PL799

Status Report at License Surrender

PGNiG Upstream Norway AS
Statoil Petroleum AS
VNG Norge AS

April 2017

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1 Key licence history

The PL799 license (Fig. 1.1) was awarded to PGNiG Upstream International AS (operator - 40%), Statoil Petroleum AS (20%), VNG Norge AS (20%) and Explora Petroleum AS (20%) on 6th February 2015 as part of the APA 2014 licensing round (TFO2014). The licence was granted for an initial period of 7 years to 6th February 2022.

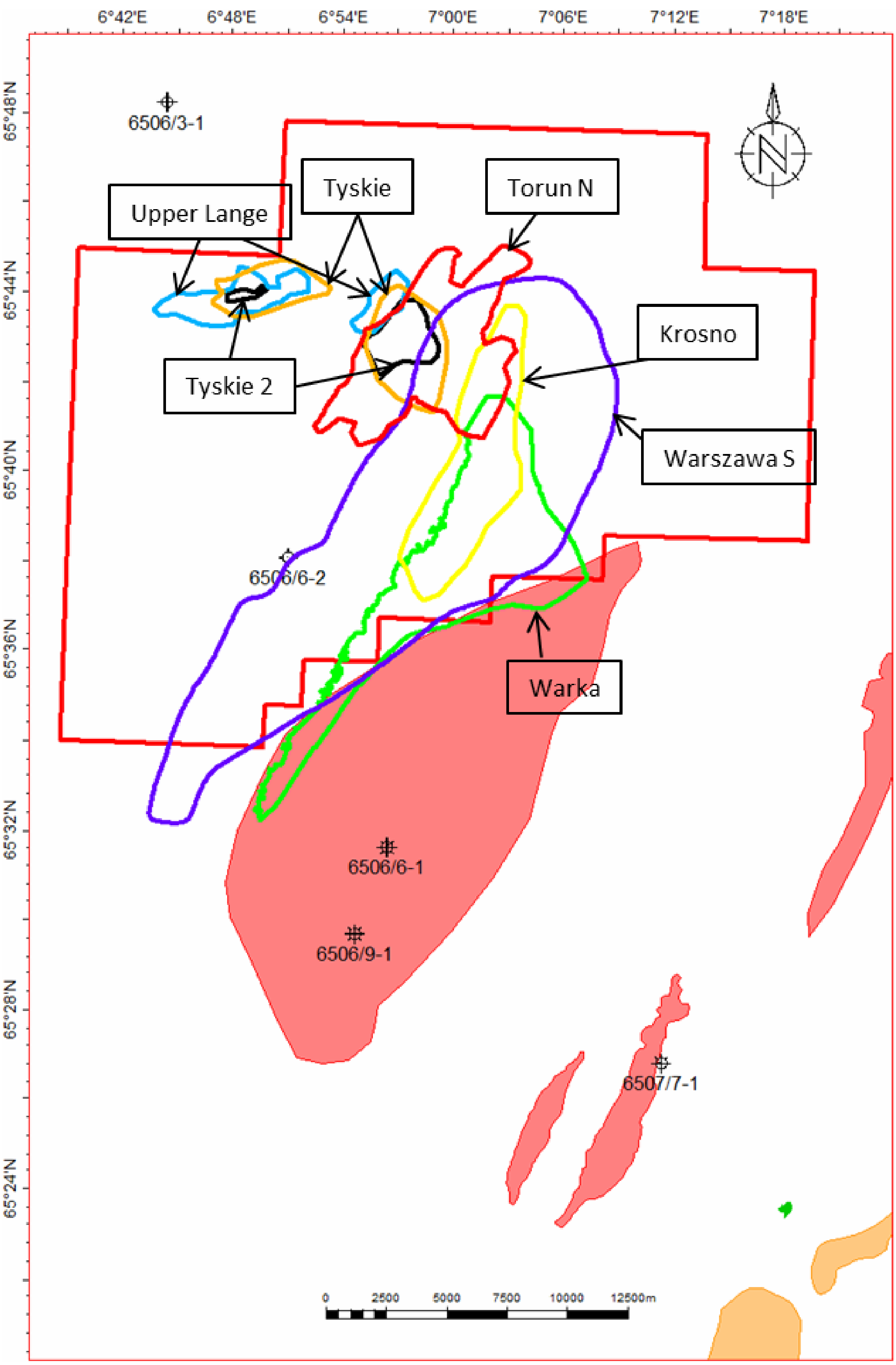

Fig. 1.1 PL799 license map. The polygons show outlines of the prospects in the license area. Prospect names are based on Polish cities and beers.

North E&P AS acquired Explora Petroleum AS in 2016 and became a partner from 24. February 2016 with 20% share in the license. North's share was later transferred to Statoil Petroleum AS, which increase its share to 40% from 29. April 2016.

The work obligations set by the authorities in the initial period was as follows:

- phase 1 - 2 years - procure or reprocess 3D seismic data, G&G studies, drill or drop decision (DoD),
- phase 2 - 2 years - drill one exploration well, concretize or drop decision (BoK),
- phase 3 - 2 years - perform conceptual studies, continuation or drop decision (BoV),
- phase 4 - 1 year - prepare development plan, decision to submit PDO or drop,

Regular license meetings have been held on the following dates:

- EC/MC Meeting No1 - 24.03.2015
- Work Meeting No1 - 25.06.2015
- EC/MC Meeting No2 - 11.11.2015
- Work Meeting No2 - 7.04.2016
- EC/MC Meeting No3 - 24.11.2016

The license work obligations have been fulfilled. One seismic survey was procured (parts of MC3D-HVG2011).
Based on the results from the studies and the internal work, the Operator of PL799 concluded to recommend partners to drill a well on Warka Prospect in the license.
The partners however did not support the Operator's recommendation and hence the license has been surrendered.

2 Database

2.1 Seismic data

To image the prospectivity in the license parts of the market available 3D seismic dataset MC3D-HVG2011 was procured from PGS. The dataset is a modern broadband seismic dataset of good quality, that was used both for interpretation, AVO and inversion studies in the license. Other seismic datasets were used for regional work (Table 2.1) (Fig. 2.1)

Table 2.1 Seismic database

3D Seismic Dataset	NPDID	Original Data	Year	Public	Qualtiy	Comments
MC3D-HVG2011	7379	Unique	2011	NO	High	Recent 3D seismic broadband technology from PGS
MN9602M		MN9602	1996	YES	Poor to Good	Survey covers most of the AOI. Variable quality in the Cretaceous section, partly poor reflectivity in the western part of the AOI.
MC3D-DTW2000	4047	Unique	2000	YES	Good to Very good	Survey convers a large area north of PL799 and the northern part of PL799. Some variations in the amplitude response indicate potential for improvements
MC3D-SKHN99M		SKH96, SKHN99, MN9601	1999	YES	Poor	Large merge but no significant signal and reflectivity enhancements from originals.

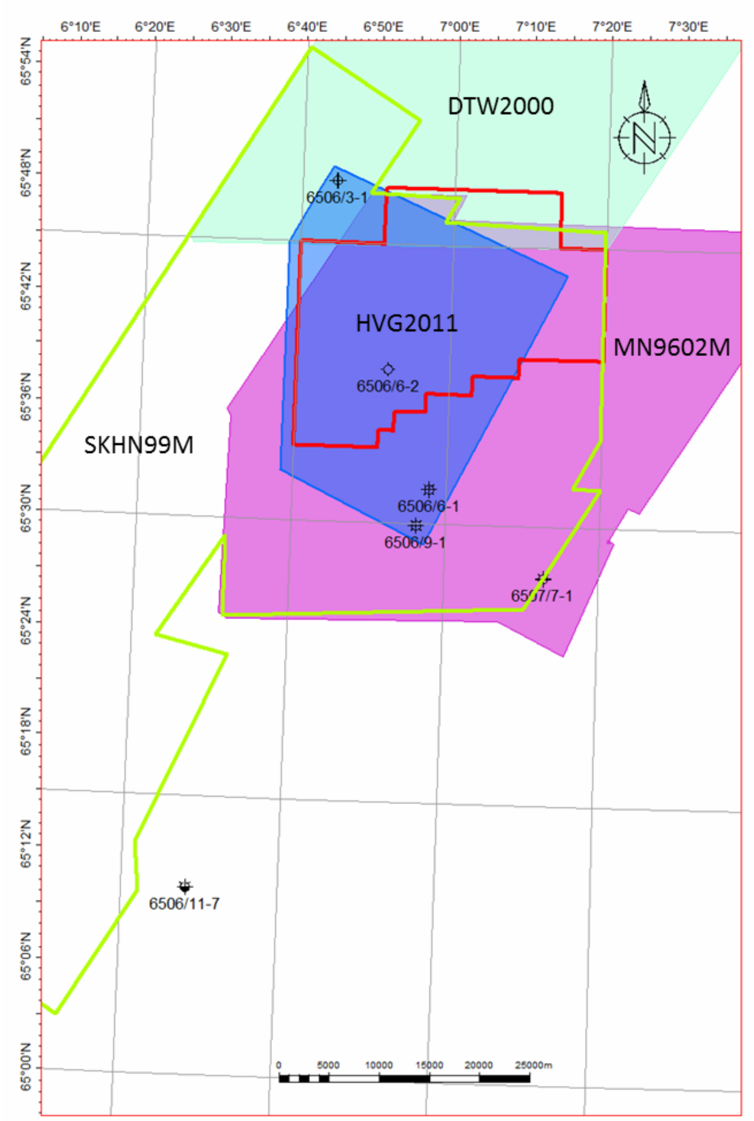

Fig. 2.1 Seismic and well database. Only key wells for the license are presented on the map

2.2 Well data

The main prospect in the license was originally the Torun N Prospect in Lysing Fm. Secondary prospectivity in several levels in Lange Fm. was identified during the license work. The well database includes key wells penetrating both Lysing Fm. sandstone and Lange Fm. sandstone layers between Marulk, Snadd, Victoria and Morvin fields. The wells have been studied to evaluate the reservoir potential in Lysing Fm. and in Lange Fm. The wells were the subject of several external and internal studies which were performed for the licence.
The key wells for Lysing Fm. analysis are listed in Table 2.2, while wells used for evaluation of the Lange Fm. sandstones are listed in Table 2.3. Publically available well data was sufficient for the analysis.

