Relinquishment Report PL150B Volund West

Fig. 1 Volund

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1 INTRODUCTION

1.1 License Owners

Aker BP ASA 65 %

Lundin Norway AS 35 %

1.2 Award and Work Program

The license was awarded on the 4th February 2011 for an initial period of 1 (one) year following the APA Licensing 2010.

The initial partners in the license were Marathon (Op) and Lundin. In 2014 Det norske merged with Marathon and become Aker BP (in 2016) which took over operatorship of the license.

License work obligations was corresponding to the work obligations in PL150

The initial period has been extended several times to allow for more work, reprocessing of seismic and make a drill decision.

The work obligations have been fulfilled.

1.3 Identified Prospectivity

PL150 B is situated in southern parts of Volve Sub-basin, on the border to Vana Sub-basin and cover parts of 24/9 (Fig. 1.1). The license is located west of the Volund field.

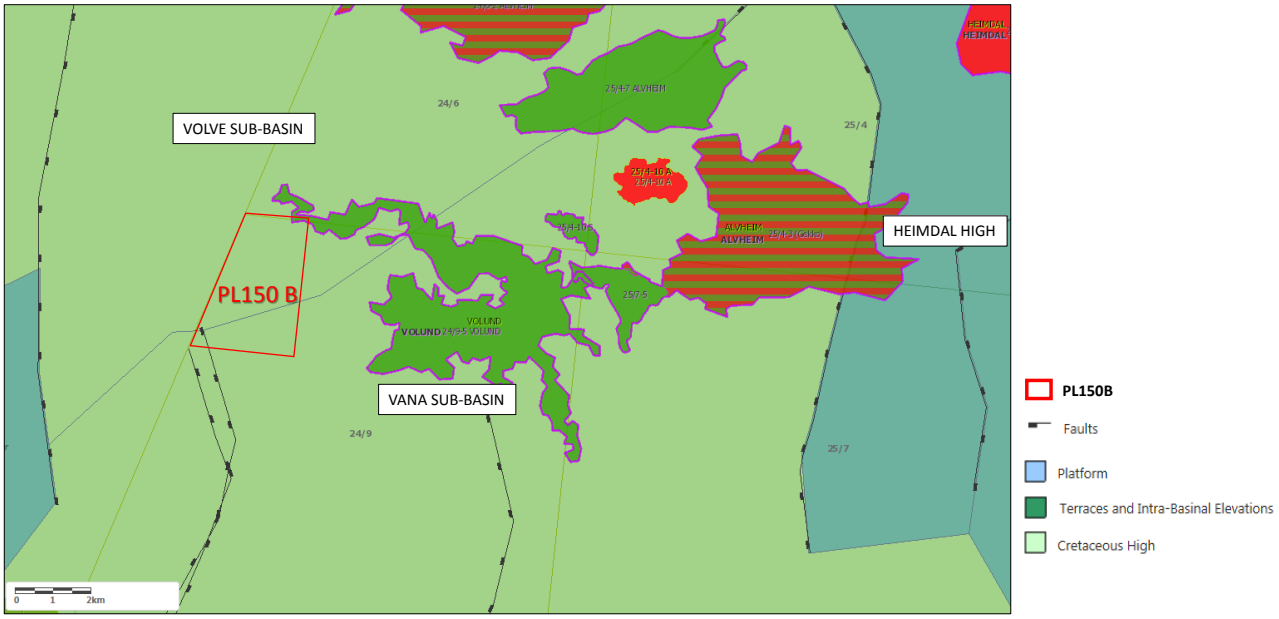

Fig. 1.1 License area and main structural elements

One prospect were identified within the PL150 B acreage, Volund West with postulated Eocene injectite as reservoir. This prospect is seen in Fig. 1.2, and a simplified stratigraphy is shown in Fig. 1.3

