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Enhancing Stratigraphic Geomodelling through Integration of Relative Geological Time and Spectral Decomposition: A Case Study from the Volve Field

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ABSTRACT

This study aims to enhance stratigraphic interpretation and geomodel construction through the integration of Relative Geological Time (RGT) and spectral decomposition in the Volve Field, North Sea. Conventional seismic interpretation often faces limitations in identifying subtle stratigraphic features such as channels and thin layers due to limited vertical resolution. To address this issue, RGT was applied to generate a stratigraphic framework with dense horizons based on relative geological time, followed by spectral decomposition using Short-Time Fourier Transform (STFT) and Continuous Wavelet Transform (CWT) to improve vertical resolution and delineate depositional features. The results show that the RGT-based stratigraphic framework successfully identified major horizons from Jurassic to Cenozoic intervals, highlighting depositional evolution within the study area. Spectral decomposition analysis at selected frequencies revealed sinuous channel geometries within the Sleipner and Hugin formations. Comparison between methods indicates that STFT provides more laterally continuous channel delineation, while CWT is more sensitive to local amplitude variations. RGB blending further enhanced visualization of channel features and improved geobody extraction. The integrated interpretation produced a three-dimensional geomodel of channel geobodies, indicating fluvio-deltaic to shallow marine depositional systems with significant lateral heterogeneity. This study demonstrates that integrating RGT and spectral decomposition improves stratigraphic interpretation, enhances geobody delineation, and reduces uncertainty in reservoir characterization. The proposed workflow can be applied to other complex depositional systems to improve stratigraphic geomodeling and reservoir analysis.

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1. INTRODUCTION

Three-dimensional seismic-based stratigraphic interpretation plays a crucial role in hydrocarbon reservoir exploration and characterization, as it provides a detailed understanding of depositional architecture and subsurface facies distribution (Calderon et al., 2021). However,

conventional seismic interpretation still faces limitations in identifying subtle stratigraphic features such as channels, thin layers, and lateral facies variations due to limited vertical resolution and low lithological impedance contrast, which increases uncertainty in reservoir characterization (Zhang et al., 2022).

Spectral decomposition has been widely applied to enhance interpretation resolution by separating the frequency components of seismic signals, enabling clearer identification of geomorphological features such as channels and sand bodies (Partyka et al., 1999; Roman et al., 2018). Recent developments in spectral decomposition techniques, particularly synchrosqueezing transform and adaptive time-frequency analysis, have significantly improved time-frequency resolution and the identification of thin stratigraphic features and subtle depositional geometries (Bi et al., 2021). These advanced approaches provide improved energy concentration and enhance channel detection in heterogeneous depositional environments.

Despite these advancements, spectral decomposition applied in the conventional time domain is often affected by structural distortions and stratigraphic inconsistencies, which may limit accurate interpretation of depositional features. The Relative Geological Time (RGT) approach was developed to generate a more consistent stratigraphic framework through the creation of dense horizons based on relative geological age equivalence. Recent developments in seismic stratigraphic modeling using machine learning and advanced time-frequency approaches have improved horizon continuity and depositional feature interpretation in structurally complex environments (Shang & Fu, 2022).

However, applying spectral decomposition or RGT individually still presents limitations. Spectral decomposition alone may not adequately address stratigraphic inconsistencies, while RGT may not sufficiently enhance vertical resolution required for identifying subtle depositional features such as thin channels and sand bodies. Therefore, integrating RGT with spectral decomposition provides complementary advantages, where RGT improves stratigraphic consistency and spectral decomposition enhances vertical resolution and geomorphological feature detection (Cubizolle et al. 2022).

This integrated approach is particularly important in the Volve Field, located in the Viking Graben, North Sea, which is characterized by complex fluvio-deltaic depositional systems and significant stratigraphic heterogeneity. Recent studies in the Volve Field indicate complex reservoir architecture and lithological variability that require advanced seismic interpretation techniques to improve reservoir characterization and geomodel development (Pelemo-Daniels & Stewart, 2024).

