Reprocessed reservoir optimized seismic supports understanding and development of PL586 Fenja Field (Norwegian Sea)

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Summary

Neptune Energy Norge and PGS present a rejuvenation project over the Fenja Field in the Norwegian Sea. Reservoir-oriented processing, supported by cooperation and knowledge sharing, helped to improve the structural imaging and assisted the understanding and development of the reservoir. The project was executed in phases, allowing product delivery on time for field development milestones. Key stages were carried out in an iterative manner leading to optimized results.

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Introduction

Following the 2020 drilling campaign for the appraisal wells, Neptune Energy Norge, with partners, launched the initiative to rejuvenate their seismic library in block PL586, located offshore Norway on the Halten Terrace in the Vøring Basin. Primary interests were the Fenja Field and the Greater Vidsyn area (Figure 1).

The need for seismic reprocessing was identified in order to derisk and optimize the well producer's placement and to reach improved understanding of the regional play; an enhanced seismic image was required. Multiple contamination, in particular at near offsets, and effective noise attenuation had to be addressed, while preserving primary amplitudes for Quantitative Interpretation (QI) work and resolution for interpretation. A more detailed velocity model was necessary, solving uncertainties of the structural imaging.

The designed sequence was optimized for the field and the nearby interests, and a full reprocessing was executed. To meet the Fenja project timeline, the reprocessing project was phased and completed in an iterative manner.
Phase 1 was a reservoir-oriented processing project of 4 months targeting the Fenja area. Starting from migrated gathers, the aim was to get the deliverables in due time for well placement optimization. The producers' well drilling campaign was planned for Q3 2021 and didn't allow for the full reprocessing project.
Phase 2 was the full reprocessing itself starting from field tapes, using all the learnings from Phase 1 and earlier processing projects, and lasted 1 year. It will be the base for updating the work in PL568, for the Fenja static model and for the exploration areas in the license.

