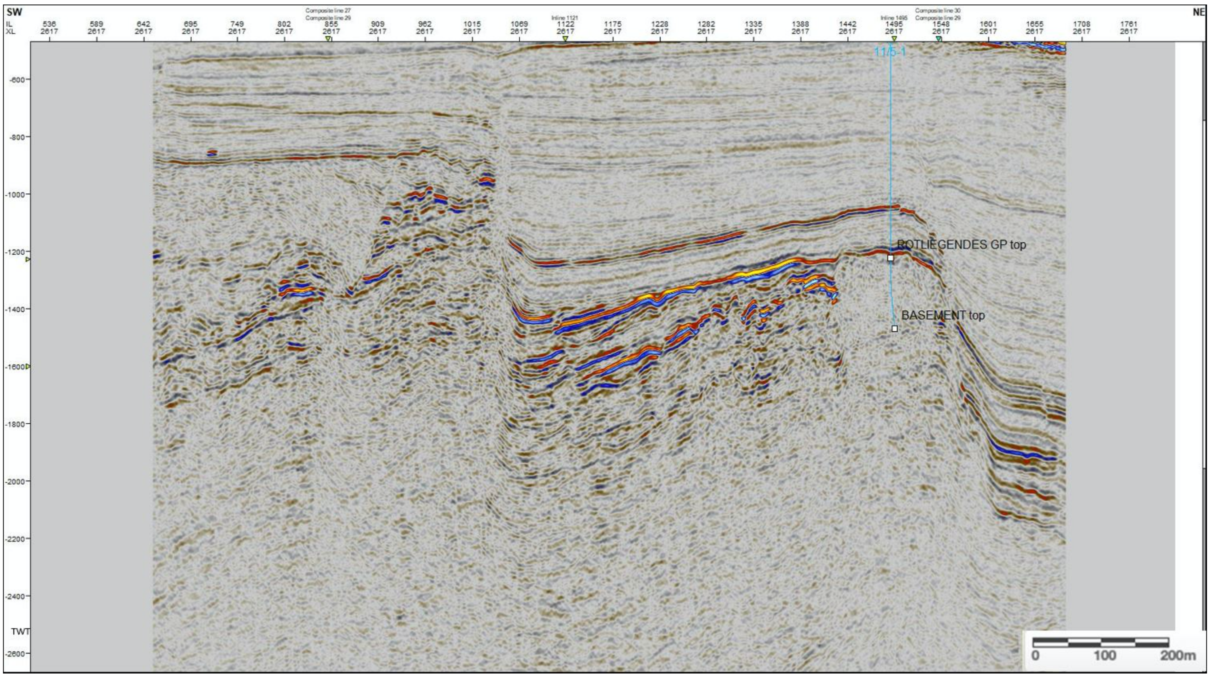


Figure 16 shows the same area in figure 16 without interpreting.

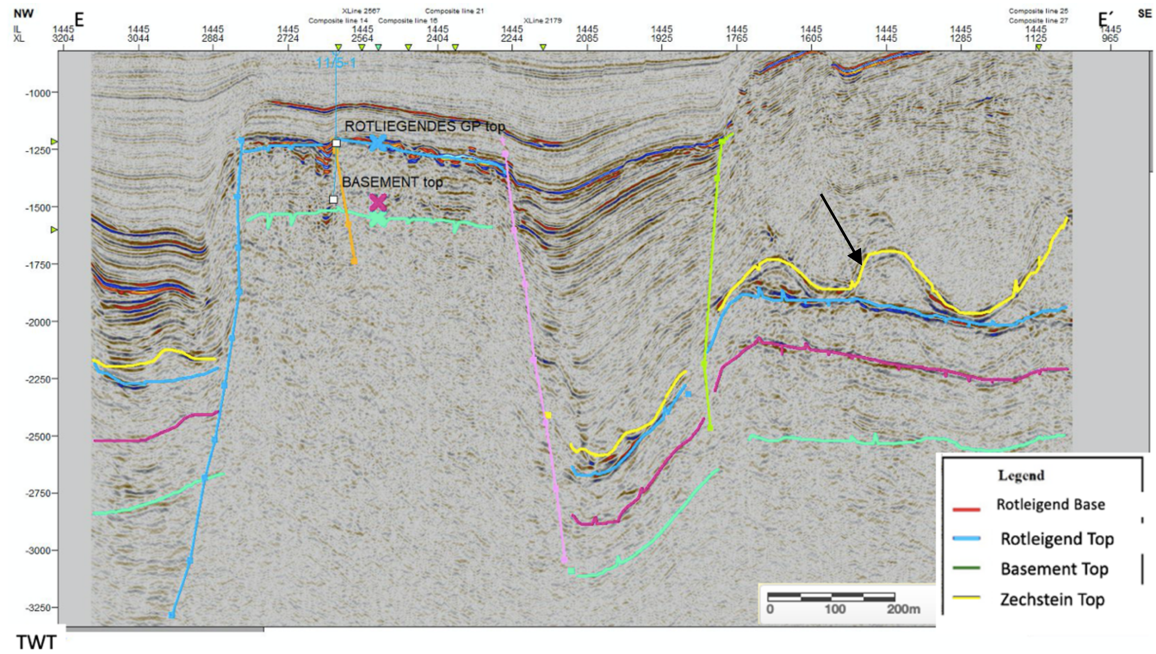


Figure 17 shows a structural map crossing the well 11/5-1 by the 3D survey in the study area. (Location in figure 5). Black arrow shows the diapir shape of the Zechstein Group in this area.