Table 2.2 Well database for Lysing Fm.

Well	NPDID	Name	Water depth m	Year	TD m MD RKB	Fm. at TD	Operator	Status	Content	Raw data availability
6506/3-1	4344	Cassandra	341	2001	3667	Lange	Chevron	Dry		Public
6506/6-1	4122	Victoria	434	2000	5491	Åre	Mobil	Discovery	Gas in Jurassic	Public
6506/6-2	6960	Albert	409	2013	3366	Early Cretaceous	Maersk Oil	Dry		Public
6506/9-1	5980	Victoria	416	2009	5664	Åre	Total	Appraisal	Gas in Jurassic	Public
6506/9-2S	6332	Fogelberg	281	2010	4805	Early Jurassic	Centrica	Discovery	Gas/cond. in Jurassic	Public
6506/11-3	1973		328	1992	4350	Not	Den norske		Oil/gas shows in Lysing&Lange	Public
6506/11-7	3322	Morvin	356	2001	4977.5	Åre	StatoilHydro	Discovery	Oil/gas in Jurassic	Public
6506/11-8	5295	Morvin	380	2006	4990	Tilje	Statoil ASA	Appraisal	Oil in Jurassic	Public
6506/12-5	852	Smørbukk S	301	1986	4587	Åre	Den norske	Appraisal	Oil in Lysing&Jurassic	Public
6507/1-1	4955	Sahara	397	2004	3745	Lange	Chevron Texaco	Dry		Public
6507/2-1	911		381	1986	4477	Åre	Norsk Hydro	Dry		Public
6507/2-2	1840	Marulk	384	1992	3958	Åre	Norsk Hydro	Discovery	Gas/cond. in Lysing&Lange	Public
6507/2-3	2299		355	1994	3972	Spekk	Norsk Hydro		Oil shows in Cret.	Public
6507/2-4	5685	Marulk	365	2008	3600	Lyr	Eni	Discovery	Gas/cond. in Lysing	Public
6507/5-3	4059	Snadd S	417	2000	3000	Lange	BP Amoco	Discovery	Gas in Lysing	Public
6507/5-6 S	6321	Snadd N	325	2010	4991	Lange	BP	Discovery	Gas in Lysing	Public
6507/7-1	138		367	1984	4825	Tilje	Conoco		Gas shows in Jurassic	Public
6507/7-12	3812		333	1999	3976	Spekk	Conoco		Oil shows in Lange	Public

Table 2.3 Well database for Lange Fm.

Well	NPDID	Name	Water depth m	Year	TD m MD RKB	Fm. at TD	Operator	Status	Content	Raw data availability
6406/1-2	4762	Sklinna Sør	383	2003	4500	Red Beds	Norsk Agip	Discovery	Gas/cond. in Lange	Public
6406/1-4	5183	Sklinna Sør	363	2005	4596	Red Beds	Eni			Public
6406/2-3	2849	Kristin	372	1997	5258	Åre	Saga	Discovery	Gas/cond. in Fangst/Båt	Public
6406/3-9	6594		315	2012	4183	Lange	Mærsk	Discovery	Oil in Lysing/Lange	Public
6506/9-1	5980	Victoria	416	2009	5664	Åre	Total	Appraisal	Gas in Jurassic	Public
6506/9-2S	6332	Fogelberg	281	2010	4805	Early Jurassic	Centrica	Discovery	Gas/cond. in Jurassic	Public
6506/11-2	1754	Lange	297	1991	4813	Åre	Statoil	Discovery	Oil/gas in Lange/Ile/Tilje	Public
6506/11-3	1973		328	1992	4350	Not	Den norske		Oil/gas shows in Lysing&Lange	Public
6506/11-4S	2736	Åsgard	303	1996	5110	Åre	Statoil		Oil/gas in Fangst/Båt	Public
6506/11-7	3322	Morvin	356	2001	4977.5	Åre	StatoilHydro	Discovery	Oil/gas in Jurassic	Public
6506/11-8	5295	Morvin	380	2006	4990	Tilje	Statoil ASA	Appraisal	Oil in Jurassic	Public
6507/2-2	1840	Marulk	384	1992	3958	Åre	Norsk Hydro	Discovery	Gas/cond. in Lysing&Lange	Public
6507/2-3	2299		355	1994	3972	Spekk	Norsk Hydro		Oil shows in Cret.	Public
6507/2-4	5685	Marulk	365	2008	3600	Lyr	Eni	Discovery	Gas/cond. in Lysing	Public
6507/7-1	138		367	1984	4825	Tilje	Conoco		Gas shows in Jurassic	Public
6507/7-12	3812		333	1999	3976	Spekk	Conoco		Oil shows in Lange	Public
6607/12-2 S	6642	Alve North	369	2011	4404	Early Jurassic	Total	Discovery	Oil/gas in Lange&Jurassic	Public

2.3 Special studies

The following studies have been performed to evaluate the prospectivity in the license:

internal studies:

- detailed mapping within Cretaceous;
- AVO study;
- petrophysical study;
- spectral decomposition analysis;
- depth conversion,

- pressure analysis;
- well cost benchmarking;

external studies:

- integrated geological and seismic inversion study (combined seismic inversion study and sedimentological / stratigraphical analysis) - CGG Robertsons 2016;
- basin modeling - Torena.

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3 Review of Geological and Geophysical studies

The main prospect identified in the licence area at application time was the Torun North prospect in the Lysing Fm. Secondary object was the Warszawa South lead in lower part of the Lange Fm. Both are seen as strong seismic anomalies. Primarily the work on the licence was focused on the Torun N prospect evaluation. At the same time extensive work was performed to identify further prospectivity within the Lange Fm. As a result several leads were recognized at different stratigraphic levels.
This section summarizes the main results of the geological and geophysical work and special studies carried out on the licence.

Seismic interpretation
The main regionally interpreted reflectors were the Seabed, Top Kai Fm., Base Tertiary (Lower Tertiary Unconformity), Top Shetland, Top Cromer Knoll, BCU, Base Viking Gp. and Top Åre coal. The depth grids of these horizons were used as input to the basin modelling study.

A detailed interpretation was carried out at the prospect level based on the HVG2011 seismic survey, both on full and far stack cubes. Synthetic seismograms were generated for all the wells covered by the seismic database(6506/3-1, 6506/6-1, 6506/6-2 and 6506/9-1) for proper interpretation of the Lysing Fm./Lange Fm. reflectors. Several horizons in the Lysing Fm. and in underlying sections have been interpreted to clarify a depositional pattern of the Lysing interval and the Torun N trap geometry.
In parallel, extensive mapping of the Lange Fm. horizons was performed. Interpretation of six continuous reflectors all over the license area allowed to subdivide the Lange Fm. into thinner stratigraphic sections for further analysis. After completion of the stratigraphic study these horizons were referred to their chronostratigraphic units (Top Aptian, Top Albian, Top Cenomanian, Middle Turonian, Top Middle Turonian and Late Turonian).
A detailed fault interpretation in the Lysing Fm. was carried out to understand the fault pattern with regards to potential HC accumulations.

AVO study
An AVO study was performed to identify if the amplitudes of a reflection could be classified as an indication of hydrocarbon filled reservoir. Potential reservoir horizons were identified over a large range of depths, resulting in the need to generate a depth varying model for how a hydrocarbon filled reservoir should behave. This model was generated using Herz-Mindlin modeling for shale, water filled sandstones and hydrocarbon filled sandstones, all calibrated to the wells in the area.
The seismic inversion study below performed seismic preconditioning, and generated intercept and gradient cubes from the seismic data. These were then used to calculate a AVO class cube and a fluid factor cube. The amplitudes from these cubes were used to categorize the reflections as reservoir filled with hydrocarbons or reservoir filled with brine. Detailed studies of the expected seismic response to tuning, net-to-gross variations and porosity variations were also performed.
The study showed that most of the identified horizons most likely represented thin, hydrocarbon filled reservoirs with limited volume potentials, except the deep Warka prospect that had amplitude behavior consistent with a thicker reservoir with good porosities filled with hydrocarbons.

External studies
Two external studies were performed in connection with the work program for PL799. They are listed in 2.3 Special studies. The Lange Fm. was main focus of the external studies as the Lysing Fm. is better known in the area(see also CGG Robertson Limited, 2014). Special efforts were put on predicting the reservoir presence and quality for identified prospects/leads

as well as on evaluation of hydrocarbon generation potential and migration paths into Cretaceous reservoirs.