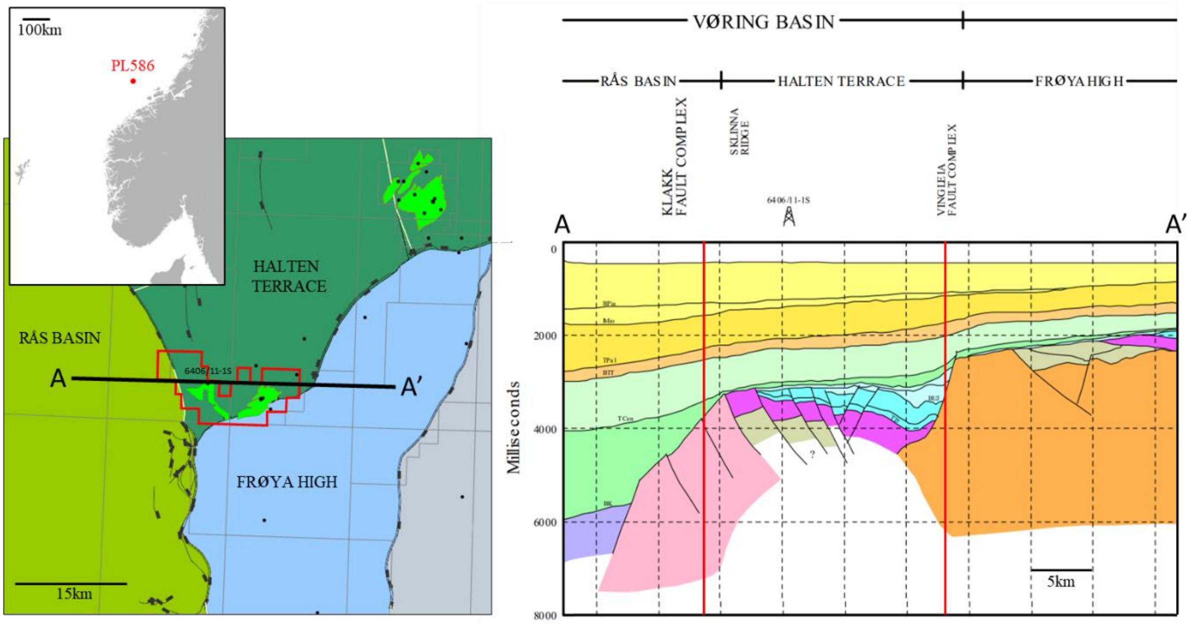


Figure 1 *Location and regional geological setting of the Fenja Field. Fenja is a field located in the Norwegian Sea, 120km north of Kristiansund that was discovered in 2014. The reservoirs contain oil and gas in sandstone of Late Jurassic age in the Melke Formation, and oil in Upper Jurassic sandstone in the Rogn Formation. The reservoirs are in a fan system at a depth of 3,200-3,500 metres, and they have variable reservoir properties. (Ref. NPD web factpage)*

Summary of reprocessing sequence

In 2014, PGS acquired and processed 6101 sq.km of multisensor streamer data as part of a large regional 3D multi-client program. In 2017, the same seismic data was included as part of a larger reprocessing project. This later dataset was selected as the best available at the time and is referred as “legacy 2017 processing” in this paper. In February 2022, the full integrity reprocessing project (500 sq.km input / 160 sq.km output) within Neptune Energy Norge and partners license block PL586, kicked off. Starting from field data, a state-of-the-art processing sequence and velocity model building flow was applied with the aim of generating an optimal product to assist understanding and development of the Fenja Field and wider exploration interests in the area.

A pragmatic target-oriented decision making

All processing steps were thoroughly tested to ensure the enhancement of the seismic data quality at each stage in the sequence. The reservoir knowledge and geophysical expectations shared at the start and along the project as well as the close cooperation and communication between Neptune Energy Norge and partners and PGS did allow for pragmatic target-oriented decision making.

Phase 1 conditioning included denoise, spectral shaping and balancing, selection of angle ranges and alignment and were benchmarked against available vintage reference datasets as well as carefully QC’ed at the key well locations. Phase 1 addressed some geophysical uncertainty during well planning that led to optimized/derisked well placement and the overall successful operation.

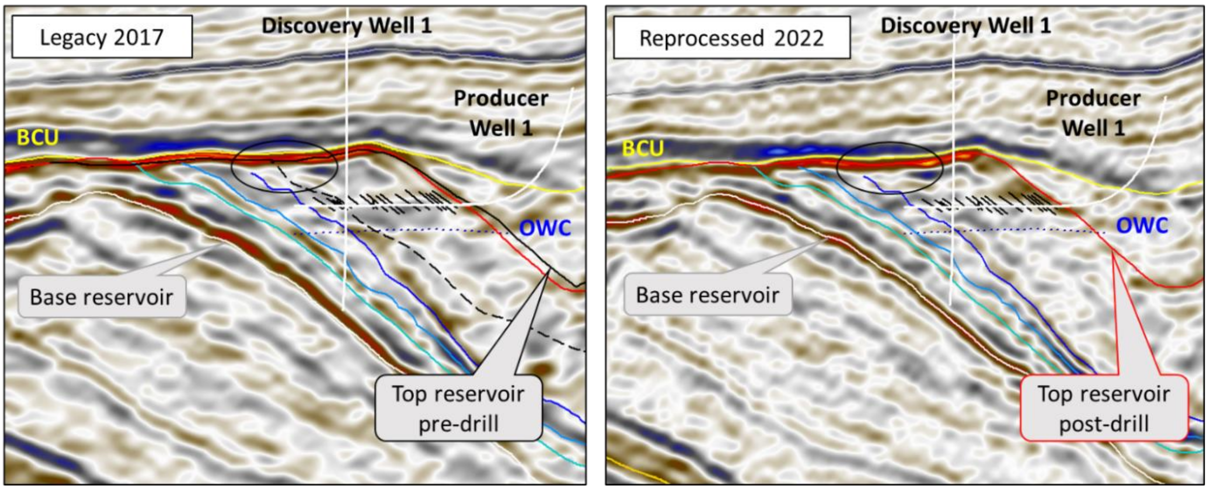
The same collaborative environment, testing and QC plans continued during phase 2 guaranteeing a strong appreciation of Neptune’s objectives and a positive and flexible approach to the project. Critical stages of the processing sequence, multiple elimination passes in particular, were carried out in an iterative manner. 1st pass multiple subtraction parametrization was revised after 2nd pass multiple subtraction based on 3D migrated volumes, leading to optimized outcome of the 2nd iteration production. The thorough demultiple testing made a positive impact for the end-user’s interpretation (Figure 3). A full TTI Q Kirchhoff pre-stack depth migration from carefully denoised data was performed. The 2022 reprocessing was successful to uncover the primary energy under a noise carpet by careful parametrization and extensive QC and benchmarking, incorporating the knowledge about the area from Neptune Energy Norge and partners.