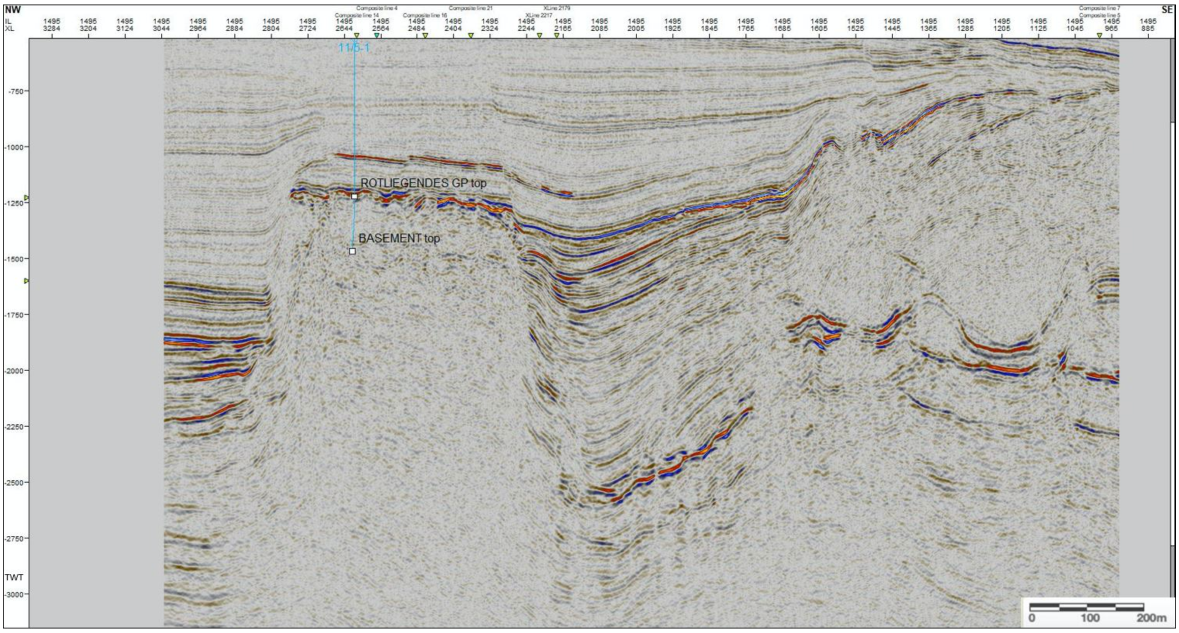


Figure 18 shows the same area in figure 18 without interpreting.

5.3 Faults:

Observation:

Different normal faults have been observed in the study area, F1, F2, and F4 in (Figure 19 and 15). These faults offset all the interpreted units from the Basement to the Rotliegend and Zechstein groups. The faults have both a planar and a more curved fault planes. The fault F1 observed in the south-western part of the study area, F3 fault located in the north-eastern part of the study area (Figure 19). Faults F1, F3, F4 and F5 has an E-W strike (Figure 19).

Wedges in Zechstein group have been observed (Figure 18).

Interpretation:

The faults interpreted to be active during deposition of the Zechstein Group, due to the observed wedges in those formations. The thickness of the Rotliegend group is almost constant along the study area and that refers to a quite tectonic activities during the depositions of this Group. The curved fault plane of F4 can be interpreted as a listric fault.

In order to get best results of the faults interpretation, Variance attribute map have been generated using Petrel (Figure 20, 21).

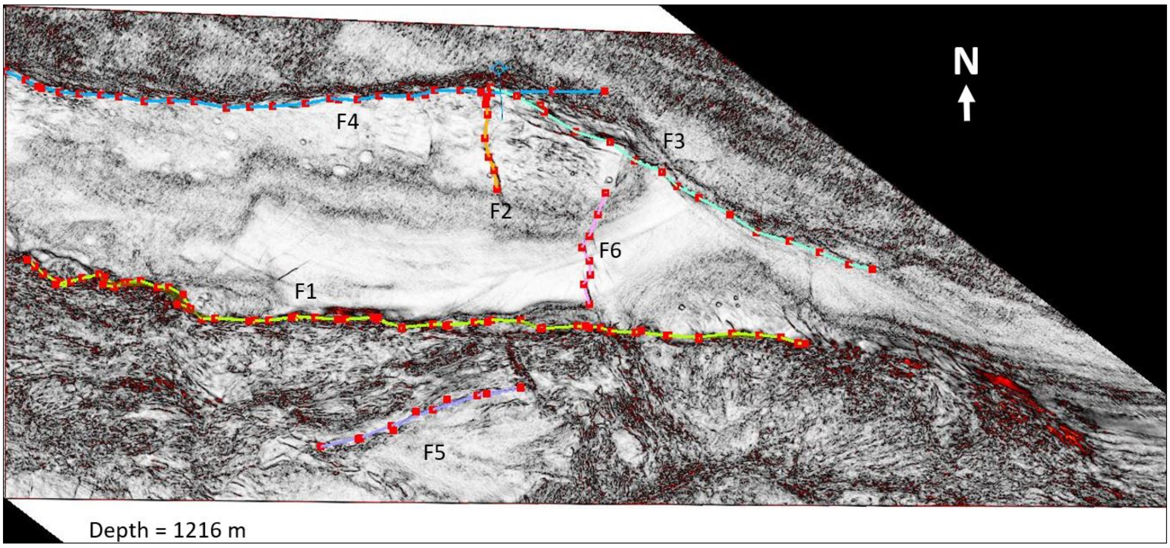


Figure 19: Shows the variance attribute map in the study area.

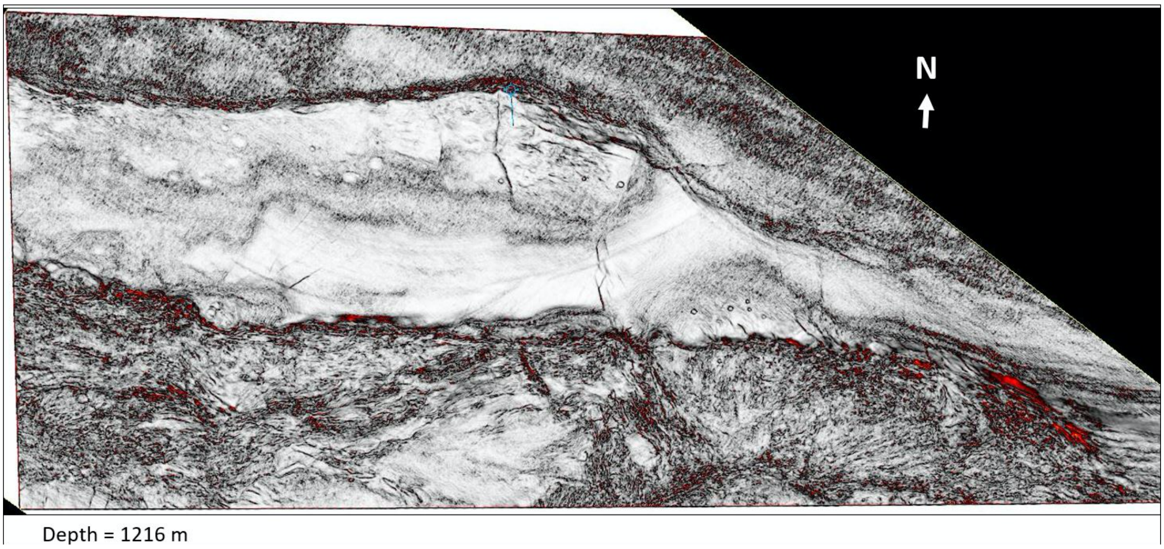


Figure 20: Shows the variance attribute map in the study area not interpreted.