A **basin modeling study** was carried out to investigate hydrocarbon expulsion and migration issues with focus on possible hydrocarbon charge to sandstones in the Lysing Fm. and various mapped Cretaceous sandstone fans in the Lange Fm.
The study shows that the Jurassic source rocks are highly mature in the area and that huge volumes of oil and gas have been expelled. The timing of expulsion relative to trap formations is encouraging compared to the deep-water areas further to the west. A major challenge for the area is migration from the Jurassic source rock levels to the Cretaceous. This is likely to have occurred due to hydraulic fracturing and capillary leakage at the apex of major closures, smaller closures and along faults.
Hydrocarbon charge to the Cretaceous sandstone levels are dominated by gas over oil and will in the sandstones occur as undersaturated gas, possibly supercritical for pressures higher than about 650 bar, but the condensate yields may still be significant. The main uncertainty for the Lange Fm. sandstone fans is migration. The setting is not optimal, but encouraging.
A major uncertainty for the Lysing Fm. is the flat lying geometry, i.e. even minor tilting back in geological time may have caused dramatic shifts in the migration directions.

An **integrated geological (sedimentology/biostratigraphy) and seismic inversion study** was performed by CGG's Geoconsulting division. Objectives of the analysis were to study the reservoir presence and distribution in the Lange Fm. and indicate reservoir parameters in the identified prospects. The results of the study are based primarily on data from 6 wells used in the geological study (6506/3-1, 6506/6-1, 6506/6-2, 6506/9-1, 6506/11-3, 6507/7-1), and 4 wells (6506/3-1, 6506/6-1, 6506/6-2, 6506/9-1) and 3D seismic survey MC3D-HVG2011 survey used for inversion study.

i. **Biostratigraphy** provided an integrated chronostratigraphic framework for the study wells. It uses the Norlex lithostratigraphic scheme. Biostratigraphic analysis showed that the Lyr Fm. was sedimented in an outer shelf setting from Valanginian to Barremian, followed by sedimentation of the Langebarn Fm. in outer shelf to upper bathyal environment during Aptian to Early Cenomanian. Common stratigraphic gaps are present in these units. The Blålange Fm. seems to lay conformably on the Langebarn Fm. in the Rås Basin, but unconformably in the Dønna Terrace. It was deposited in Early Cenomanian to Early Coniacian in an outer shelf to upper bathyal environment.
ii. **Sedimentology** provided facies analysis of cored sections in the Lange Fm. in 6506/3-1, 6506/11-3 and 6507/7-1 wells. Six facies associations were identified based on the core description. Reservoir quality is a function of depositional environment (i.e. facies associations). The facies associations were applied to the uncored sections of the Blålange and the Langebarn Fms. To enable a better calibration with the seismic inversion model, the facies associations were upscaled into "good reservoir" (high density turbidites), "poor reservoir" (low density turbidites, hybrid event, debris flow) and "non-reservoir" (distal turbidites, settling mud) groups. CGG created reservoir maps for 4 layers in the Blålange and Langebarn Fms. In the Langebarn Fm. the good reservoir potential is mainly focused on the eastern part of the license, along the upper slope at the break of the Dønna terrace. In the Blålange Fm. the good reservoir potential is focused in the north of the license where the deposit is more proximal.
iii. An **Inversion study** was performed in parallel with the sedimentology study described above, and utilized the results from the sedimentological study to define the acoustic properties of facies associated with good and poor reservoir. Preconditioning of the seismic data used in the inversion was performed at an early stage of the inversion. The preconditioning consisted of input of raw migration gathers, pre-stack radon demultiple, pre stack time alignment, angle stacking, denoise and post stack time

alignment. The result of the preconditioning was a dataset with improved signal to noise. The Low Frequency Model required in the inversion was generated using scaled seismic migration velocities and filtered well logs from all the wells covered by the seismic. Each of the wells covered by the seismic was used as input to the inversion. The facies identified in the sedimentlogical study was used to perform a Bayesian classification on the inverted seismic volumes, to classify the data into no-reservoir, poor reservoir, good reservoir with brine and good reservoir with hydrocarbons. The resulting data was hence used in estimating a sedimentological environment for depositing the identified reservoirs. The result was to a large degree in agreement with the AVO study preformed previously, and identified the Warka prospect as a potential drilling candidate.

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4 Prospect update report

In the APA 2014 application one prospect (Torun North in the Lysing Fm.) and five leads (Torun South, Gdansk, Gdansk North in the Lysing Fm., Warszawa South and Radom in the Lange Fm.) were mapped within the area of interest (Fig. 4.1). The Gdansk and the Gdansk North leads were outside the awarded license. The Radom lead area was downgraded early on and was not covered by the MC3D-HVG2011 survey.

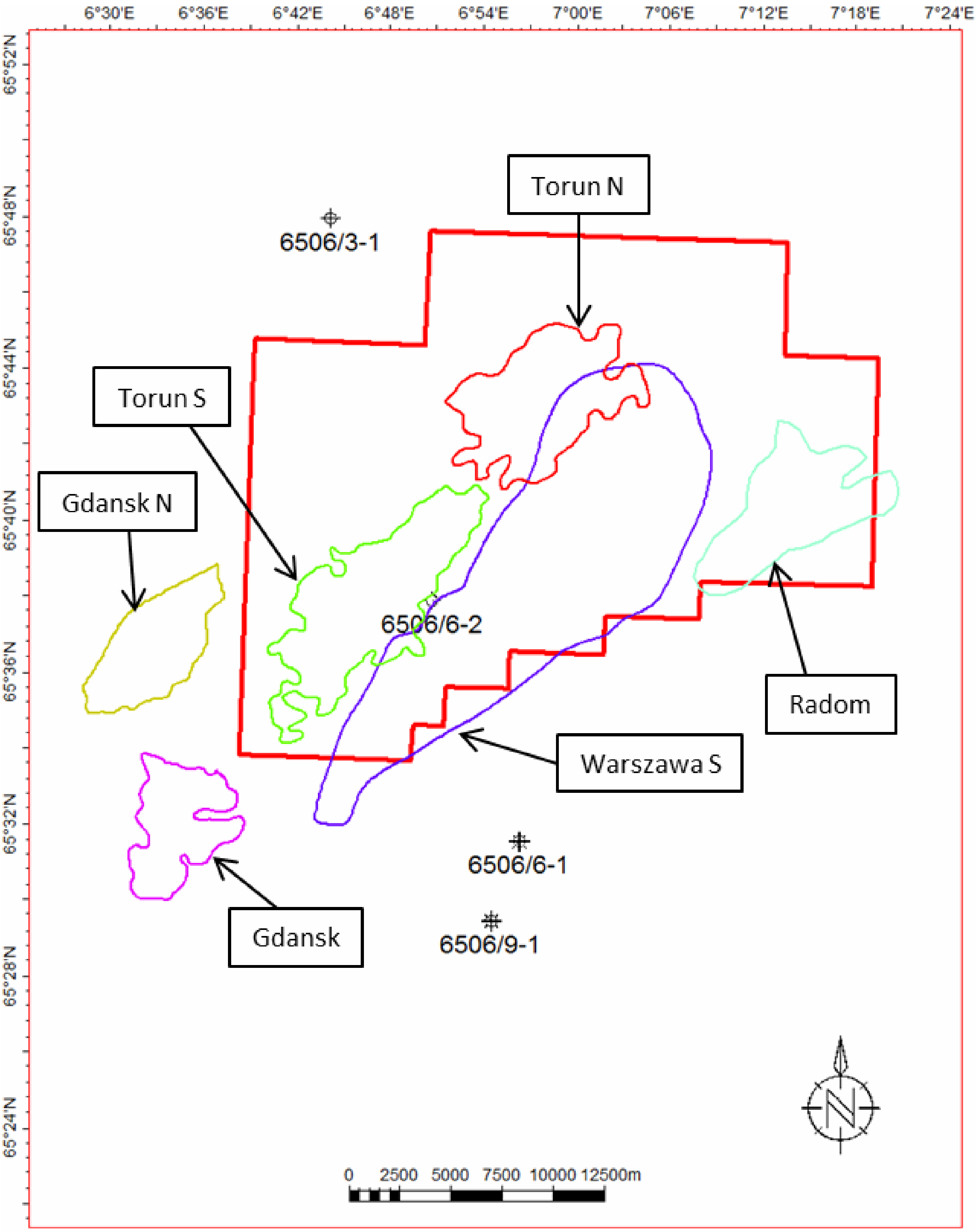

Fig. 4.1 Prospectivity identified in application phase

In addition, five leads were defined in Lange Fm.: Upper Lange, Tyskie, Tyskie 2, Krosno and Warka.

Torun North (Lysing Fm.)

Originally, Torun North was the main object in the license (Table 4.1). The prospect is a part of the vast Lysing fm. turbidite system deposited throughout the Haltenbanken area. The prospect is a stratigraphic trap with a structural component, defined as a seismic amplitude anomaly (Fig. 4.2). Detailed mapping of the Lysing Fm. horizons and fault system was performed on the common seismic database (HVG2011). It resulted in better trap definition - borders of the trap were changed compare to application phase and the trap showed segmentation. The reservoir is penetrated by the nearby wells (6506/6-2, 6506/6-1, 6506/9-1). It gives control on reservoir quality which is regarded as good (55-90 m thick, mode porosity 21%). The rock physics/AVO analysis indicates that all interpreted amplitudes represent various strengths of AVO anomalies. It was concluded that the anomalies seen in the Lysing Fm. represents hydrocarbons (gas) with limited volume potential within the trap (Table 4.2). The inversion results show high probability of good reservoir and the highest probability of HC presence over the prospect area (Fig. 4.3). The trap is regarded as underfilled probably due to escape of hydrocarbons during tilting.