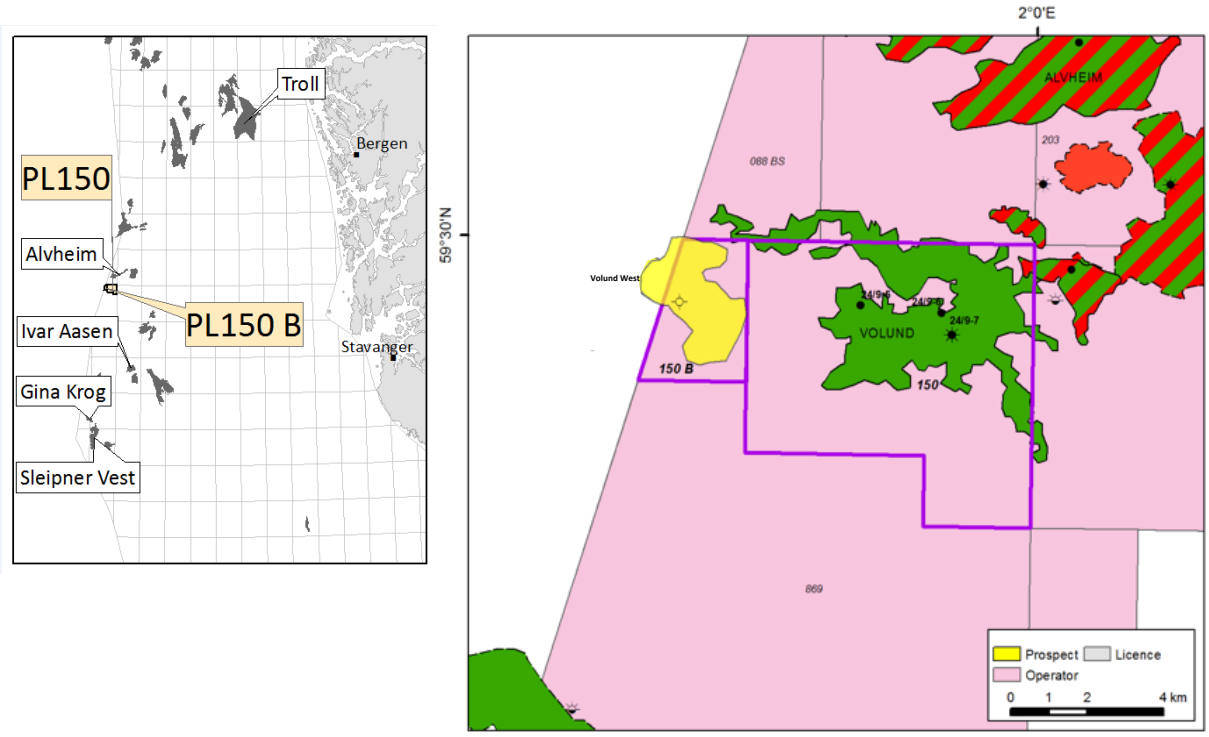

Fig. 1.2 Prospect overview

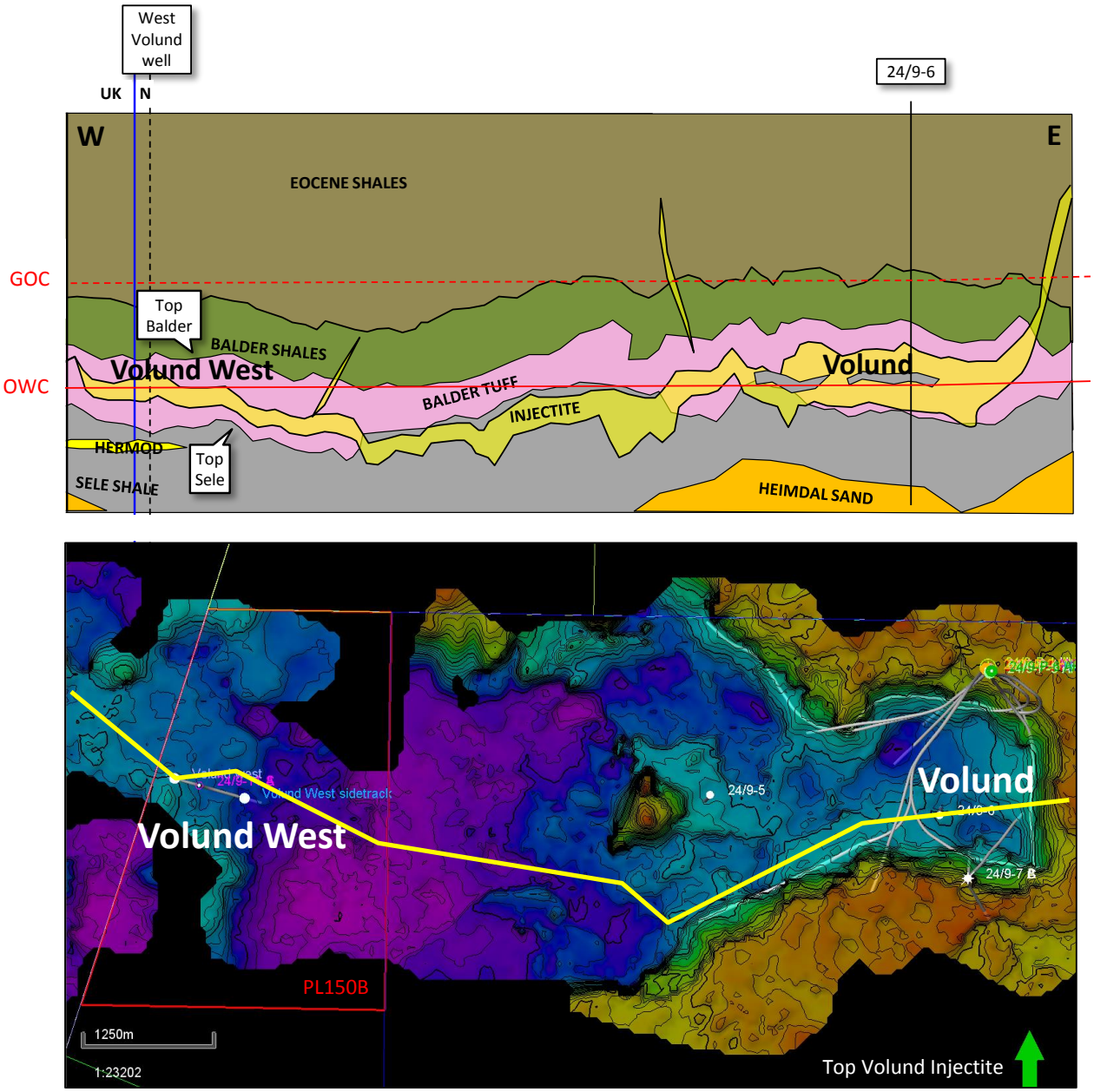

Fig. 1.3 Simplified stratigraphy for the Volund West Prospect

The main objective of the well 24/9-11S was to evaluate the hydrocarbon potential of the prognosed Eocene injected sands, injected from Hermod sands (of Paleocene age) in the Volund West Prospect (Fig. 1.3).

Fig. 1.4 shows the target locations at the top reservoir depth map. There is an amplitude brightening within this interval in Volund West, it is similar to Volund, although less marked (Fig. 1.5). There is a strong AVO response, which is associated with hydrocarbons in porous sands in the Alvheim area. However, it was risked to may also be due merely to porosity. And that was the result of the well, it was water wet high porous sand, see Table 1.1 and Fig. 1.6.

The Volund West exploration well targeted a sandstone sill (injectite) that lies below the Balder and Balder Tuff. The injected sands appear correlative to the injected sands at the Volund Field (4 to 8 km to the east). The Volund West sands are injected into the Sele and Balder formation shales. The area southeast is the source area for the injection complex and defines the structural spill

point between the Volund Field and the Volund West Prospect (Fig. 1.3). The Volund West injection is mainly a single sill, parallel to the background bedding of the Balder formation. The reservoir properties of the injected sand in the Volund West Prospect was expected to be of similar quality as in the adjacent Volund Field. The injection process has enhanced the reservoir properties with the injected sandstones commonly having an average porosity of 32% compared to 27-28% of the in situ Hemod . The result from the Volund West Well, 24/9-11S, was an average porosity of 33,6 %, see Table 1.1 and Fig. 1.6. .

Table 1.1 Reservoir properties, main reservoir in 24/9-11S

Depth top (metres)	Depth base (metres)	Gross (metres)	Net (Metres)	Net to Gross	Phie average	Sw av	Vsh AM	Perm AM
2088.100	2095.600	7.5	7.163	0.955	0.336	0.954	0.047	5238.093