The next sections show preliminary illustrations of how the 2022 reprocessed dataset supports further the understanding of PL586 Fenja Field.

Enhanced reservoir geometry understanding

Figure 2 compares legacy (A) and reprocessed (B) full stack. The latest product shows better alignment of seismic events and surfaces adjusted after drilling the producing wells. Layers are not deposited continuously all over the field but appear patchier in the new image (B). The edge of the reservoir can also be observed with more confidence on the reprocessed dataset (circled area).

Reservoir layering has a significant impact on production performance. The structural dips used to derive the layering of the geomodel (static model) have been assessed using a combination of HR image tool (Terrasphere) for detailed interpretation and reservoir mapping (Geosphere) for large scale geometries. These data appear to be consistent with the reprocessed seismic, providing a more robust structural dip evaluation to be used for the geomodel.

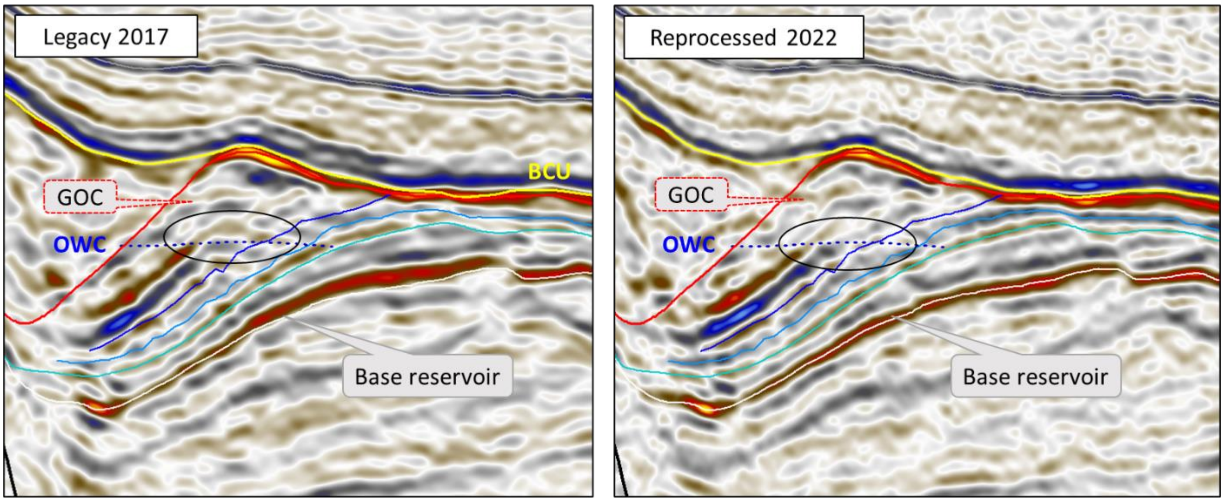


A B

Figure 2 *Full stacks from different vintages A: legacy 2017 processing, B: 2022 reprocessing. The structure inside the reservoir is more visible after reprocessing. No pinching on the top reservoir as apparently observed on previous datasets (circled area).*

Recovering genuine fluid contacts response

The intra-reservoir interpretation was challenging from legacy data due to the presence of multiples masking the top of the fluid contact (OWC). Figure 3 illustrates the attenuation of these multiples by the reprocessing (B) allowing a more confident mapping of the fluid contacts (more subtle seismic signature) inside the Fenja Field compared to legacy observations (A) whilst improving the layering definition inside the reservoir.