Table 4.1 Original volumes for the Torun N prospect from APA application

Table 5: Prospect data (Enclose map)									
Block	6506/6&3, 6507/1&4	Prospect name	Torun North	Discovery/Prosp/Lead	Prospect	Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	
Play name	NPD will insert value	New Play (Y/N)		Outside play (Y/N)					
Oil, Gas or O&G case:	Gas	Reported by company	PGNiG UI AS	Reference document				Assessment year	2014
This is case no.:	1 of 1	Structural element	Dønna Terrace	Type of trap	Structural	Water depth [m MSL] (>0)	400	Seismic database (2D/3D)	3D
Resources IN PLACE and RECOVERABLE		**Main phase**				**Associated phase**			
Volumes, this case		Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)
In place resources	Oil [10^6 Sm^3] (>0.00)					0,89	2,00	2,05	3,23
	Gas [10^9 Sm^3] (>0.00)	5,58	13,40	12,70	19,80				
Recoverable resources	Oil [10^6 Sm^3] (>0.00)					0,50	1,09	1,19	1,91
	Gas [10^9 Sm^3] (>0.00)	3,17	6,94	7,39	11,70				
Reservoir Chrono (from)	Turonian	Reservoir litho (from)	Lysing Fm.	Source Rock, chrono primary	Upper Jurassic	Source Rock, litho primary	Spekk Fm.	Seal, Chrono	Santonian
Reservoir Chrono (to)	Coniacian	Reservoir litho (to)	Lysing Fm.	Source Rock, chrono secondary	Lower Jurassic	Source Rock, litho secondary	Åre Fm.	Seal, Litho	Kvitnos Fm.
Probability [fraction]									
Technical (oil + gas + oil & gas case) (0.00-1.00)	1,00	Oil case (0.00-1.00)	0,00	Gas case (0.00-1.00)	1,00	Oil & Gas case (0.00-1.00)	0,00		
Reservoir (P1) (0.00-1.00)	0,95	Trap (P2) (0.00-1.00)	0,80	Charge (P3) (0.00-1.00)	0,50	Retention (P4) (0.00-1.00)	0,70		
Parametres:	Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)	2970	2970	2970						
Area of closure [km^2] (> 0.0)	16,4	28,2	40,8						
Reservoir thickness [m] (> 0)	65	74	83						
HC column in prospect [m] (> 0)	35	47	54						
Gross rock vol. [10^9 m^3] (> 0.000)	1,621	1,625	1,627						
Net / Gross [fraction] (0.00-1.00)	0,65	0,70	0,78						
Porosity [fraction] (0.00-1.00)	0,18	0,21	0,23						
Permeability [mD] (> 0.0)	27,5	178,5	1019,0						
Water Saturation [fraction] (0.00-1.00)	0,20	0,26	0,33						
Bg [Rm3/Sm3] (< 1.0000)	0,0037	0,0037	0,0037						
1/Bo [Sm3/Rm3] (< 1.00)									
GOR, free gas [Sm^3/Sm^3] (> 0)	7092	6211	5494						
GOR, oil [Sm^3/Sm^3] (> 0)									
Recov. factor, oil main phase [fraction] (0.00-1.00)									
Recov. factor, gas ass. phase [fraction] (0.00-1.00)									
Recov. factor, gas main phase [fraction] (0.00-1.00)	0,50	0,59	0,65						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0,50	0,59	0,65	For NPD use:					
Temperature, top res [°C] (>0)	115			Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Pressure, top res [bar] (>0)	393			Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation	1. PHIE>=0.1	2. Vsh<=0.5	3. Sw<=0.6					Kart nr	NPD will insert value

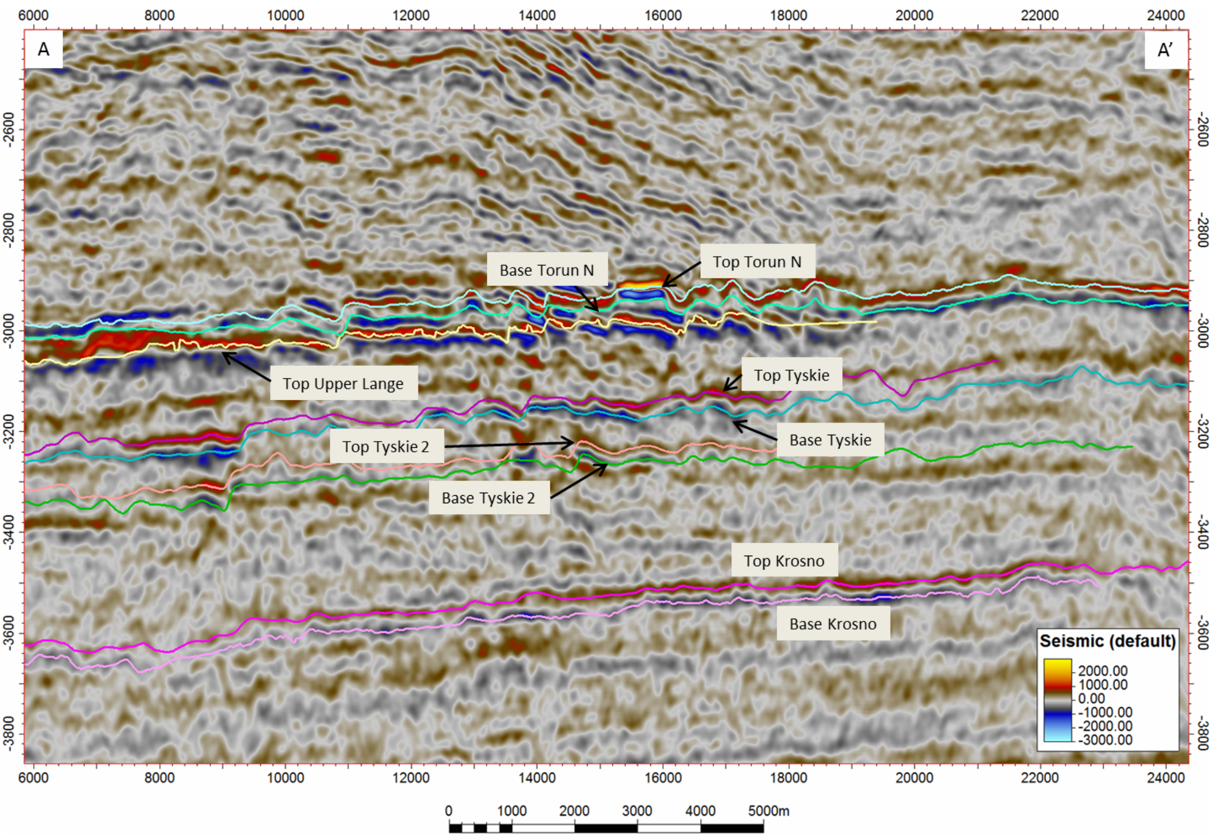

Fig. 4.2 Prospects in Lysing and Lange Fms (except for Warka prospect)

Table 4.2 Updated prospect data and volumes for Torun N

Table 5: Prospect data (Enclose map)									
Block	6506/6&3, 6507/1&4	Prospect name	Torun North	Discovery/Prosp/Lead		Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	
Play name	NPD will insert value	New Play (Y/N)		Outside play (Y/N)					
Oil, Gas or O&G case:	Gas	Reported by company	PGNiG UN AS	Reference document	0			Assessment year	2016
This is case no.:		Structural element	Dønna Terrace	Type of trap	Structural	Water depth [m MSL] (>0)	400	Seismic database (2D/3D)	
Resources IN PLACE and RECOVERABLE		**Main phase**				**Associated phase**			
Volumes, this case		Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)
In place resources	Oil [10^6 Sm^3] (>0.00)								
	Gas [10^9 Sm^3] (>0.00)	0,50	0,70	4,40	7,50	0,08	0,09	0,60	1,20
Recoverable resources	Oil [10^6 Sm^3] (>0.00)								
	Gas [10^9 Sm^3] (>0.00)	0,28	0,34	2,50	4,40	0,02	0,02	0,16	0,30
Reservoir Chrono (from)	Turonian	Reservoir litho (from)	Lysing Fm.	Source Rock, chrono primary	Upper Jurassic	Source Rock, litho primary	Spekk Fm.	Seal, Chrono	Santonian
Reservoir Chrono (to)	Coniacian	Reservoir litho (to)	Lysing Fm.	Source Rock, chrono secondary	Lower Jurassic	Source Rock, litho secondary	Åre Fm.	Seal, Litho	Kvitnos Fm.
Probability [fraction]									
Technical (oil + gas + oil & gas case) (0.00-1.00)	1,00	Oil case (0.00-1.00)	0,00	Gas case (0.00-1.00)	1,00	Oil & Gas case (0.00-1.00)	0,00		
Reservoir (P1) (0.00-1.00)	0,90	Trap (P2) (0.00-1.00)	0,80	Charge (P3) (0.00-1.00)	0,90	Retention (P4) (0.00-1.00)	0,80		
Parametres:	Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)	2955	2955	2955						
Area of closure [km^2] (> 0.0)	3,0	8,0	9,3						
Reservoir thickness [m] (> 0)	65	74	83						
HC column in prospect [m] (> 0)	43	52	59						
Gross rock vol. [10^9 m^3] (> 0.000)	0,528	0,539	0,541						
Net / Gross [fraction] (0.00-1.00)	0,60	0,70	0,78						
Porosity [fraction] (0.00-1.00)	0,15	0,21	0,26						
Permeability [mD] (> 0.0)	27,5	178,5	1019,0						
Water Saturation [fraction] (0.00-1.00)	0,30	0,20	0,10						
Bg [Rm3/Sm3] (< 1.0000)	0,0040	0,0038	0,0037						
1/Bo [Sm3/Rm3] (< 1.00)									
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)									
Recov. factor, oil main phase [fraction] (0.00-1.00)									
Recov. factor, gas ass. phase [fraction] (0.00-1.00)									
Recov. factor, gas main phase [fraction] (0.00-1.00)	0,50	0,56	0,62						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0,22	0,25	0,28	For NPD use:					
Temperature, top res [°C] (>0)	115			Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Pressure, top res [bar] (>0)	393			Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation	1. PHIE>=0.1	2. Vsh<=0.5	3. Sw<=0.6					Kart nr	NPD will insert value