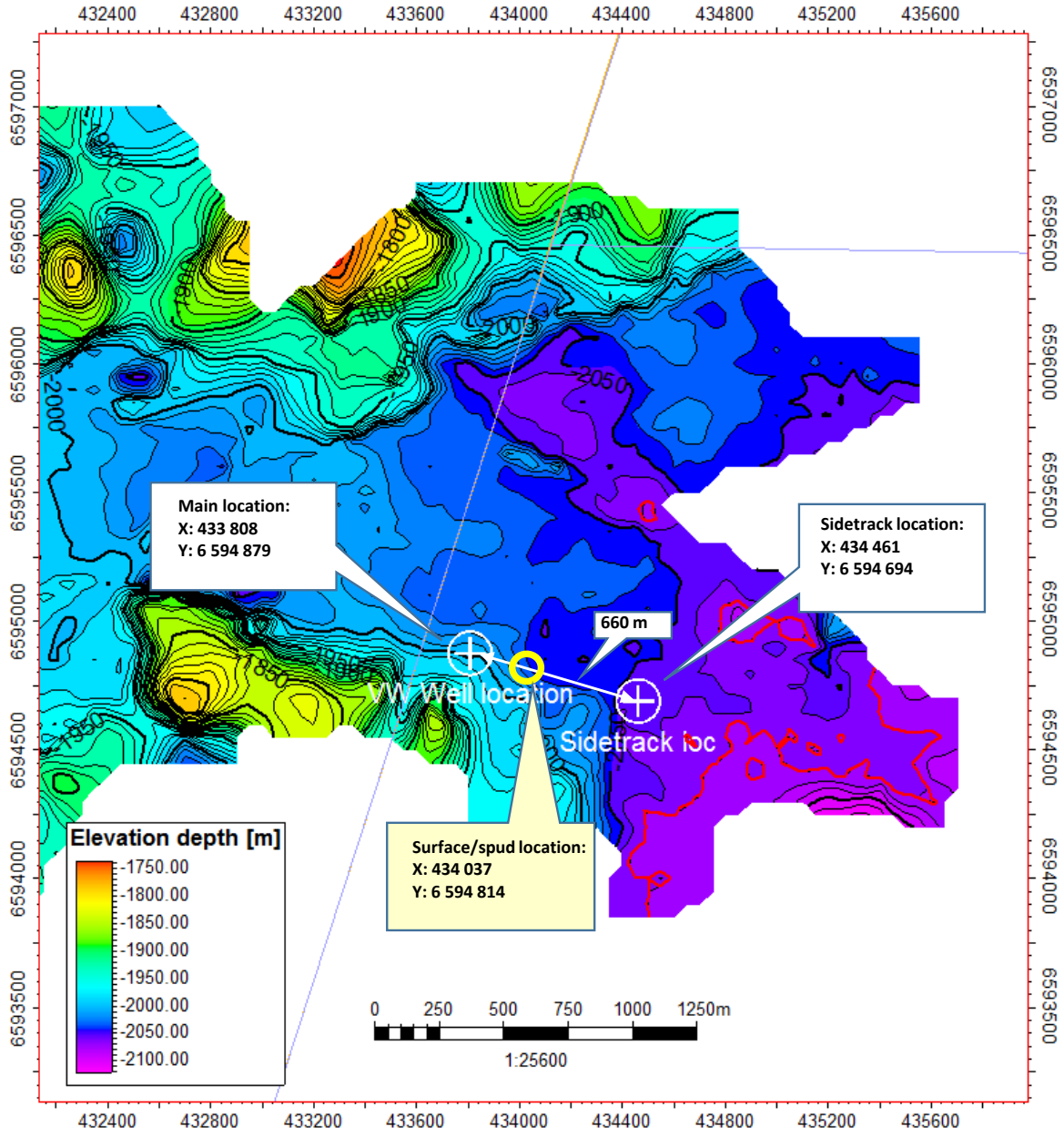

Fig. 1.4 Volund West Top reservoir depth map. Main target at top reservoir level to the west, and optional side track to the south east. The well was planned as an Y-well, surface/spud location is marked in yellow on the map