5.4 Time structural maps:

Observation:

The structural map for Rotliegend-Base in TWT (ms) (Figure 24), the main structures are similar in the all units in the study area.

The structural map for Rotliegend Group top in TWT (ms) is shown in (Figure 23). The depth variations and the main structures of the Rotliegend Group are very different from the Zechstein Group, but quite similar to the elevation for Rotliegend Base and the Basement Top (Figure 24 and 25). The depth decreases toward the centre of the basin.

The two major normal faults that offset this formation has E-W trending. The third fault has S-N trending.

The time structural map for Zechstein group in TWT (ms) is shown in Figure 22. The middle part of the map is empty because this Group is absence in this part. The elevation has a big variation based on the components of the formation. The highs consist of salt basically, while the rest of the group consists of a combination of salt and shale and other components supported by the GR log variations.

Interpretation:

The absence of the Zechstein group in the central part of the study area in figure 22, can be interpreted to be a result of an uplift during the deposition of Zechstein Group in this part of the study area. The big variation of the components in Zechstein group can reflect the variations in the elevation of the group in the study area, where it consists of salt in the part of diapir shape (Black arrow in figure 17). While the shale dominated in the western part of the study area (Figure 9, 11 and 13).

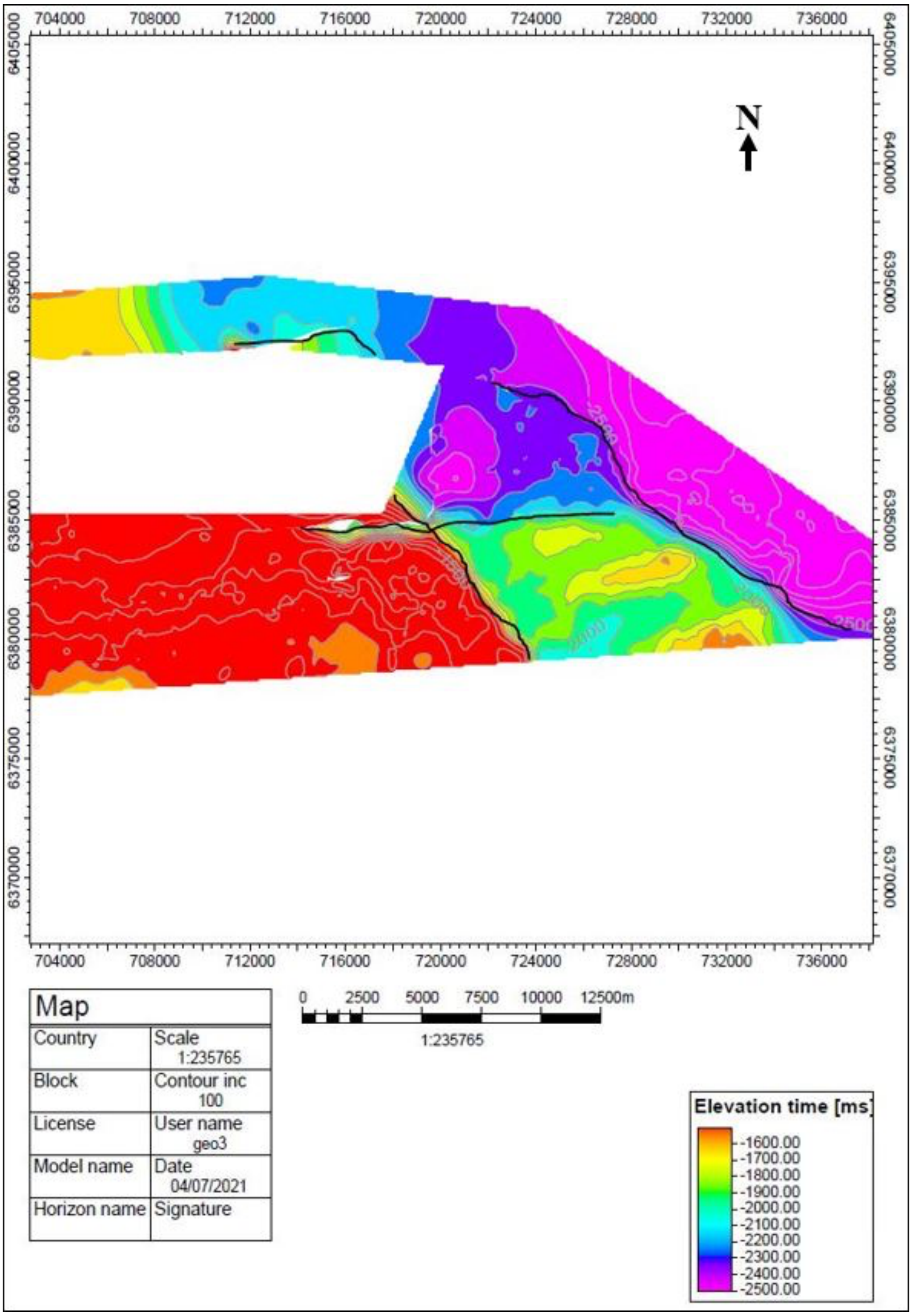


Figure 21: Time structural map of the top of the Zechstein Group. The white polygons represents the area where the Zechstein Group is abscent.