The Jurassic reservoir interval, particularly within the Sleipner and Hugin formations, exhibits discontinuous reflectors, lateral facies variations, and complex channel architectures influenced by depositional processes and tectonic structures (Krishna et al., 2024). Previous studies indicate that the Hugin Formation in the Volve Field consists of shallow-marine to fluvio-deltaic deposits with significant heterogeneity and lateral lithological variations, which complicate reservoir characterization and increase interpretation uncertainty (Wahyuni & Ramdani, 2025). In addition, recent studies on the Volve Field highlight complex faulted structures and heterogeneous reservoir architecture that require integrated seismic interpretation approaches rather than single-attribute analysis. These geological characteristics increase interpretation uncertainty when using single-attribute approaches, making integrated methods necessary to improve depositional feature delineation (Kartika et al., 2025).

Therefore, this study integrates RGT and spectral decomposition to enhance stratigraphic geomodeling in the Volve Field. Recent studies demonstrate that integrating multiple seismic attributes and stratigraphic-based frameworks improves reservoir characterization accuracy and reduces uncertainty in heterogeneous depositional systems (Naseer et al., 2024). This integrated approach is expected to improve geobody delineation, clarify depositional geometries, and generate a more realistic and geologically consistent stratigraphic geomodel. Ultimately, this study aims to reduce uncertainty in reservoir characterization and provide a better understanding of reservoir heterogeneity in complex depositional systems.

2. METHODS

The research methodology is divided into three main stages: Input, Process, and Output, as illustrated in Figure 1. These stages are designed to integrate RGT based stratigraphic interpretation and spectral decomposition to enhance geobody delineation and improve stratigraphic geomodel construction in the Volve Field.

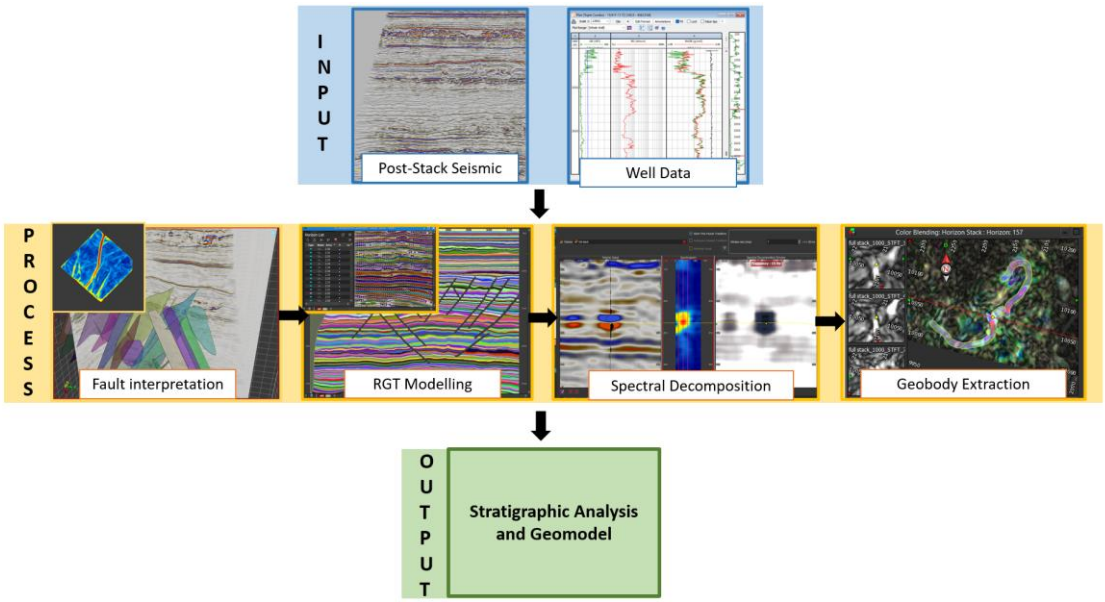


Figure 1. Workflow of the study

2.1 Input

The data used in this study consist of three-dimensional post-stack seismic data and well data from the Volve Field, Block 15/9, Viking Graben, North Sea. The 3D post-stack seismic data serve as the primary dataset for stratigraphic interpretation and seismic attribute analysis. In addition, well data are used as geological control to improve the accuracy of seismic interpretation.