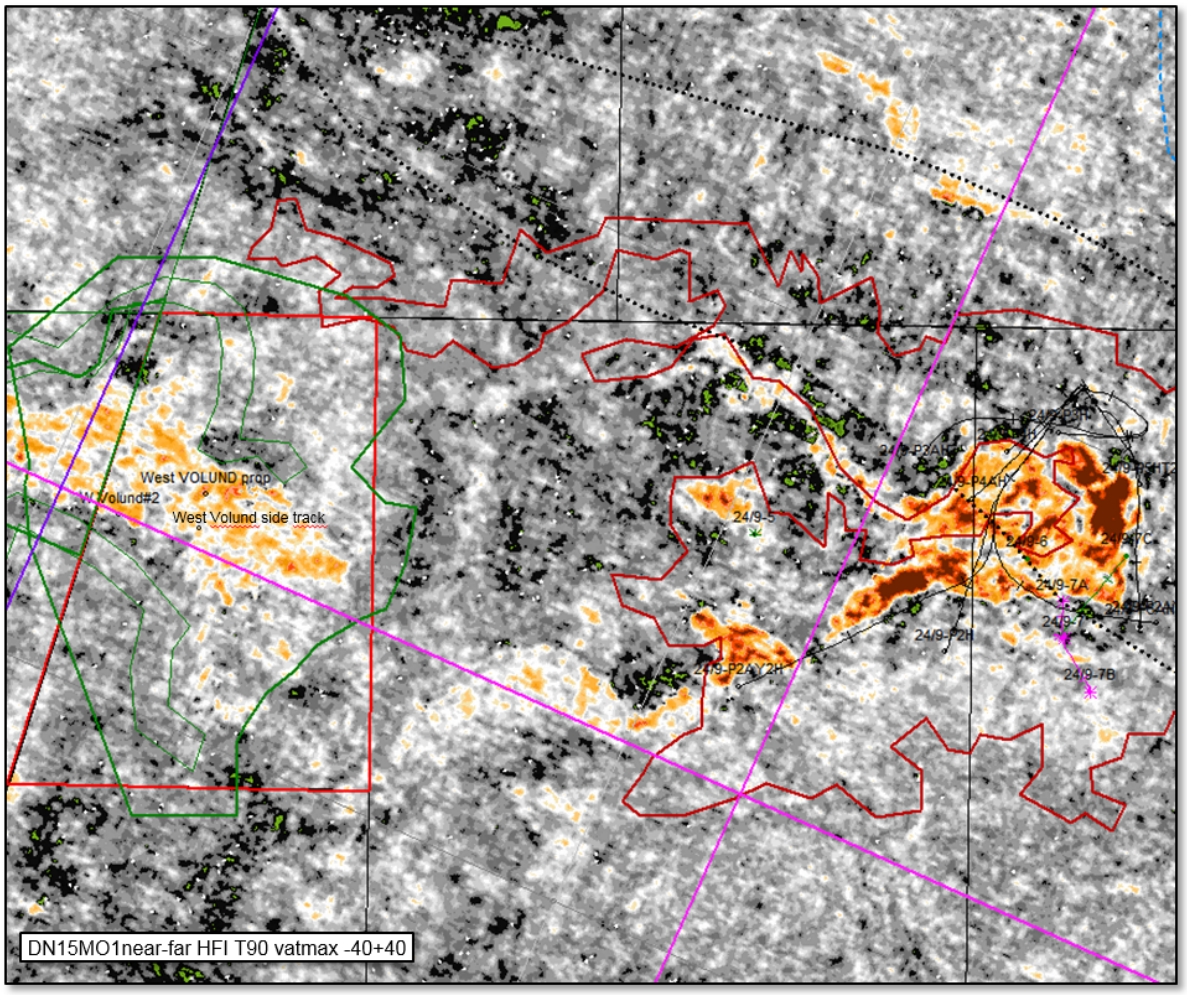

Fig. 1.5 AVO response at Volund and Volund West. An amplitude map within a 40 ms interval above the Top Sele in the DN15M01 near-far HFI

The underlying organic shales of Draupne and Heather formations are the source rocks for the hydrocarbons in the Alvheim and Volund area. Maturation studies indicate that hydrocarbon expulsion, and migration, started in the South Viking Graben during the latest Cretaceous time and continues to present day. The hydrocarbons are believed to have migrated up dip into the Tertiary reservoir rocks by vertical diffusion and along fault planes. The Draupne formation probably acts as a barrier for migration of hydrocarbons from the underlying Heather formation. Migration pathways was thought to be similar for the Volund West Prospect and the Volund Field.