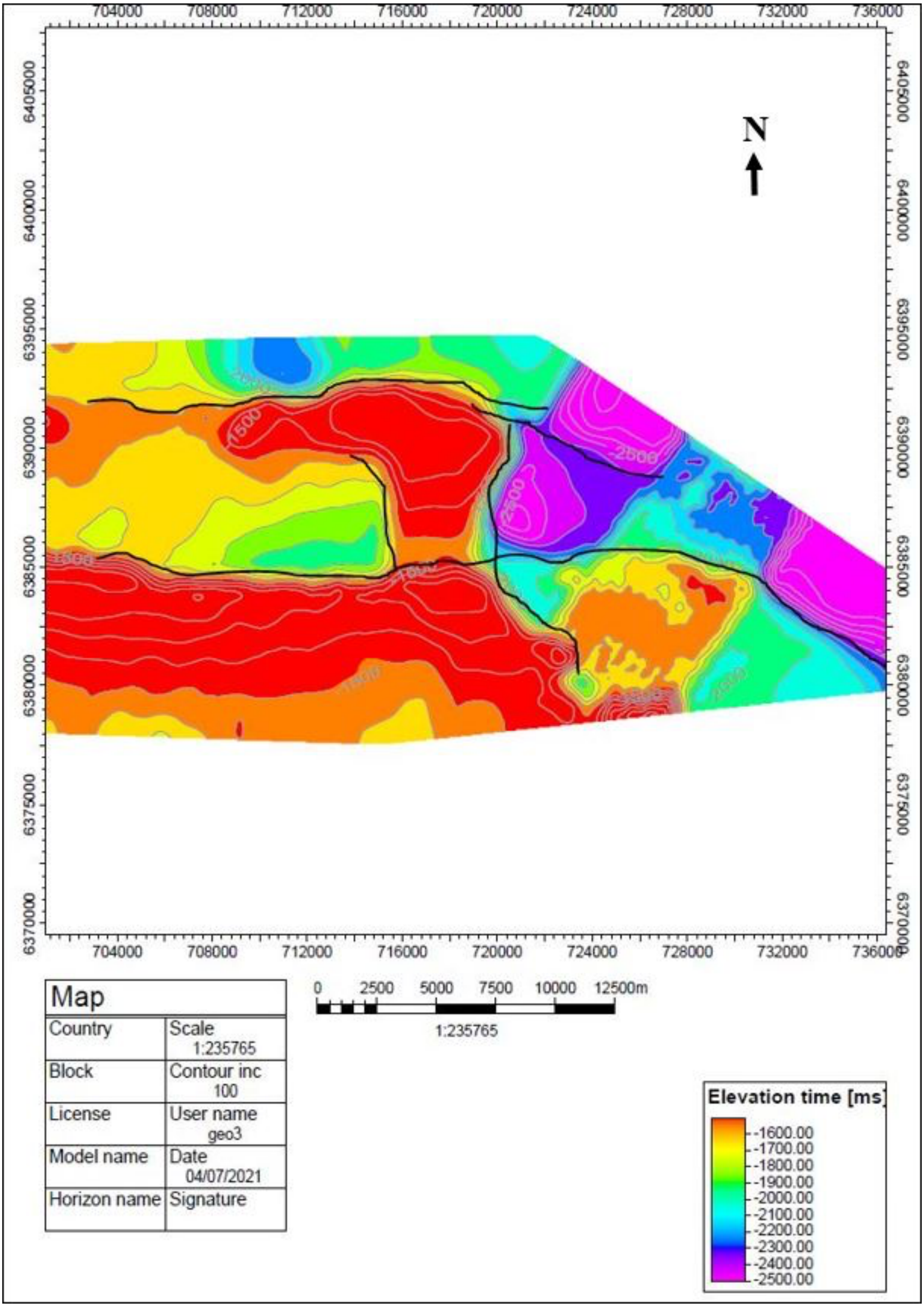


Figure 22: Time structural map of the top of the Rotliegend Group.