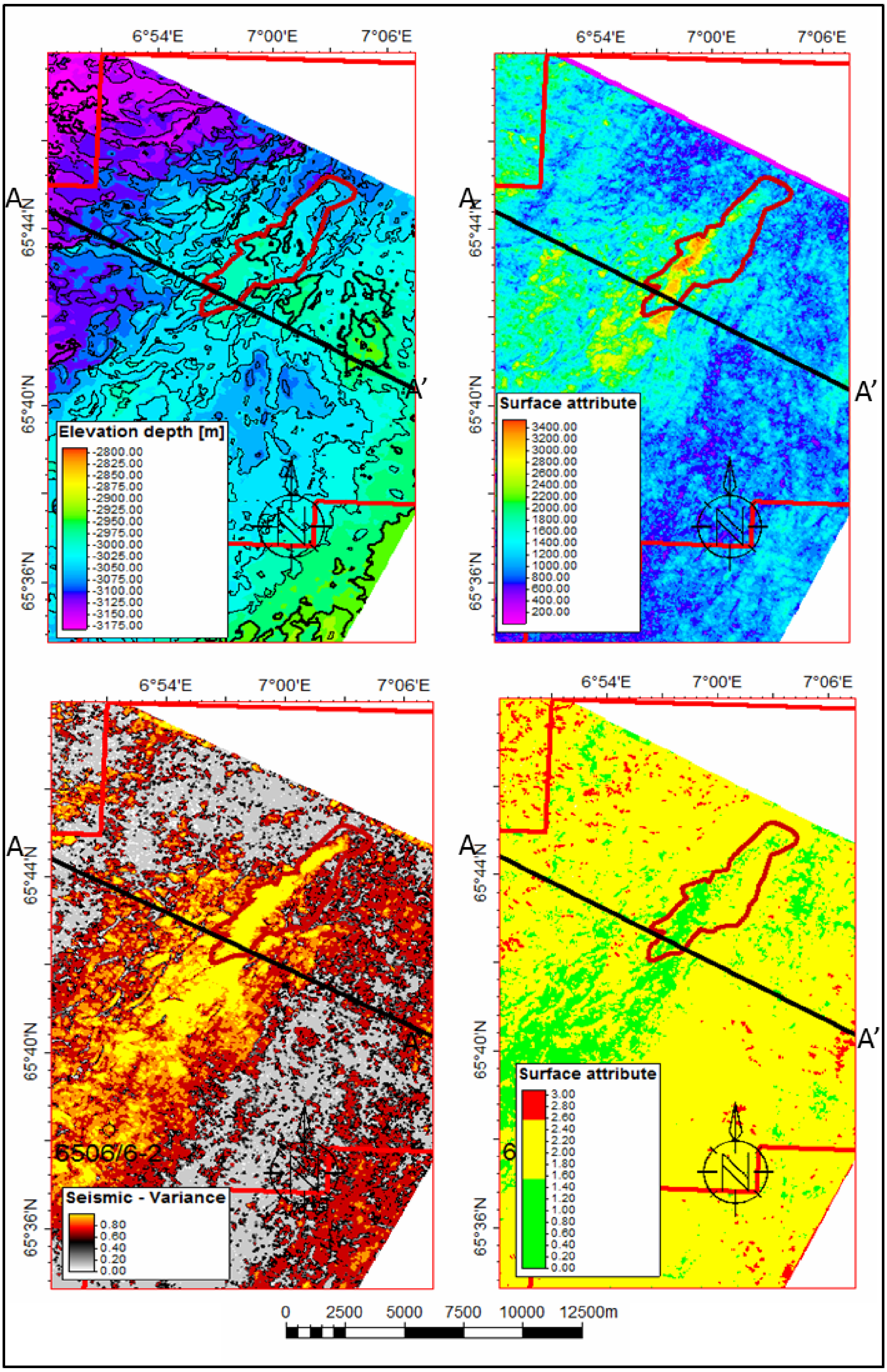

Fig. 4.3 The Torun N prospect - structural and attribute maps. The maps show (from upper left to lower right): structural map, RMS amplitude, AVO strength, most probable facies (green - good reservoir, yellow - poor reservoir, red - no reservoir).
The black line is location of a cross section in Fig. 4.2.

The following prospects were identified during detailed mapping of the Lange Fm. They are interpreted as deep water fan systems in different stages of the Late Cretaceous. Compare to the Lysing Fm. system they are limited spatially. They are defined as amplitude anomalies. It is assumed that these systems were deposited from a N-NE direction.

Upper Lange (Lange Fm. - Late Turonian)
The 6506/6-2 well penetrate these sands, showing about 20 m of poor, water wet sand with around 8% porosity. The well is drilled at the edge of the fan, making it probable that there are better sands more axial to the fan. The depth is very close to the same depth as for the Lysing Fm.
The AVO class of the strongest amplitude areas are II to III, consistent with hydrocarbons. We can expect, based on AVO analysis, that the sands are subject to tuning, possibly with a lower N/G, with a net thickness of below 10 m, but with a fairly high porosity (~20%).
The facies classification based on inversion indicates a very limited area of good reservoir in this amplitude (however, good reservoir is possible but under tuning thickness, as indicated during the AVO analysis) (Fig. 4.4). Tuning will also have a strong effect on the output from inversion (lower AI change and lower Vp/Vs ratio change) hence the lithofacies are also affected. The inversion results are showing elevated probabilities of good reservoir in the same areas as indicated by the AVO analysis, but not showing any increased probability of finding hydrocarbons.

Tyskie (Lange Fm. - Middle Turonian)
Tyskie and Tyskie 2 can be regarded as one depositional system with two stacked reservoir levels. Tyskie 2 has smaller extent and can be marked as initial phase of sedimentation followed by a main pulse in the Tyskie prospect level.

None of the wells has penetrated this sands. The depth of these reflectors are not very different to the Lysing sands. The AVO class of the highest amplitude areas are again class II to III, consistent with hydrocarbons. Based on this we would expect that the sands are hydrocarbon saturated, but with low net thicknesses (<10 m) or potentially low N/G but with relatively high porosities (~20%). It is difficult to separate between oil and gas.
The inversion facies extraction mostly indicates poor reservoir, but with some small spots of good reservoir (Fig. 4.5). The reason for this could again be a mixture of poor reservoir properties and thin reservoirs. When displaying the probability of good reservoir we see a very spotty looking image, partly consistent with what has been seen in the AVO analysis, but it also indicates a more geological looking deposition. The probability of hydrocarbon map is showing a very low probability of hydrocarbons.

Tyskie 2 (Lange Fm. - Middle Turonian)
There is no well control over this sands either (Fig. 4.6). The depth of these reflectors are a bit deeper than the Lysing sands at around 3500 m. The AVO class of the highest amplitude areas are again class II to III, consistent with hydrocarbons. Similarly to the Tyskie prospect, we would expect that the sands are hydrocarbon saturated, but with a very low net thicknesses (~5 m) and with relatively good porosities (~20%). The reservoir classification is indicating minor amounts of poor reservoir in the Tyskie 2 prospect. Again, the uncertainty is due to the thickness of the reservoir, tuning could easily lead to an underestimation of reservoir properties. At the same time there is little evidence of good reservoir in good reservoir probability, indicating even more tuning, or only poor reservoir. There is no evidence of hydrocarbons shown in the probability of hydrocarbons map.

Krosno (Lange Fm. - Cenomanian)
The expected reservoir has not been penetrated by any well. The depth of these reflectors are approximately 3900 m (Fig. 4.7). The AVO class of the highest amplitude areas are again