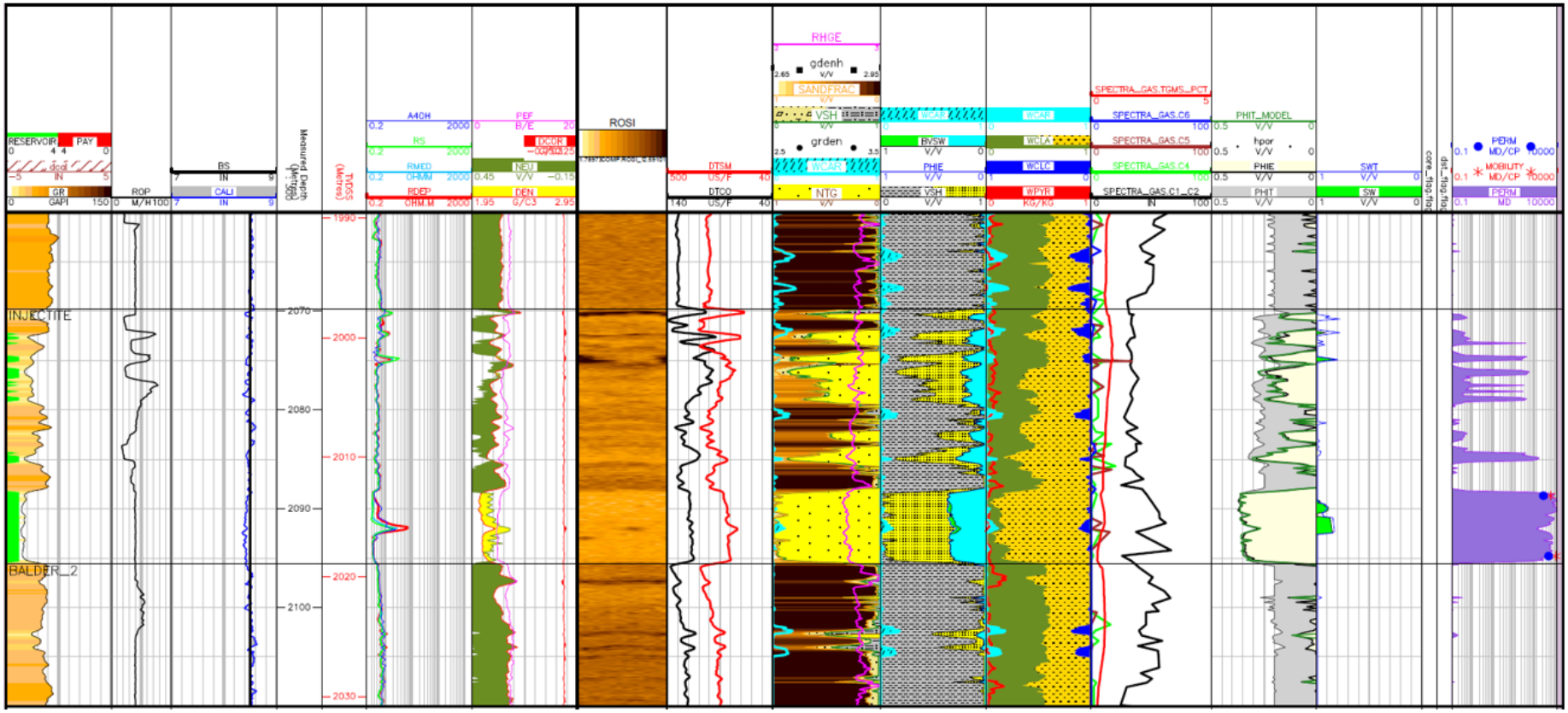

Fig. 1.6 24/9-11S CPI

2 DATABASE

2.1 Seismic Database

Several seismic datasets have been used in the evaluation of the PL150B area. The final geophysical evaluation of PL150 B was done on the 2015 reprocessing and merge of the NH9603 and PGS MC3D Geostreamer surveys (PGS reprocessing).

2.1.1 Seismic reprocessing

3D seismic reprocessing were done as described in 1.2 Award and Work Program. This was fulfilled by the reprocessed survey DN15M01, which is a part of the Greater Alvheim Area work carried out by Det norske (now AkerBP).

The Greater Alvheim reprocessing includes MC3D-NVG (NVG09/NVG10/NVG11), MC3D-SVG11, MC3D-BYL2013, MV3D-Q16203 and NH9603. DN15M01 is reprocessed using a state of the art PSDM processing flow including Complete Wavefield Imaging (CWI) comprising of Full Waveform Inversion (FWI) with Seperated Wavefield Imaging (SWIM) for quality control, TTI Velocity Model Building with dual azimuth model building over the NH9603 area and Final TTI Q-Kirchhoff Migration. This was done to increase the seismic resolution and improve the disturbed imaging beneath the shallow channels in the area. The seismic database is listed in Table 2.1 and shown in Fig. 2.1

Table 2.1 Seismic database

3D Seismic survey	Survey Type	Year	Offset data	Comment
DN15M01	PSDM Reprocessed 3D	2015	x	Detnor reprocessing including MC3D-NVG09/10/11, MC3DSVG11, MC3D-BYL2013, MV3D-Q16203 and NH9603