Five wells were utilized in this study, including F-11 T2, F-15 A, 19 A, 19B&BT2, and 19S&SR. The available well data include well logs, stratigraphic markers, checkshot data, and geological reports from the Volve Field. The checkshot data were used for the well-to-seismic tie process, allowing correlation between depth and time domains in the seismic data. Stratigraphic markers were employed to constrain horizon interpretation and assist in identifying key stratigraphic intervals within the study area. The integration of well and seismic data enables more accurate stratigraphic interpretation and reduces uncertainty in stratigraphic geomodel construction.

2.2 Process

The initial stage involves fault interpretation using automated seismic interpretation techniques implemented in Paleoscan, particularly the Automatic Fault Extraction (AFE) algorithm. Automated fault extraction has recently been shown to improve structural delineation efficiency and reduce interpreter bias, especially in complex subsurface settings using 3D seismic volumes. The interpreted faults are subsequently incorporated as structural constraints in the RGT-based stratigraphic modelling workflow, enabling the construction of stratigraphic surfaces that are geologically consistent and structurally constrained (Cubizolle et al., 2025).

Following fault interpretation, RGT modelling is performed to generate a continuous stratigraphic framework. The process begins with grid model construction that considers both lateral and vertical seismic resolution. Reflector propagation is then applied to generate dense stratigraphic horizons based on relative geological age. Recent studies demonstrate that RGT volumes significantly improve stratigraphic interpretation by enabling horizon tracking across discontinuities and enhancing depositional feature identification, including channels and stratigraphic sand bodies. The

resulting RGT domain facilitates interpretation within a chronostratigraphic framework, improving geological consistency compared to conventional time-based interpretation approaches.

After constructing the RGT model, spectral decomposition analysis is applied to enhance vertical resolution and identify subtle stratigraphic features. In recent seismic interpretation workflows, spectral decomposition using Continuous Wavelet Transform (CWT) and Short-Time Fourier Transform (STFT) has proven effective for detecting thin beds, channels, and stratigraphic discontinuities in 3D seismic data. These frequency components are extracted at selected dominant frequencies and subsequently integrated using RGB blending to enhance visualization of geomorphological features. Integrating spectral decomposition within the RGT-based stratigraphic domain improves feature continuity and interpretation accuracy compared to conventional time-slice analysis (Castagna & Sun, 2006).

The final stage involves geobody extraction based on spectral decomposition attributes within the stratigraphic domain. Channel features identified from RGB-blended spectral volumes are extracted and visualized as three-dimensional geomodels. This workflow enables improved delineation of channel geometry and lateral sand distribution, ultimately enhancing stratigraphic geomodelling and reservoir characterization in complex depositional environments (Lacaze et al., 2020).

2.3 Output

The results of this study consist of stratigraphic analysis and a three-dimensional stratigraphic geomodel of the Volve Field developed through the integration of RGT and spectral decomposition. The RGT model serves as the primary stratigraphic framework to generate geologically consistent horizons, while the spectral decomposition results are utilized to identify and delineate depositional features such as channels and sand bodies within the target interval. The identified geological features are subsequently extracted as geobodies and visualized in a three-dimensional geomodel to represent depositional architecture and lateral reservoir distribution more realistically. This integrated approach enhances stratigraphic interpretation and provides a better understanding of reservoir heterogeneity in the Volve Field.

3. RESULT AND DISCUSSION

3.1 Seismic Stratigraphic Framework

The seismic stratigraphic framework in the study area was constructed using the RGT model to generate stratigraphically consistent horizon interpretations. This approach enables the identification of major horizons from the Jurassic to Cenozoic intervals based on relative geological age equivalence. The interpretation results reveal several key horizons, including the Sleipner Formation, Hugin Formation, Heather Formation, Draupne Formation, and younger Cretaceous to Cenozoic intervals, as shown in Figure 2. This stratigraphic framework highlights variations in reflector characteristics that reflect changes in depositional environments and basin evolution within the Volve Field.