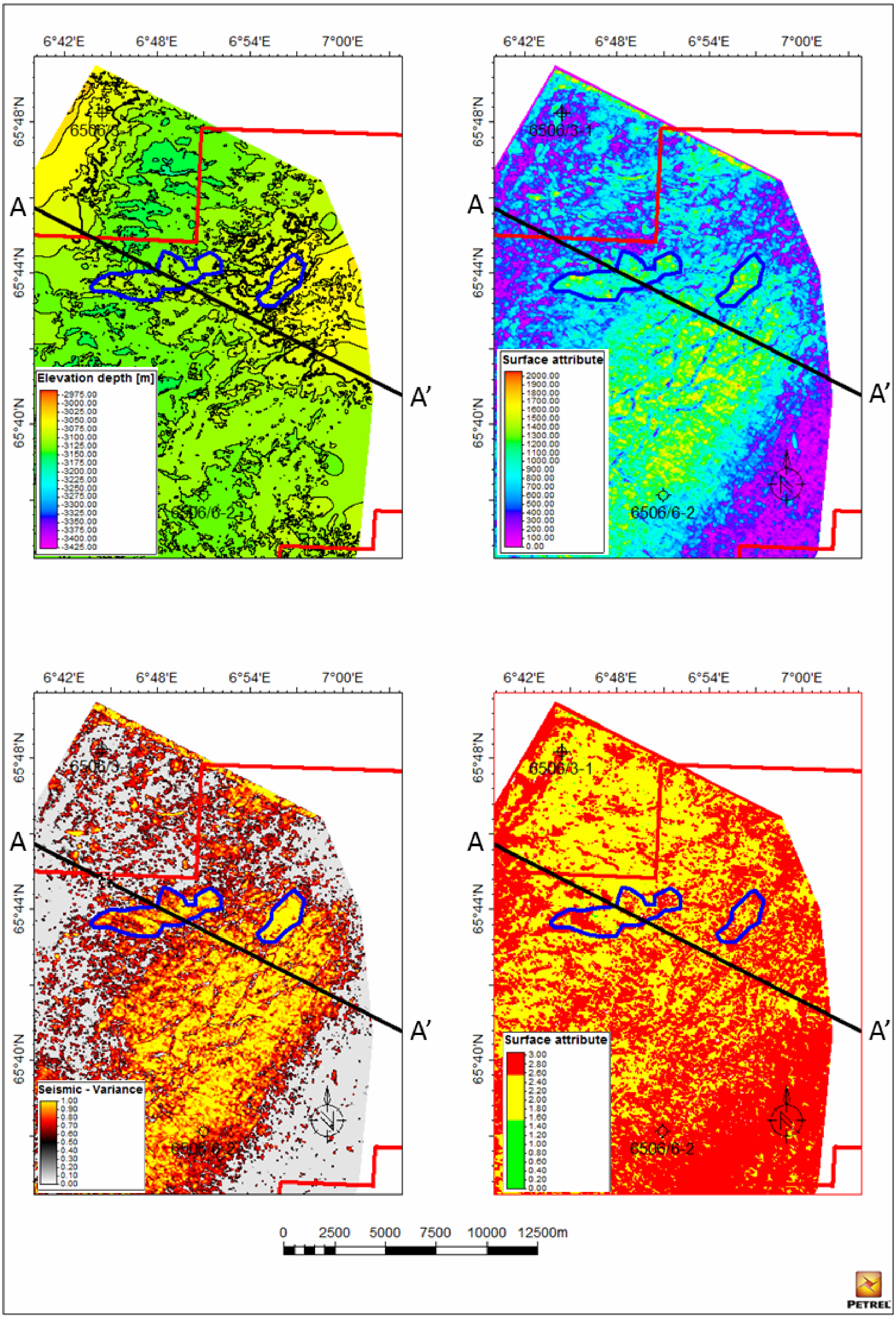

Fig. 4.4 The Upper Lange prospect. Map explanation in Fig. 4.3
Cross section is in Fig. 4.2

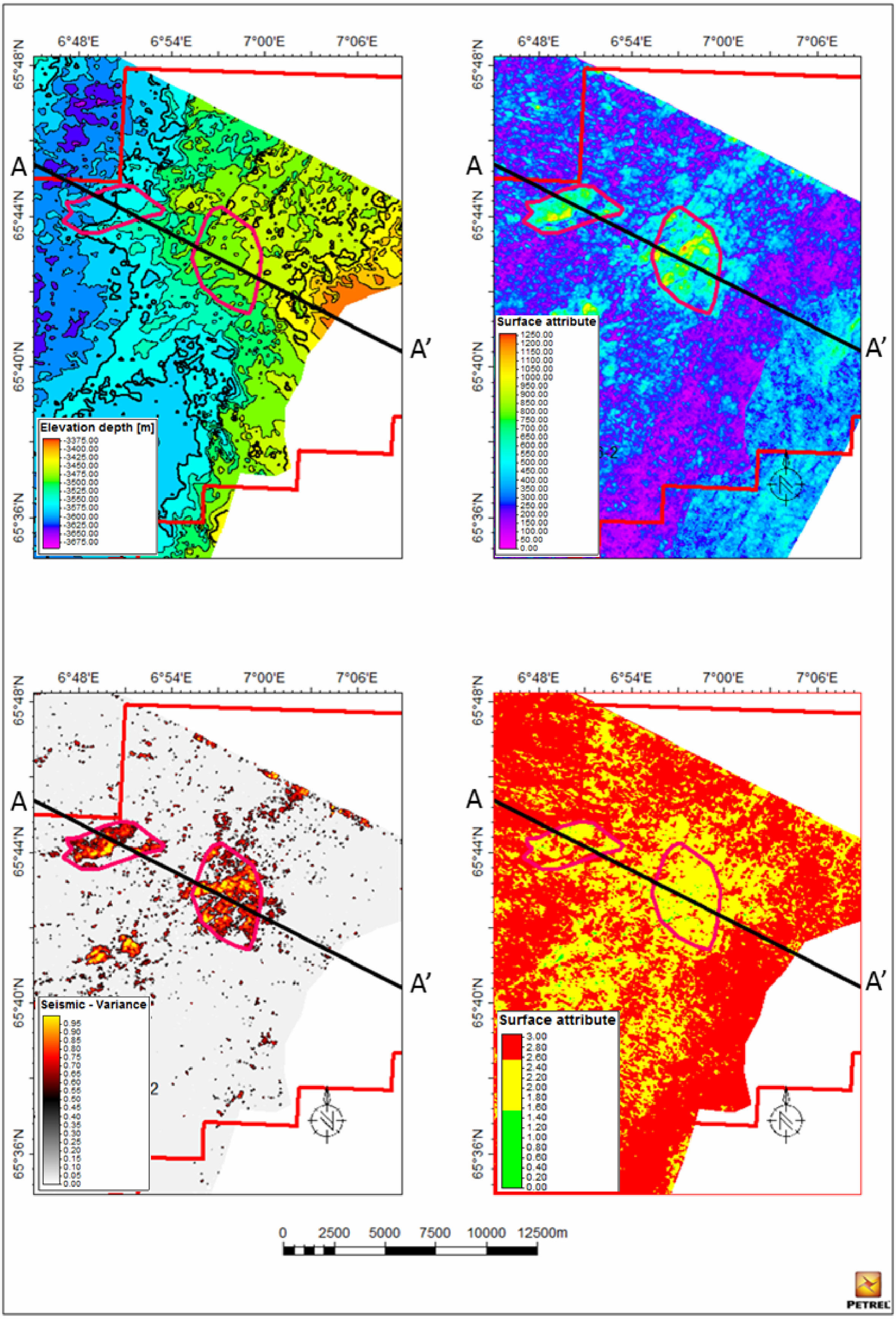

Fig. 4.5 The Tyskie prospect maps. For map explanation, see Fig. 4.2
The cross section is in Fig. 4.2

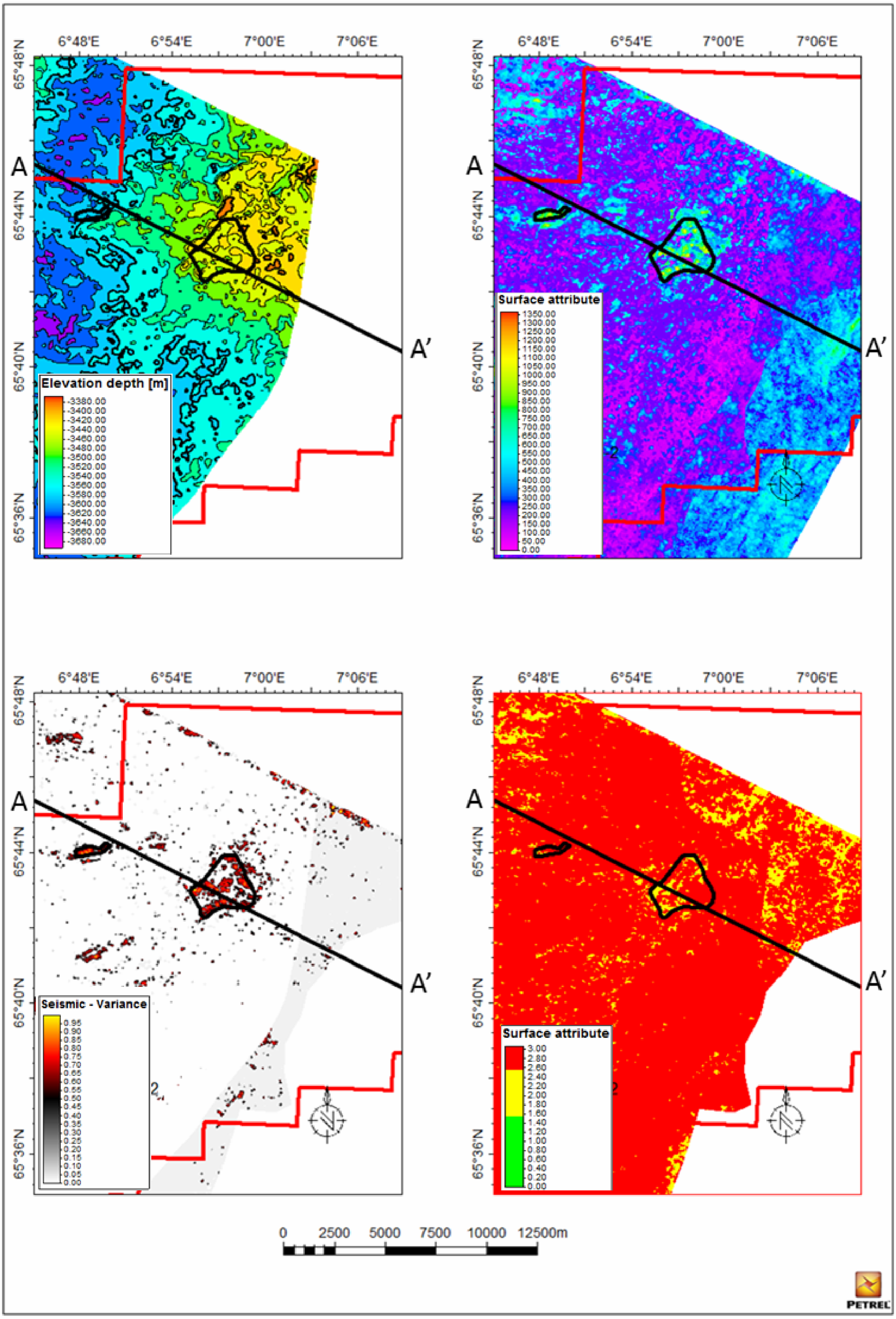

Fig. 4.6 The Tyskie 2 prospect maps. For figure explanation, see Fig. 4.3
The reference cross section is in Fig. 4.2