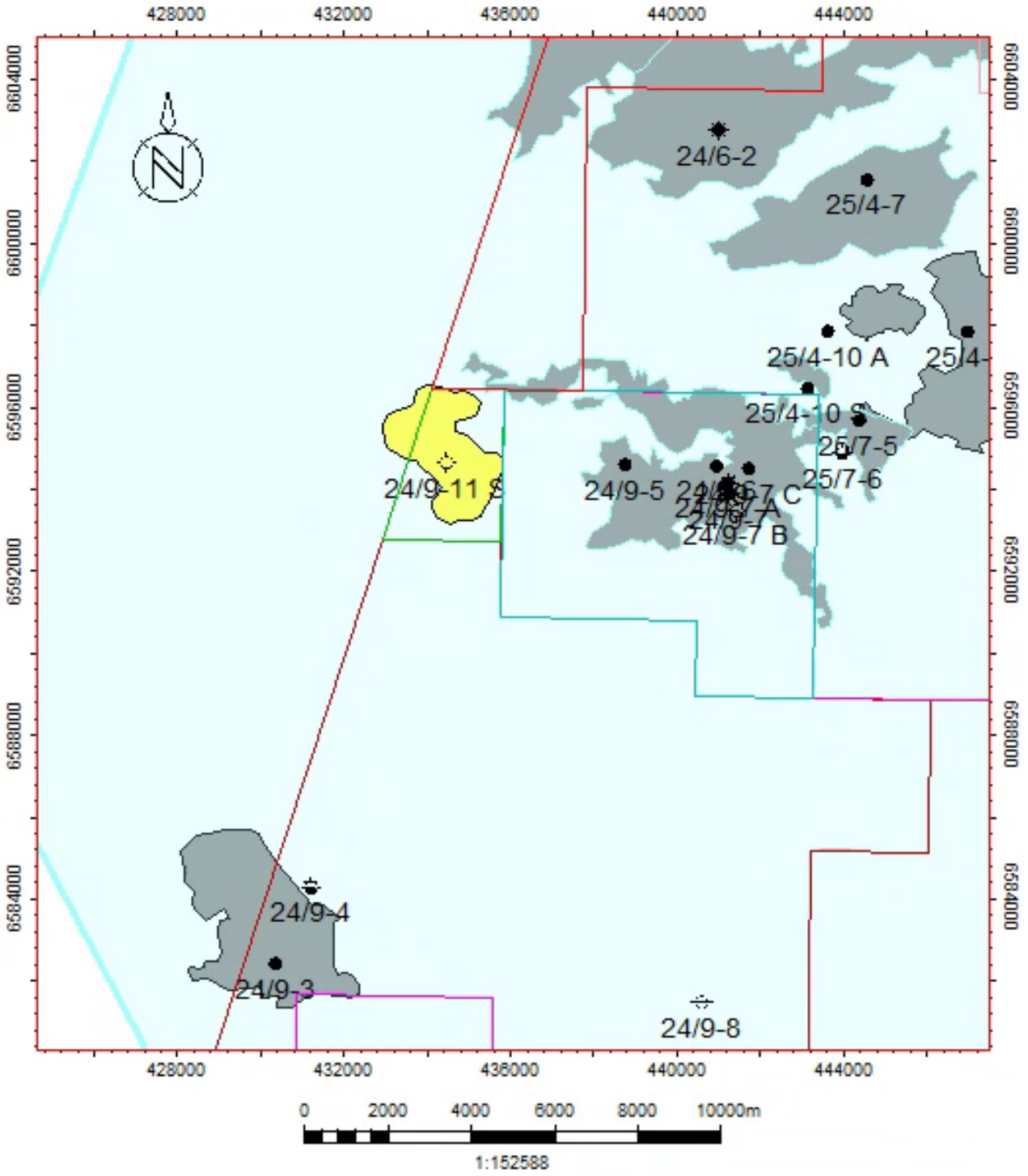

Fig. 2.1 Seismic database *In light blue: 3d coverage of DN15M01*

2.2 Well Data

A list of reference wells is presented below in the Table 2.2 and Fig. 2.2

Table 2.2 Well database

Well	Result	Year	Operator	TD	FM at TD
24/9-4	Shows	1991	Fina	2208	Lista
24/9-5	Oil	1993	Fina	2860	Jorsalfare
24/9-6	Oil	1994	Fina	2255	Heimdal
24/9-7	Oil/Gas	2004	Marathon	2279	Heimdal
25/4-10 S	Oil	2009	Marathon	2912	Hermod
25/7-5	Oil	1997	Norsk Hydro	2736	Heimdal
24/9-P x mm	N/A	N/A	Marathon	N/A	Balder/Sele