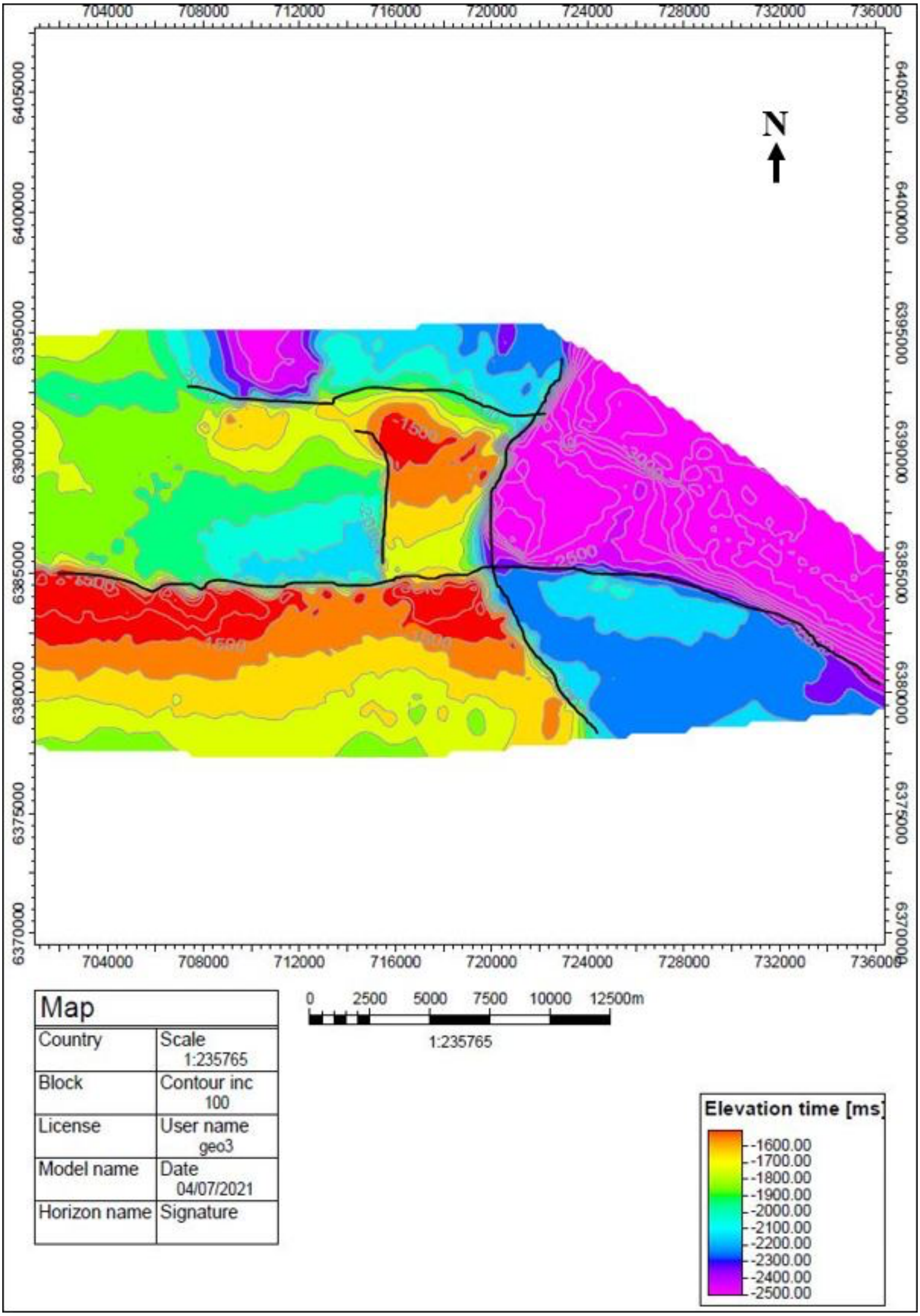


Figure 23: Time structural map of the Base of the Rotliegend Group.

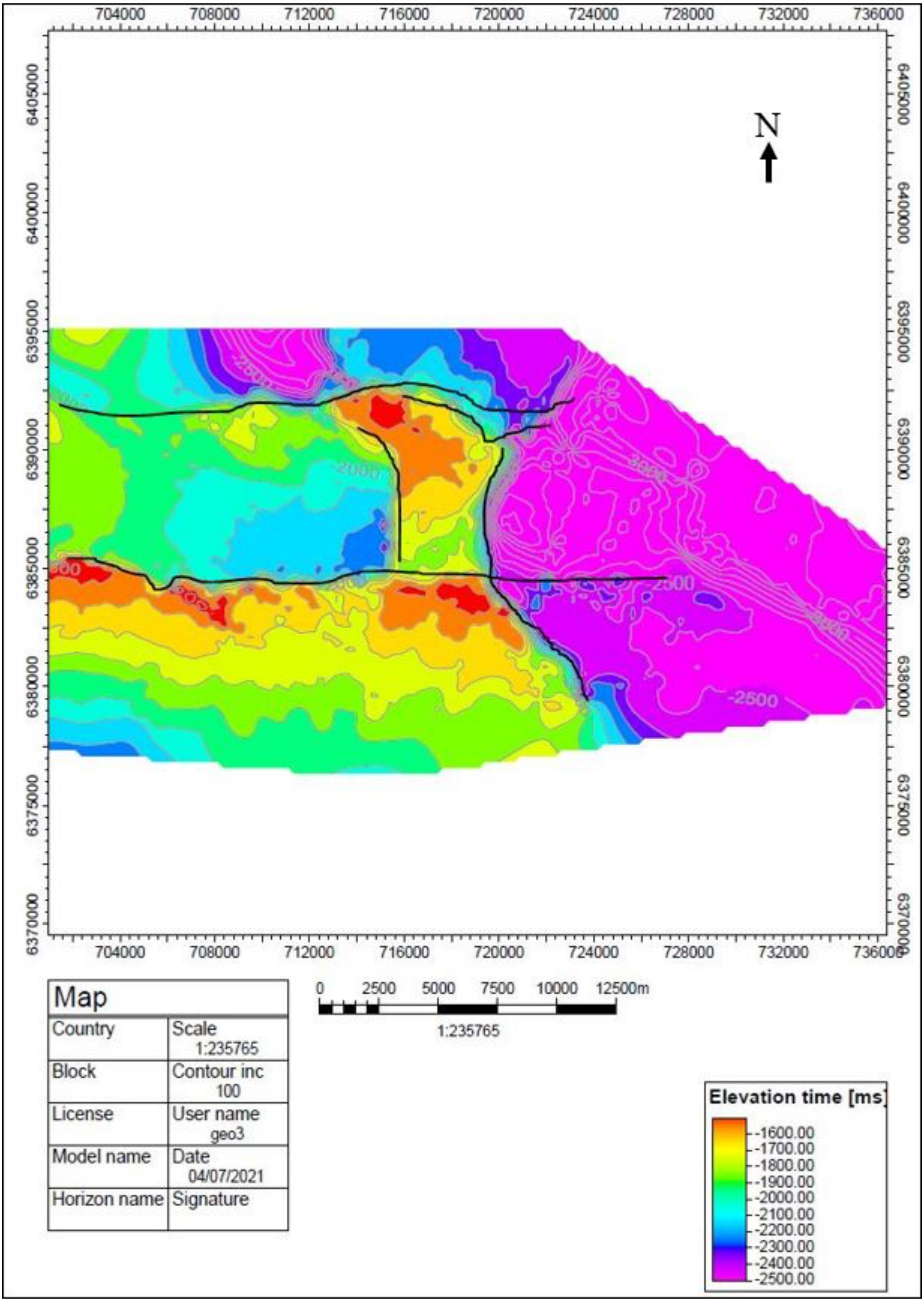


Figure 24: Time structural map of the top of the Basement.

5.5 Time Thickness maps:

Observation:

The Time Thickness map of the Zechstein group (Figure 25) shows that there is less variation in thickness on the south part of the study area. The depocenter located to the east of the Time Thickness map. The thickness varies from 0 to 500 ms (TWT).

Time thickness of the Rotliegend group (Figure 26) shows a quite similar thickness in the entire study area. The east part of the map shows higher values of the thickness in the study area. The thickness varies from 250 to 500 ms (TWT).

Time thickness of the Pre-Rotliegend Group (Figure 27) shows constant variations in the west part of the study area ca 500 m. and relatively constent values in the eastern part ca 250 m, This variation associated to a fault that can indicate fault activity before the deposition of Rotliegend.

Interpretation:

The difference in thickness variation in Zechstein formation in the study area can be interpreted to be a result of fault activity in the study area or due to the variation of the components of the formation, where it consists of salt in the diapir shape, and shale in the rest area (Figure 23). Another reason back these variations can be the Post-depositional movements of the salt. So long there are some wedges founded in this group, then this variation can be interpreted to be a result of the fault activity during the deposition of this group.
The reason back the absence in Zechstein Formation in a big part of the area can be a result of an erosion or uplift in the area.