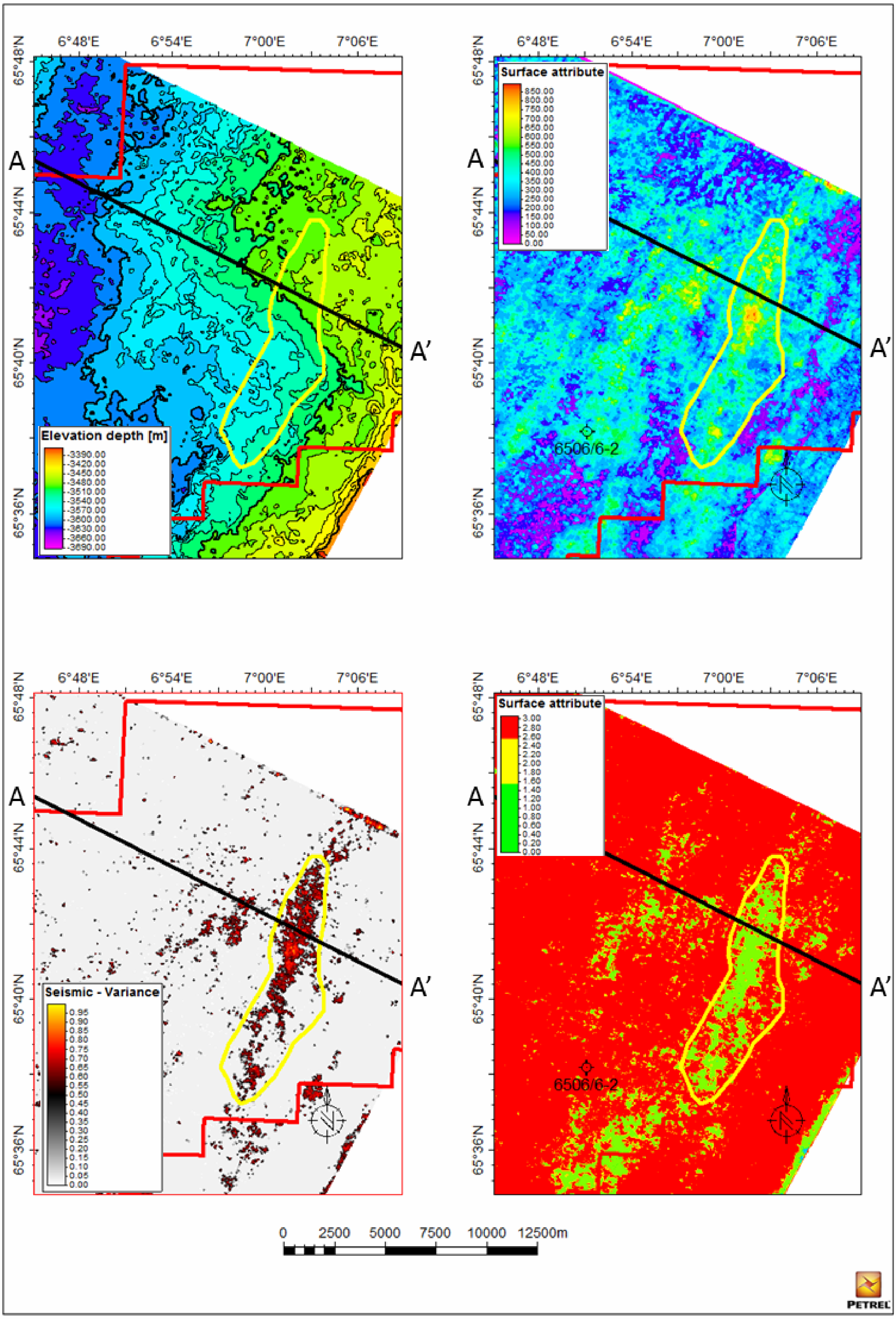

Fig. 4.7 The Krosno prospect. The map explanation is in Fig. 4.3.
The cross section is in Fig. 4.2

class II to III, consistent with hydrocarbons. Based on this we would expect that the sands are hydrocarbon saturated with relatively high porosities (~20%). It is difficult to separate between oil and gas. By comparing these amplitudes to the amplitudes of the Lysing amplitudes and the Warka horizon, it becomes clear that these amplitudes are 60% lower than expected, probably as a result of a net thinner reservoir. With this assumption we can assume that the net thickness of these sands are ~10 m.
The reservoir classification is indicating a poor reservoir in this lead. Again, this can be caused by a thin reservoir. There is no indication of elevated probability of hydrocarbons from the Bayesian classification.

Warka (Lange Fm. - Albian)
The Warka prospect is seen as strong, depth consistent amplitude anomaly (Fig. 4.8). The Warka prospect is interpreted as a slope fan system deposited from the east from the Haltenbanken area on slope of the Rås Basin. It is located on a saddle between the Victoria and the Marulk Highs. The Warka reservoir rocks have not been penetrated by any of the nearby wells. The depth of the interesting part of this reflector is around 4300-4600 m. The AVO class of the highest amplitude areas are class II, the model is expecting a class I for a 14% porosity sandstone both with hydrocarbons and with water. The class II AVO seen here is more in line with a 18-20% porosity. The strength of the AVO anomaly indicates that the data is not tuned, indicating a good thickness and good N/G. The sedimentological calibrated inversion has identified the Warka prospect as a high chance (60/70%) of having good reservoir (reservoir quality equivalent to high density turbidites) (Fig. 4.9). The probability cube for hydrocarbons is indicating an elevated chance of finding hydrocarbons in the Warka prospect, however the amount of hydrocarbons are not consistent with what was found in the AVO analysis. The AVO analysis takes into account depth variations of the reservoir while the inversion interpretation is heavily influenced by the shallow Lysing sands.