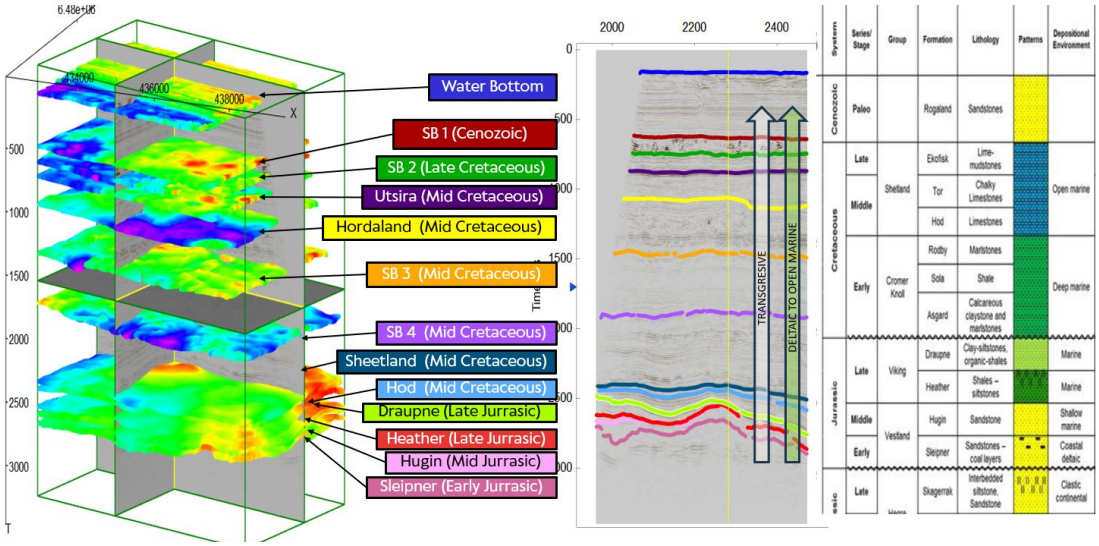


Figure 2. Seismic stratigraphic framework of the Volve Field showing interpreted horizons from Jurassic to Cenozoic intervals integrated with regional stratigraphy and depositional environments

The Volve Field is located in the South Viking Graben, North Sea, where hydrocarbon accumulation is mainly associated with Jurassic sandstone reservoirs deposited during syn-rift tectonic activity. Previous studies indicate that the main productive reservoir in the Volve Field is the Hugin Formation, which consists of shallow marine sandstone with strong lateral heterogeneity and structural compartmentalization due to fault-controlled deposition (Sanei et al., 2023; Talinga & Reine, 2021). These structural controls significantly influence reservoir distribution and stratigraphic architecture within the field.

Within the Jurassic interval, particularly in the Sleipner and Hugin formations, seismic reflectors exhibit discontinuous characteristics with hummocky reflection patterns and significant lateral amplitude variations. These reflector characteristics indicate high stratigraphic heterogeneity commonly associated with high-energy depositional environments such as coastal deltaic to shallow marine settings. Similar depositional characteristics in the Volve Field have been reported where the Hugin Formation consists of interbedded sandstone and mudstone deposited in shallow-marine to shoreface environments, resulting in complex reservoir heterogeneity (Sandunil et al., 2024).

Non-parallel reflector geometries and lateral discontinuities also suggest the development of channels and sand bodies that may serve as potential reservoir units in the Volve Field. Previous studies indicate that channelized sandstone bodies within the Hugin Formation show multiple reservoir quality zones controlled by depositional facies variations and structural compartmentalization.

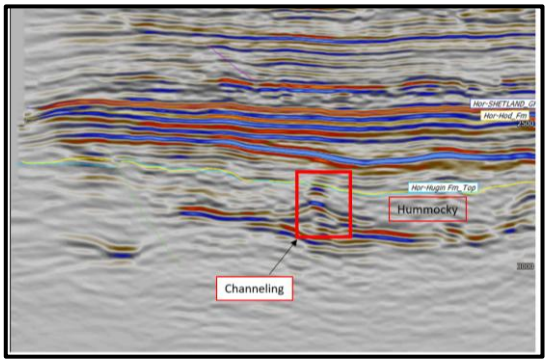
In the overlying interval, the Heather and Draupne formations display more continuous and relatively parallel reflectors with more homogeneous amplitudes. These reflector characteristics indicate a transition to marine basin to deep marine depositional environments dominated by shale lithology. The Draupne Formation is widely recognized as a major source rock in the Viking Graben, deposited under restricted marine conditions with high organic content during basin subsidence.