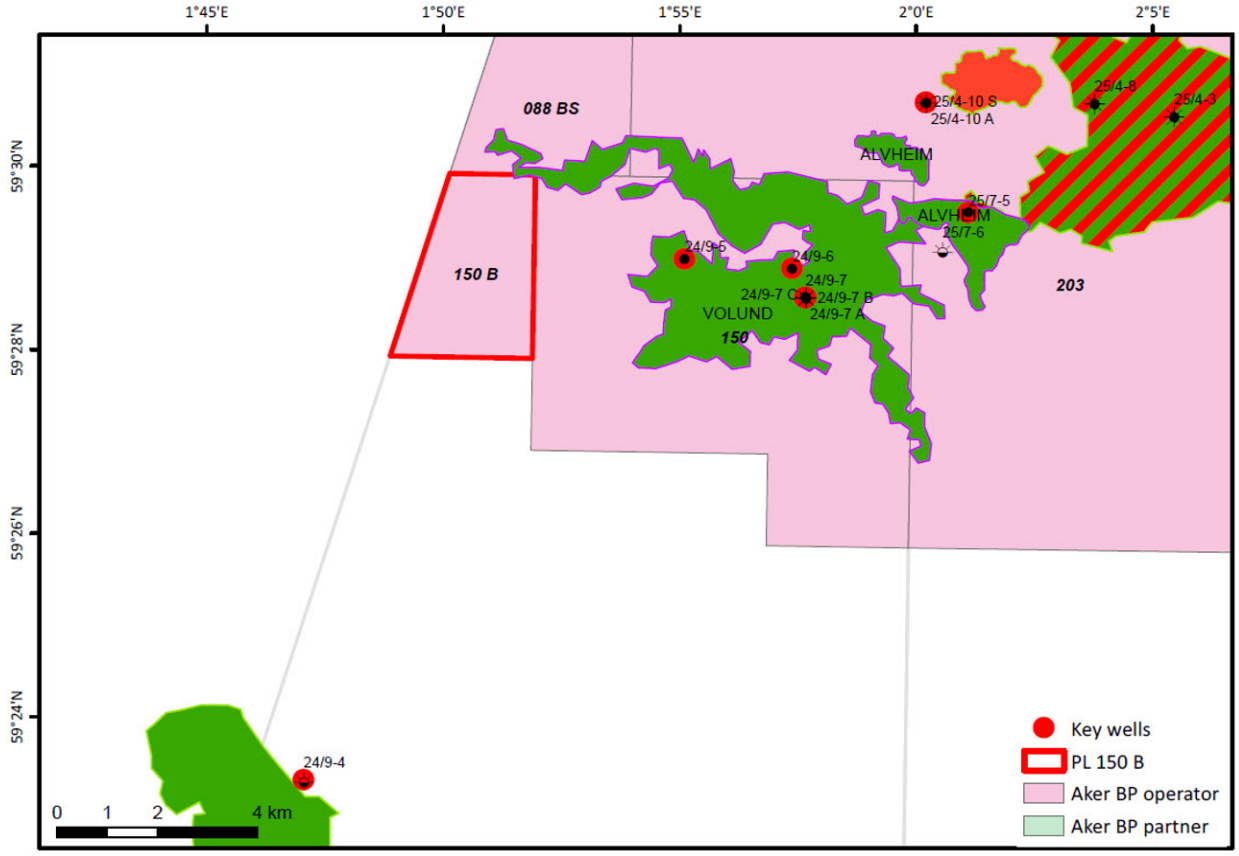

Fig. 2.2 Volund West reference wells marked in red. In addition the production wells in Volund are also used as reference wells (not marked on the map)

2.3 Special Studies

Seismic conditioning and analysis

Extensive geophysical work has been carried out on the entire dataset. This includes de-noising, spectral balancing and variable time adjustment of every angle stack to optimize for further AVO work. Coloured inversion for every stack and EEI cubes (Intercept vs Gradient rotations) resulting in lithology and fluid cubes are also produced.

Spectral decomposition

Spectral attribute analysis through spectral decomposition (Partyka et al. 1999) on DN15M01 has been performed at several stratigraphic levels. The spectral decomposition was carried out in order to understand reservoir distribution, in particular to enhance the imaging of depositional structures and injectites. Spectral decomposition is a frequency transform of a relatively short time window to capture details from a certain stratigraphic interval. By decomposing the signal into discrete frequency bands, some details not distinguished in a full bandwidth signal will become visible. In the case of a discrete layer in a background model, low frequencies will tune at thicker intervals than high frequencies. By exploiting RGB colour blending techniques, the discrete frequency components can be blended to illustrate thickness changes, highlighting depositional features and exploring for anomalies related to hydrocarbons. If a fluid contact is present, this will also impose a tuning response towards a dipping reservoir. Results from these studies are integrated with the prospect evaluation for better evaluation.

OGS

OpenGeoSolution based in Calgary, Canada carried out a spectral inversion and curvature analysis study on the whole DN15M01 dataset. Spectral inversion maximises the detection and resolution of layering that can be characterised using the bandwidth of available signal. This is done by uncoupling the source wavelet shape from the interference profile within the bandwidth of usable signal. Traditional techniques ink resolution and detection to the source wavelet shape in context of a single layer embedded in a quiet background. Spectral inversion on the other hand, relates resolution and detection to the available signal bandwidth, signal-to-noise ratio, the complexity of the local layering architecture, and the complexity of impedance contrasts within the local distribution of layering.

3 REMAINING PROSPECTIVITY

No remaining prospectivity identified

4 CONCLUSION

No remaining prospectivity is identified in the PL150B, and the license work program has been completed. G&G exploration work done in the license: evaluation of complex injectite geology. Interpretation, AVO evaluation and analysis of reprocessed seismic, DN15M01. Maturation and definition of the Volund West Prospect. The prospect was an amplitude driven prospect in injected Hermod sands, similar to the Volund Field. It was a high chance of success with 40 %, and the key risk was the seal. The exploration well 24/9-11 S (Volund Vest) was drilled with Transocean Arctic during the period 01.06.2017 - 13.06.2017. The exploration well was classified as dry, but with possible indications of residual hydrocarbons in the reservoir zone.

5 REFERENCES

Partyka et al. (1999): Interpretational applications of spectral decomposition in reservoir characterization, The Leading Edge, Vol.18, 353- 360.