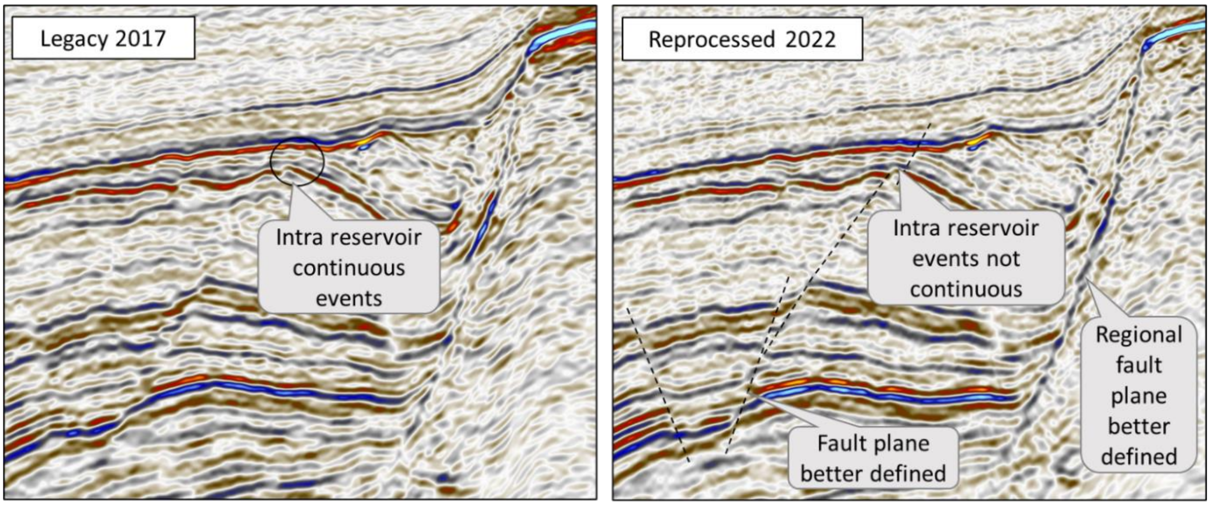


A B

Figure 3 *Full stacks from different vintages A: legacy 2017 processing, B: 2022 reprocessing. The multiples overlapping the OWC response in the legacy dataset are now removed revealing the genuine fluid contact response (circled area).*

Better fault definition

Updated migration velocity model resulted in improved fault imaging both at the scale of the regional Vøring Basin and at intra-reservoir fault planes. Figure 4 illustrates the differences in fault interpretation between legacy (A) and reprocessed data (B).



A B

Figure 4 *Updated fault interpretation: legacy 2017 processing (A) and 2022 reprocessing (B). Intra-Fenja Field faults are predicted to be small scale. Cross-discipline integration with DST (drill stem test) data and fluid simulation is expected to bring light on the leaking/sealing properties of the fault system within the Fenja Field. The uplift of the enhanced reprocessed data is also valuable around the Greater Vidsyn Ridge (exploration targets) where the geology is more controlled by faults.*

Conclusion

After reviewing available datasets in 2019, it became clear that reprocessing was needed to better understand the Fenja Field. The workflow has been optimized, taking into consideration the seismic data quality, the field geometry complexity and the field development timing constrains.

The iterative approach of the project successfully met the field development deadlines with tailored deliveries at each step.

Phase 1 outputs have been key to update the seismic picking (horizons and faults interpretation), but especially to generate seismic attributes used to understand the reservoir properties distribution inside the Fenja Field. Based on these products, the locations of the 4 injector/producer wells have been optimized in due time before the 2022 drilling campaign to target the best areas for production optimization.

Phase 2 seismic data was delivered in parallel to the drilling of the producer wells. The findings from these new wells seems to be supported by the reprocessed seismic. A full static model update will be performed by integrating geological data, updated concepts and seismic information.

The next phase of the project will include the utilisation of the updated geomodel for dynamic flow simulation and its optimization as production data will become available from Q1 2023.

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