In the Cretaceous to Cenozoic intervals, seismic reflectors exhibit more continuous and relatively homogeneous patterns with several stratigraphic discontinuities interpreted as sequence boundaries. These intervals indicate a trend toward open marine depositional environments dominated by fine-grained lithologies, while variations in stratigraphic thickness suggest the influence of regional subsidence. Similar stratigraphic evolution has been reported in the South Viking Graben, where post-rift sedimentation produces more continuous reflector patterns compared to Jurassic syn-rift deposits.

Overall, the RGT-based stratigraphic framework provides a strong foundation for spectral decomposition analysis and geobody interpretation, particularly for identifying depositional features such as channels and sand bodies within the Jurassic reservoir interval.

3.2 Spectral Decomposition Analysis

Initial interpretation was conducted on vertical seismic sections to identify reflector characteristics within the target interval, particularly in the Sleipner and Hugin formations. Reflectors within the Jurassic interval exhibit discontinuous characteristics with hummocky reflection patterns and significant lateral amplitude variations. In addition, convex-up reflector geometries are observed in several areas, as shown in Figure 3. These reflector characteristics indicate high stratigraphic heterogeneity commonly associated with high-energy depositional systems such as shallow marine to fluvio-deltaic environments. The convex-up geometry also suggests possible channel-fill deposits formed by the accumulation of relatively coarse-grained sediments within channel bodies (Mitchum et al., 1977; Posamentier & Walker, 2006).



Gambar 3. Seismic section showing hummocky reflectors and channeling features within the Jurassic interval.

To further enhance the identification of depositional features, spectral decomposition analysis was performed using CWT and STFT at frequencies of 15 Hz, 43 Hz, and 71 Hz. These frequencies were selected to represent different vertical resolution scales, where low frequencies highlight large-scale depositional geometries, intermediate frequencies emphasize primary channel geometries, and high frequencies reveal finer stratigraphic details (Partyka et al., 1999; Naseer et al., 2024). The spectral decomposition results were then combined using RGB blending to enhance amplitude contrast and improve subsurface geomorphological visualization, as shown in Figure 4.

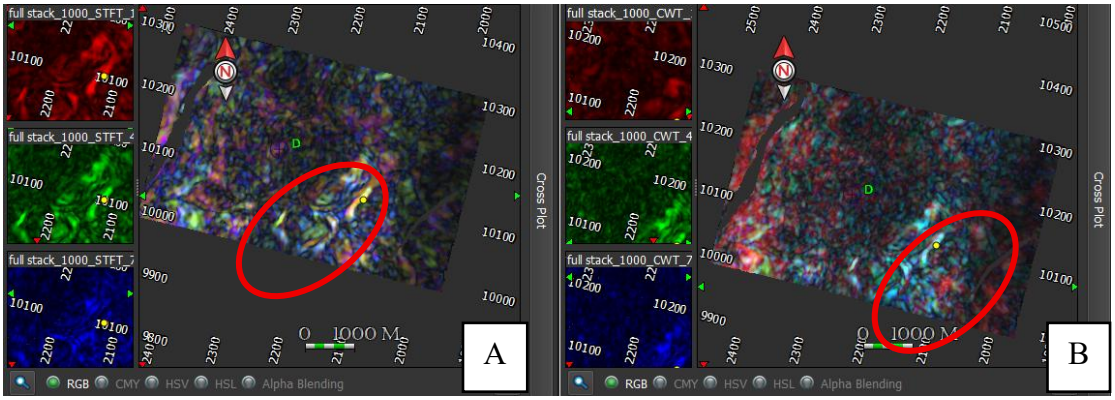


Figure 4. 3D geomodel of channel geobody extracted from RGT-based spectral decomposition,

The RGB blending results reveal elongated and sinuous features with clear lateral continuity, interpreted as channel systems within the Jurassic interval. These channel features appear more distinct compared to conventional seismic sections, indicating that spectral decomposition enhances vertical resolution and improves the identification of subtle depositional features. Additionally, color variations in the RGB blending results suggest changes in lithological characteristics and layer thickness, which may be associated with sand body distribution within the channel system.