The similar values of thickness in Rotliegend Group suggest that this group was deposited during a quiescent period.

The variations in the Pre-Rotliegend thickness can be interpreted to be a result to fault activity in the area.

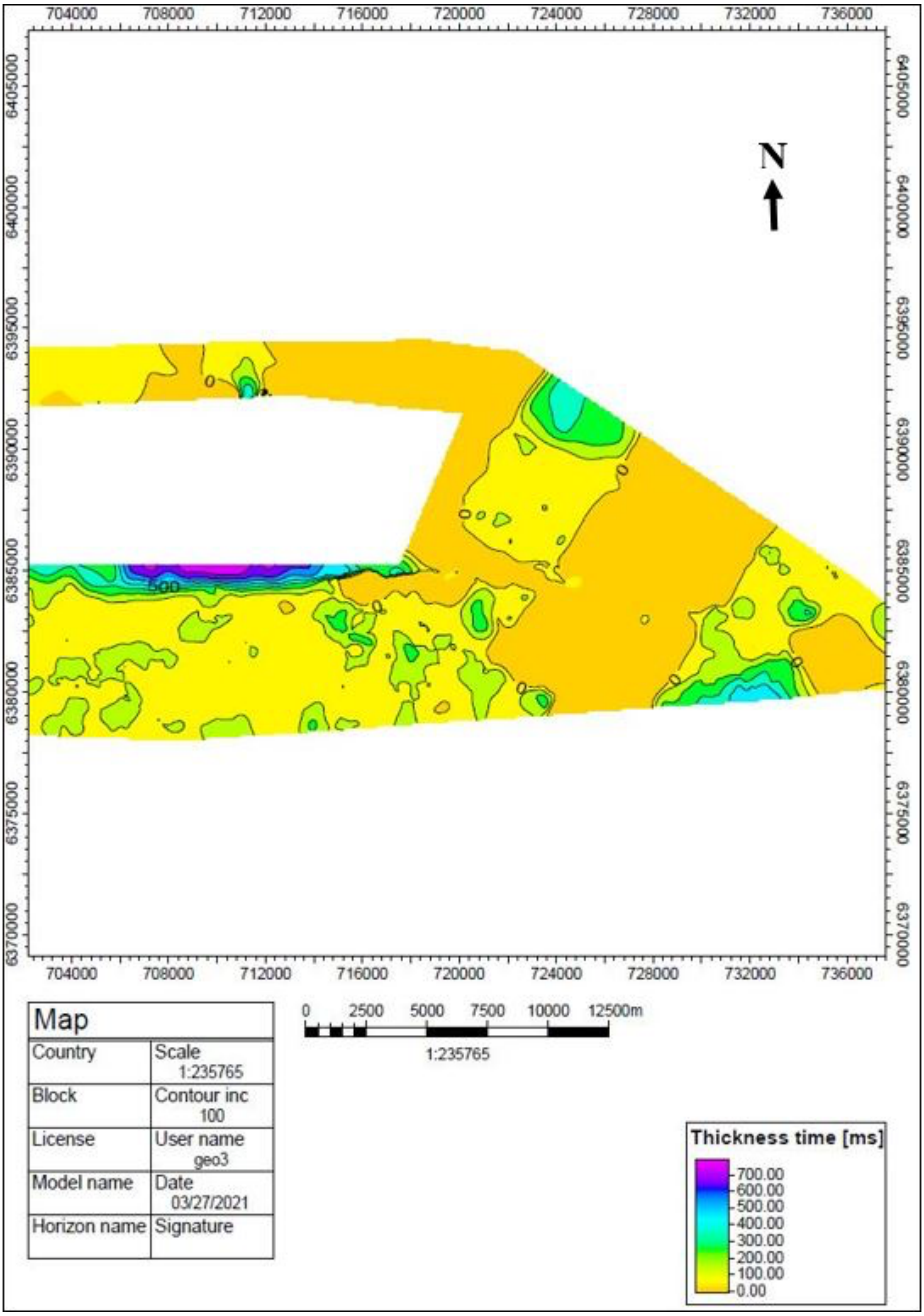
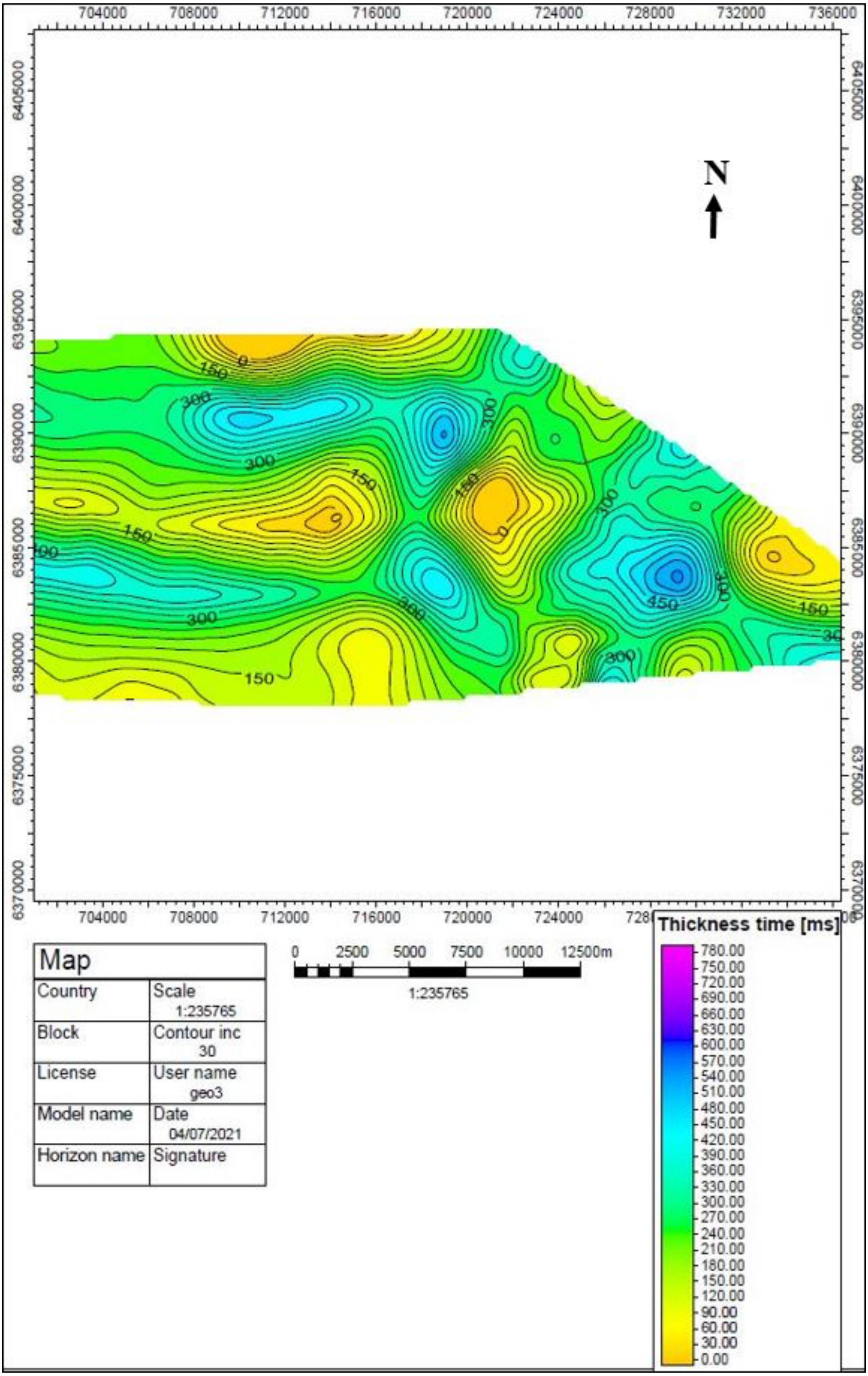