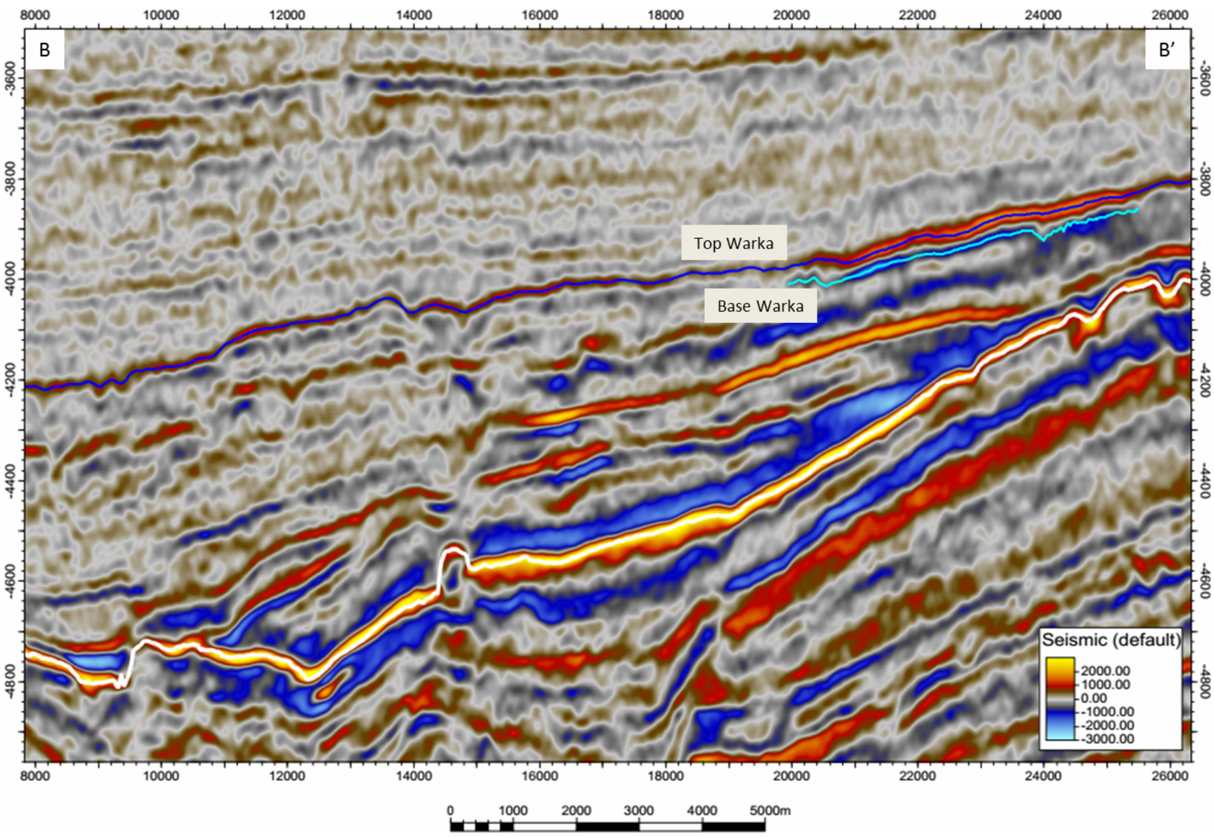

Fig. 4.8 A cross section through the Warka prospect

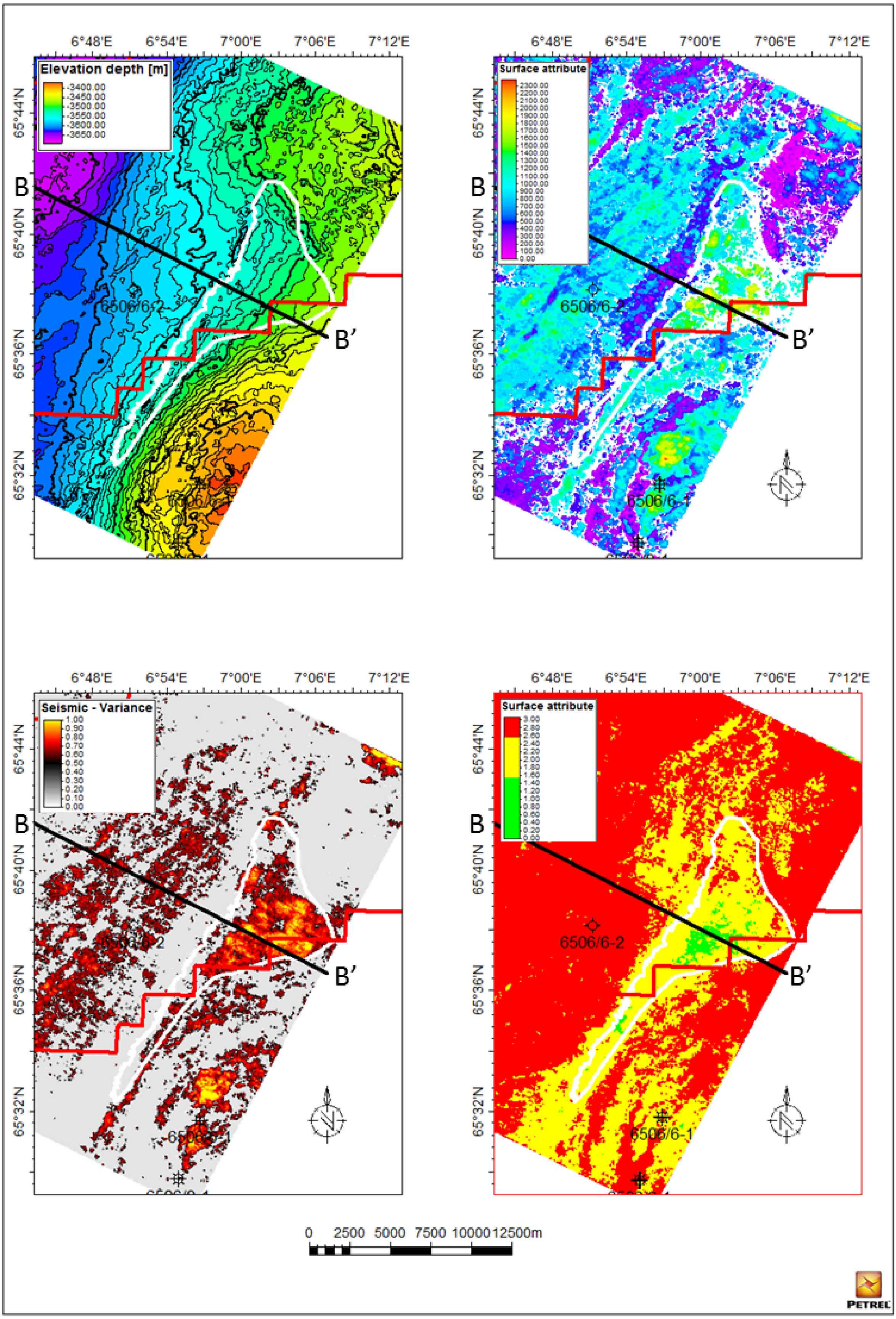

Fig. 4.9 The Warka prospect. Explanation to the maps is in Fig. 4.3.
The cross section is in Fig. 4.8

The Warka prospect was upgraded to the main prospect in the license with the Operator's drill recommendation (Table 4.3).

Table 4.3 Prospect data for Warka

Table 5: Prospect data (Enclose map)

Block	6506/6, 6507/4	Prospect name	Warka	Discovery/Prosp/Lead	Prospect	Prosp ID (or New!)	NPD will insert value	NPD approved (Y/N)	
Play name	NPD will insert value	New Play (Y/N)		Outside play (Y/N)					
Oil, Gas or O&G case:	Gas	Reported by company	PGNiG UI AS	Reference document	0			Assessment year	2016
This is case no.:		Structural element	Dønna Terrace	Type of trap	Stratigraphic	Water depth [m MSL] (>0)	400	Seismic database (2D/3D)	
Resources IN PLACE and RECOVERABLE		**Main phase**				**Associated phase**			
Volumes, this case		Low (P90)	Base, Mode	Base, Mean	High (P10)	Low (P90)	Base, Mode	Base, Mean	High (P10)
In place resources	Oil [10^6 Sm^3] (>0.00)								
	Gas [10^9 Sm^3] (>0.00)	6,75	25,00	29,10	49,70	1,10	2,14	9,50	21,50
Recoverable resources	Oil [10^6 Sm^3] (>0.00)								
	Gas [10^9 Sm^3] (>0.00)	3,14	9,97	13,90	24,20	0,50	1,20	4,50	10,20
Reservoir Chrono (from)	Albian	Reservoir litho (from)	Lange Fm.	Source Rock, chrono primary	Late Jurassic	Source Rock, litho primary	Spekk Fm.	Seal, Chrono	Cenomanian
Reservoir Chrono (to)	Albian	Reservoir litho (to)	Lange Fm.	Source Rock, chrono secondary	Early Jurassic	Source Rock, litho secondary	Åre Fm.	Seal, Litho	Lange Fm.
Probability [fraction]									
Technical (oil + gas + oil & gas case) (0.00-1.00)	1,00	Oil case (0.00-1.00)	0,00	Gas case (0.00-1.00)	1,00	Oil & Gas case (0.00-1.00)	0,00		
Reservoir (P1) (0.00-1.00)	0,48	Trap (P2) (0.00-1.00)	1,00	Charge (P3) (0.00-1.00)	0,80	Retention (P4) (0.00-1.00)	0,60		
Parametres:	Low (P90)	Base	High (P10)	*Comments*					
Depth to top of prospect [m MSL] (> 0)	4335	4335	4335						
Area of closure [km^2] (> 0.0)	28,0	40,0	52,2						
Reservoir thickness [m] (> 0)	40	50	60						
HC column in prospect [m] (> 0)	150	230	275						
Gross rock vol. [10^9 m^3] (> 0.000)	1,350	2,975	5,075						
Net / Gross [fraction] (0.00-1.00)	0,37	0,57	0,73						
Porosity [fraction] (0.00-1.00)	0,14	0,17	0,19						
Permeability [mD] (> 0.0)	3,0	23,0	135,0						
Water Saturation [fraction] (0.00-1.00)	0,30	0,21	0,15						
Bg [Rm3/Sm3] (< 1.0000)	0,0033	0,0032	0,0031						
1/Bo [Sm3/Rm3] (< 1.00)									
GOR, free gas [Sm^3/Sm^3] (> 0)									
GOR, oil [Sm^3/Sm^3] (> 0)									
Recov. factor, oil main phase [fraction] (0.00-1.00)									
Recov. factor, gas ass. phase [fraction] (0.00-1.00)									
Recov. factor, gas main phase [fraction] (0.00-1.00)	0,40	0,48	0,55						
Recov. factor, liquid ass. phase [fraction] (0.00-1.00)	0,40	0,48	0,55	For NPD use:					
Temperature, top res [°C] (>0)				Innrapp. av geolog-init:	NPD will insert value	Registrert - init:	NPD will insert value	Kart oppdatert	NPD will insert value
Pressure, top res [bar] (>0)	760			Dato:	NPD will insert value	Registrert Dato:	NPD will insert value	Kart dato	NPD will insert value
Cut off criteria for N/G calculation	1.	2.	3.					Kart nr	NPD will insert value

Due to and AVO anomaly more in line with organic rich shales the **Warszawa S** has not been evaluated further and is regarded as a lead.

5 Technical evaluations

A technical evaluation and an economic analysis were performed for the Torun N and the Warka prospect. In-place volumes were generated in GeoX, permeability range was populated from petrophysical analysis of offset wells. A tie-back to FPSO Skarv (30 km away) is considered for both, as volumes are too small to justify a stand-alone development. The prospects would be developed as subsea tiebacks, utilizing subsea templates. Pressure depletion has been adopted for production strategy. The maximum wellhead pressure for Warka has been estimated at the level of 630 bar (P10 case with reservoir pressure 780 bar). An appraisal well for P10 case includes 15 days extended well test EWT. Nearby Victoria field could be considered as a joint development case at a later stage. CO_2 content of 10-11% in Victoria currently prevents the idea of merging gas streams from Victoria and Warka.

The economic evaluation of Torun is showing that the EMV of the prospect is negative. NPV is only positive for the P10 success case.
The economic evaluation of Warka is showing that the EMV of the prospect is positive. NPV is positive both for the P50 and P10 cases.

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6 Conclusions

The evaluation of the licence area has contributed to increased understanding of depositional system and sand distribution of the Lange Fm. The analysis showed that turbidity systems are most likely present in the prospect area in many different stages in Cretaceous. In the Operator's opinion the Cretaceous play is underexplored in the license area.

The reasons for surrender:

Based on the geological and geophysical evaluation, and positive economical analysis, the Operator recommended to drill the Warka prospect. The license partners did not support the drill decision. According to voting rules the license has therefore been surrendered.

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CGG Robertson Limited, 2014. Sedimentology, petrography and reservoir quality analysis of the Late Cretaceous Lysing Formation (report made for PL648S)