Comparison between STFT and CWT indicates that STFT produces more laterally continuous channel delineation than CWT (Naseer et al., 2017). The STFT results show more stable and well-

defined channel geometries, whereas the CWT results appear more fragmented. This difference is related to the characteristics of STFT, which uses a fixed time window, resulting in more stable frequency resolution, while CWT employs a variable window that is more sensitive to small amplitude variations but produces lower lateral continuity (Sinha et al., 2003; Mandong et al., 2025)

The integration of spectral decomposition within the RGT-based stratigraphic domain indicates that channel features develop laterally within the Jurassic interval, particularly in the Sleipner and Hugin formations. The sinuous geometry and good lateral continuity suggest fluvio-deltaic to shallow marine depositional systems that may form sand-prone reservoirs with high stratigraphic heterogeneity. These results demonstrate that the integration of RGT and spectral decomposition improves geobody delineation and provides a more comprehensive understanding of depositional architecture in the Volve Field.

3.2 Channel Geobody Interpretation

Based on the spectral decomposition results within the RGT-based stratigraphic domain, depositional features resembling channels were extracted and visualized as three-dimensional geomodels, as shown in Figure 5. The RGT-based approach allows interpretation within a more stratigraphically consistent domain, thereby reducing structural distortion and improving the lateral continuity of depositional features. In addition, the application of spectral decomposition using RGB blending enhances amplitude contrast and clarifies channel geometries that were previously difficult to identify using conventional seismic data.

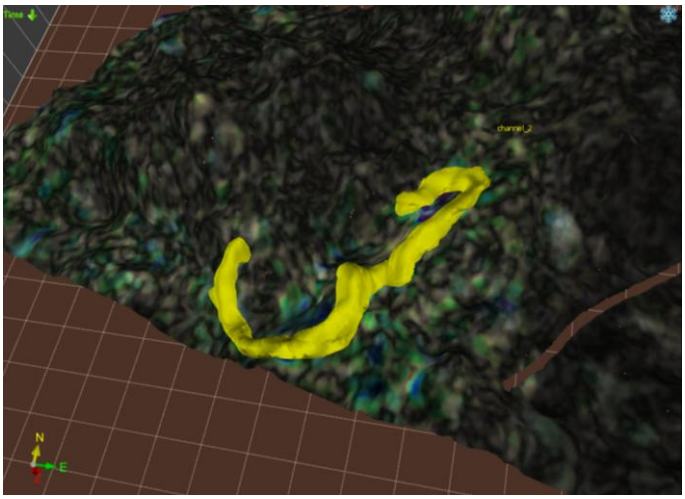


Figure 5. Comparison of spectral decomposition results using RGB blending at selected frequencies. (A) STFT and (B) CWT

The resulting channel geomodel exhibits elongated and sinuous geometries with significant lateral width variations. These characteristics indicate laterally developed channel systems with high stratigraphic heterogeneity. Furthermore, the convex-up channel geometry suggests possible channel-fill deposits formed by the accumulation of relatively coarse-grained sediments. The observed meandering patterns also indicate lateral depositional systems commonly associated with fluvio-deltaic to shallow marine environments (Posamentier & Walker, 2006; Chopra & Marfurt, 2007).

The lateral distribution of channels identified within the Jurassic interval, particularly in the Sleipner and Hugin formations, indicates potential sand body development that may serve as hydrocarbon reservoirs. The high lateral heterogeneity within the channel system also suggests potential variations in reservoir quality, which is important for reservoir characterization and field development. The integration of RGT and spectral decomposition enables more accurate geobody delineation and improves the understanding of subsurface depositional architecture in the Volve Field.

To further validate the extracted channel geobody, the spectral decomposition results were compared with available well log data within the target interval. The interpreted geobody is primarily located within the Hugin Formation, which is widely recognized as a sandstone-dominated reservoir interval deposited in fluvio-deltaic to shallow marine environments. Wells intersecting this interval generally show relatively low gamma-ray values, indicating cleaner sandstone lithology, accompanied by moderate to high resistivity responses and relatively higher porosity values. These well log characteristics are consistent with sand-prone channel deposits and support the interpretation of the extracted geobody as sandstone-dominated channel systems. The spatial correspondence between the interpreted geobody and the Hugin Formation further increases confidence in the depositional interpretation and confirms the potential of these channel features as prospective hydrocarbon reservoir zones within the Volve Field.