Figure 25: Time thickness map of the Zechstein group.



N
Thickness time [ms]
780.00
750.00
720.00
690.00
660.00
630.00
600.00
570.00
540.00
510.00
480.00
450.00
420.00
390.00
360.00
330.00
300.00
270.00
240.00
210.00
180.00
150.00
120.00
90.00
60.00
30.00
0.00
0 2500 5000 7500 10000 12500m
1:235765
Map
Country
Scale 1:235765
Block
Contour inc 30
License
User name geo3
Model name
Date 04/07/2021
Horizon name
Signature
704000 708000 712000 716000 720000 724000 728000 732000 736000
6405000 6400000 6395000 6390000 6385000 6380000 6375000 6370000

Figure 26: Time thickness map of the Rotliegend Group.

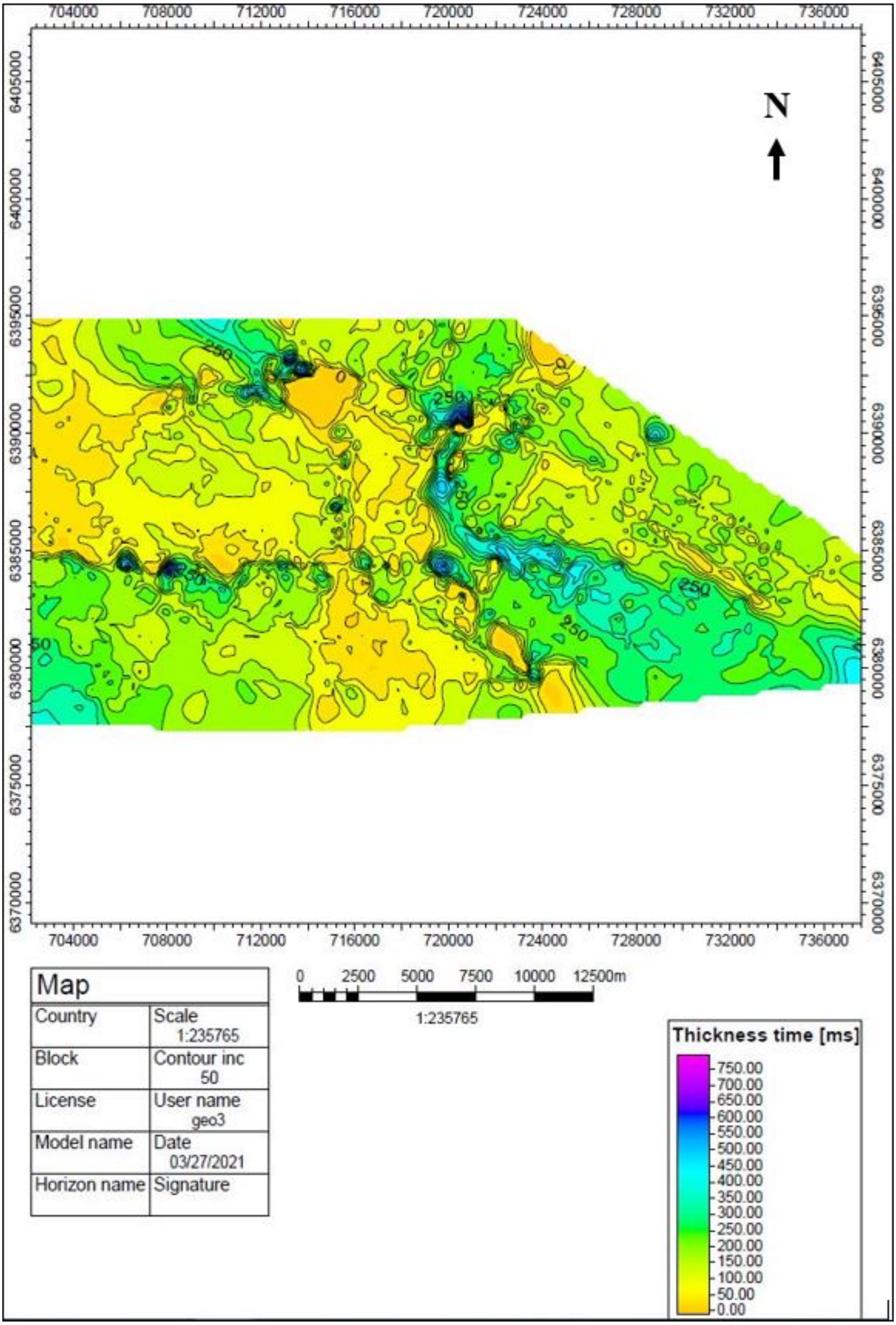


Figure 27: Time thickness map between the Rotliegend Base and the Basement (Pre-Rotliegend succession).