Overall, the channel geomodel results demonstrate that the integration of RGT and spectral decomposition significantly improves stratigraphic interpretation and geobody delineation. This approach not only clarifies depositional geometries but also provides important insights into lateral reservoir distribution and stratigraphic heterogeneity within complex depositional systems in the Volve Field.

4. CONCLUSION

This study aims to improve stratigraphic interpretation and geomodel construction through the integration of RGT and spectral decomposition in the Volve Field, North Sea. Based on the results, the RGT-based approach successfully generated a more geologically consistent stratigraphic framework, enabling the identification of major horizons and clarifying depositional environment changes from the Jurassic to Cenozoic intervals.

Spectral decomposition analysis using STFT and CWT within the stratigraphic domain revealed depositional features in the Jurassic interval, particularly within the Sleipner and Hugin formations, with improved clarity. The integration of spectral decomposition results using RGB blending successfully identified sinuous channel geometries with good lateral continuity, interpreted as fluvio-deltaic to shallow marine depositional systems. Furthermore, geobody extraction produced three-dimensional geomodels illustrating lateral channel distribution and stratigraphic heterogeneity with potential hydrocarbon reservoir characteristics.

The results demonstrate that integrating RGT and spectral decomposition enhances geobody delineation and reduces uncertainty in stratigraphic interpretation within complex depositional systems. This approach has the potential to be applied to other fields with similar geological characteristics and can be further developed through integration with well data and additional seismic attributes to improve reservoir characterization more comprehensively.

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REFERENCES

Bi, Z., Wu, X., Geng, Z., & Li, H. (2021). Deep relative geologic time: A deep learning method for simultaneously interpreting 3-D seismic horizons and faults. *Journal of Geophysical Research: Solid Earth*, 126(9), e2021JB021882. https://doi.org/10.1029/2021JB021882

Calderon, M. D., Castagna, J. P., Meza, R., Chen, S., & Jiang, R. (2021). Use of seismic spectral decomposition, phase, and relative geologic age as attributes to improve quantitative porosity prediction in the Daqing Field, China. *Applied Sciences*, 11(17), 8034. https://doi.org/10.3390/app11178034

Castagna, J. P., & Sun, S. (2006). Comparison of spectral decomposition methods. *First Break*, 24(1), 75–79. https://doi.org/10.3997/1365-2397.24.1093.26885

Chopra, S., & Marfurt, K. J. (2007). *Seismic attributes for prospect identification and reservoir characterization*. Tulsa, OK: Society of Exploration Geophysicists.

Cubizolle, F., Daynac, N., & Lacaze, S. (2020). *From seismic interpretation to property filled gridding using the relative geological model*. 82nd EAGE Conference & Exhibition, Amsterdam, The Netherlands, 8–11 December 2020. https://doi.org/10.3997/2214-4609.202011753

Cubizolle, F., Durot, B., & Evano, L. (2022). Enhancing geological features delineation by combining a relative geological time model with the matching pursuit spectral decomposition. *SEG/AAPG International Meeting for Applied Geoscience & Energy Expanded Abstracts*, 1288–1291. https://doi.org/10.1190/IMAGE2022-3749793.1

Kartika, A., Handoyo, H., Sigalingging, A. S., Pangestu, F. B., & Husain, M. W. (2025). Reservoir characterization using integrated seismic inversion and multiattribute analysis based on probabilistic neural network (PNN). *ARRUS Journal of Engineering and Technology*, 5(6), https://doi.org/10.35877/jetech4411

Krishna, S., Irfan, S. A., Keshavarz, S., Thonhauser, G., & Ilyas, S. U. (2024). Smart predictions of petrophysical formation pore pressure via robust data-driven intelligent models. Multiscale and Multidisciplinary Modeling, Experiments and Design, 7, 5611–5630. https://doi.org/10.1007/s41939-024-00542-z

Lacaze, S., Durot, B., Devilliers A., & Pauget, F. (2020) Comprehensive Seismic Interpretation to Enhance Stratigraphy and Faults. *15th International Congress of the Brazilian Geophysical Society & EXPOGEF.* https://doi.org/10.3997/2214-4609.202011753

Mandong, A., Loke, M. H., Acworth, I., & Dahlin, T. (2025). Advancing seismic interpretation through spectral decomposition. *86th EAGE Annual Conference & Exhibition*. https://doi.org/10.3997/2214-4609.202571004

Mitchum, R. M., Vail, P. R., & Sangree, J. B. (1977). Seismic stratigraphy and global changes of sea level. In C. E. Payton (Ed.), *Seismic stratigraphy—Applications to hydrocarbon exploration* (pp. 117–133). American Association of Petroleum Geologists.