6. Discussion:

Jackson and Lewis (2013) defined the depositional limits of the Zechstein salt to the east of the Farsund basin across the Lista Nose Fault Blocks (Figure 4). In. this study we find that the limits of this depositions continue eastwards across the southern part of the basin.

6.1 Structural evolution for the Farsund basin:

In this part, all observations, along with previous studies of the study area, have been used to create an evolution model describing the three main studied units and their structural elements, 1) Pre-Rotliegend succession, 2) Rotliegend Group, 3) Zechstein Group.

Pre-Rotliegend:

The thickness variation observed in the Pre-Rotliegend succession is associated in this study area to the N-S fault located in the southeastern part of the study area which suggest extensional movement in the Pre-Rotliegend. As a result of this tectonic movements, the two wells in the study area did not penetrate this unit.

Rotliegend Group:

The Rotliegend group is widely deposited in the study area. Based on the relatively constant thickness, I suggest that there was no paleotopographic highs at the timing of deposition of the Rotliegend Group. The surface base of the Rotliegend group is homogeneous and there is no evidence of barriers acting for deposits. A long period of tectonic stability resulted in a constant thickness of this group in the most parts of the study area. The depocenters in the east part of the study area can be interpreted to be a result of depositions above the hanging wall in the previous units, inherited topography from the Pre-Rotliegend fault activity.

Zechstein:

Thick stratigraphic packages of salt and carbonates of the Zechstein group have been deposited widely in the Farsund basin caused in significantly increasing in thickness in the area that contain this group. The thickness variation and the distribution of this group controlled by Rotliegend topographic relief along with the sub-salt basinal faults. Diapirs located in the eastern part of the study area indicate deeper water conditions. In the western part of the study area, shallower conditions dominated in this area indicating carbonates/shales components. Faults that were active during the deposition of Zechstein affected the composition and the thickness of diapirs (Figure 25).

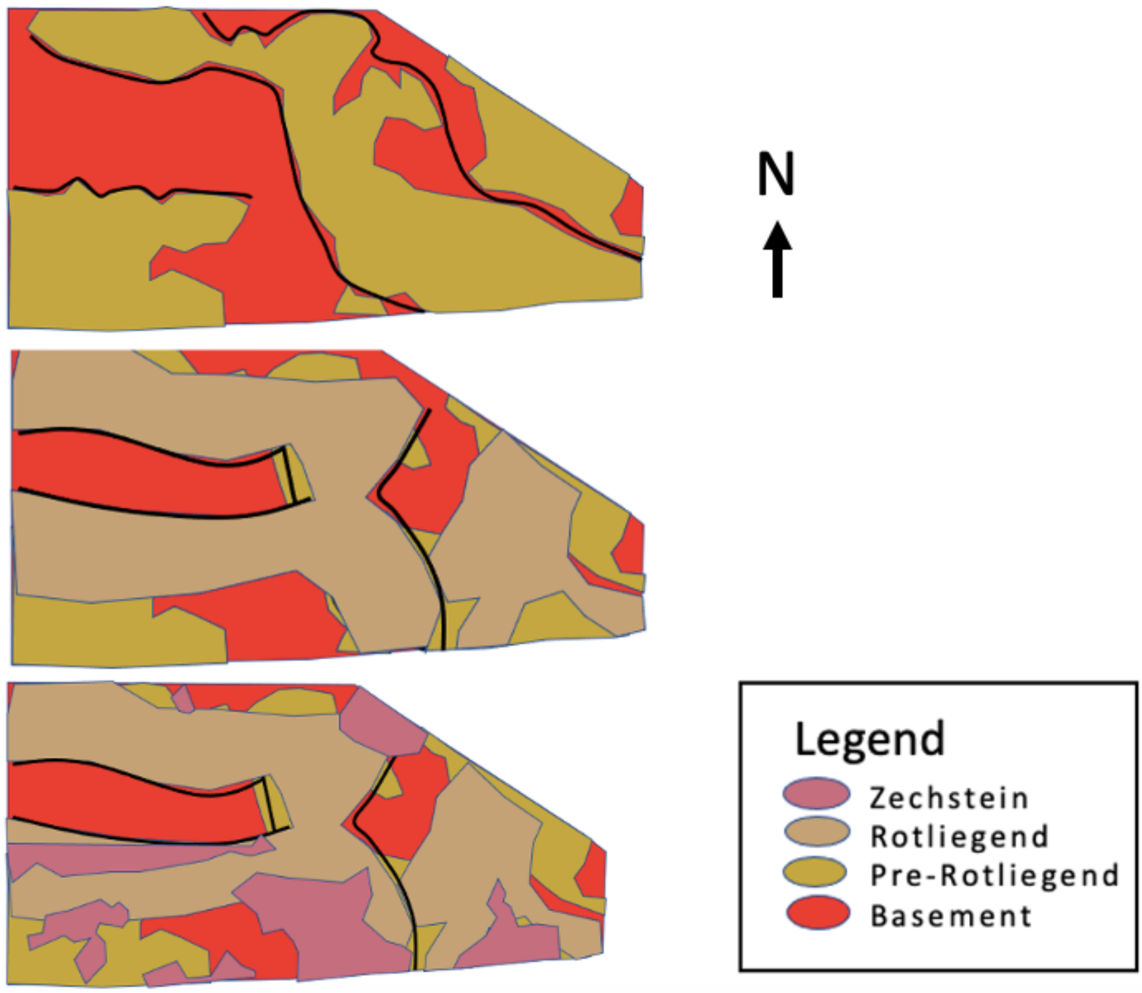


Figure 28: illustration for the proposed evolution model in the study area.

7.0 Conclusion:

In this study 2D and 3D seismic data used to improve the knowledge of the Late Permian units in the Farsund basin area. Using this data to generate structural maps for the units in the study area.

Based on the observations, a tectonic quiescent period is interpreted in the area during the time of deposition of the Rotliegend Group, and active extensional tectonics during both of Pre-Rotliegend and the Zechstein group.

At the base of the Zechstein Group high GR values are interpreted as the possible presence of the organic-rich Kuprerschiefer Formation.

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