Naseer, M. T., Asim, S., Solangi, S. H., & Abbasi, S. A. (2017). Continuous wavelet transforms of spectral decomposition analyses for fluvial reservoir characterization of Miano Gas Field, Indus Platform, Pakistan. *Arabian Journal of Geosciences*, 10, 292. https://doi.org/10.1007/s12517-017-2920-5

Naseer, M. T., Naseem, S., Singh, A., Khalid, P., Redwan, A. E., Li, W., Rafiq, F. M. F., Khan, I., Abd El Aal, A., Al-Awah, H., & Kontakiotis, G. (2024). Seismic attributes and spectral decomposition-based inverted porosity-constrained simulations for appraisal of shallow-marine Lower Cretaceous sequences of Miano gas field, Southern Pakistan. *Heliyon*, 10(4), e25907. https://doi.org/10.1016/j.heliyon.2024.e25907

Partyka, G., Gridley, J., & Lopez, J. (1999). Interpretational applications of spectral decomposition in reservoir characterization. *The Leading Edge*, 18(3), 353–360. https://doi.org/10.1190/1.1438295

Pelemo-Daniels, D., & Stewart, R. R. (2024). Petrophysical property prediction using seismic inversion attributes: Volve Field. *Applied Sciences*, 14(4), 1345. https://doi.org/10.3390/app14041345

Posamentier, H. W., & Walker, R. G. (2006). *Facies models revisited*. SEPM (Society for Sedimentary Geology).

Román, A. S. F. & Yutsis, V. (2018). Application of spectral decomposition methods to the definition of stratigraphic features associated with channel reservoirs in the Southeast Petroleum Province, México. *Pure and Applied Geophysics*, 176, 873–883. https://doi.org/10.1007/s00024-018-1999-2

Sandunil, K., Bennour, Z., Ben Mahmud, H., & Giwelli, A. (2024). Effects of tuning decision trees in random forest regression on predicting porosity of a hydrocarbon reservoir: A case study of the Volve oil field, North Sea. *Energy Advances*, 3, 2335–2348. https://doi.org/10.1039/D4YA00313F

Sanei, M., Ramezanzadeh, A., & Asgari, A. (2023). Building 1D and 3D static reservoir geomechanical properties models in the Volve Field. *Arabian Journal of Geosciences*, 16, 142. https://doi.org/10.1007/s13202-022-01553-7

Shang, S., & Fu, S. (2022). Spectral decomposition using improved synchrosqueezing transform for seismic data interpretation. *Journal of Seismic Exploration*. 31(1), 53–64.

Sinha, S., Routh, P. S., Anno, P. D., & Castagna, J. P. (2003). Spectral decomposition of seismic data with continuous wavelet transform. *Geophysics*, 68(2), 712–722. https://doi.org/10.1190/1.1567243

Talinga, D., & Reine, C. (2021). Fluid saturation and pressure changes in the Hugin Formation, Volve Field. *GeoConvention 2021 Conference Proceedings*.

Wahyuni, S. Y., & Ramdani, A. (2025). Enhanced reservoir characterization in the Volve Field, North Sea: A comparative study between deterministic and stochastic inversions and its application to probabilistic neural network. *Indonesian Petroleum Association*.

Wang, Y., Liu, Z., & Chen, Q. (2022). Seismic time-frequency spectral decomposition by matching pursuit. *Geophysics*, 72(1): V13-V20. https://doi.org/10.1190/1.2387109

Zhang, Z., Yao, Z., & Wang, P. (2022). Fine complex geological structure interpretation based on multiscale seismic dip constraint. *Journal of Geophysics*, 2022, 1–15. https://doi.org/10.1155/2022/1529935