

PL 928

Relinquishment Report



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1 KEY LICENSE HISTORY

The PL928 license is located in the eastern part of the northern North Sea, structurally situated on the Måløy slope east of the Gjøa Field and north of the Nova discovery. PL928 covers part of block 35/9. License outline and nearby fields and discoveries are shown in Fig. 1.1. The Titan discovery made in 2010, with initial prospects and leads identified in the APA 2017 application are shown in Fig. 1.2. Prospects and leads mapped in the license are further described in section 4 Prospect Update.

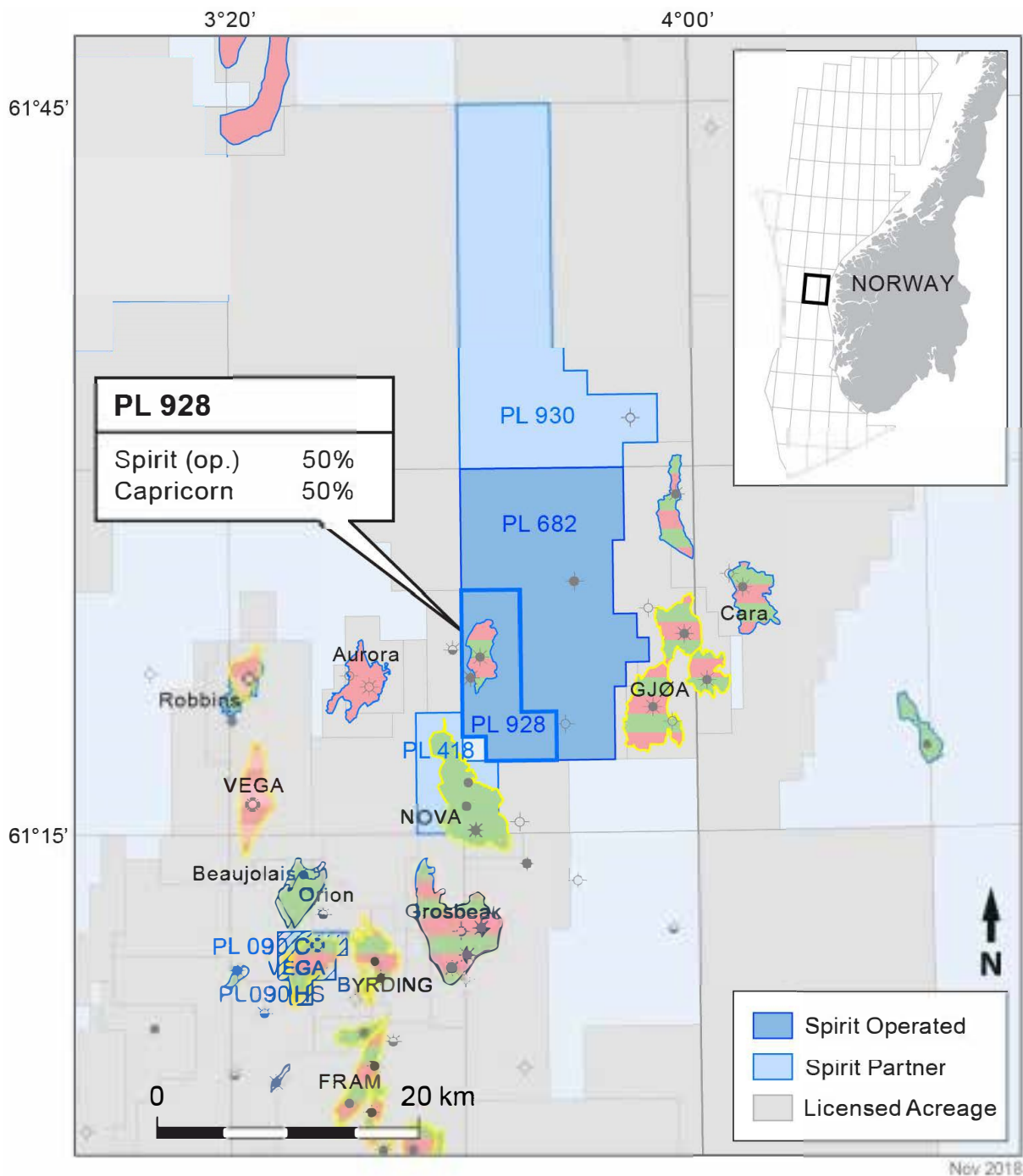


Fig. 1.1 License overview map PL928 - license area with fields and discoveries

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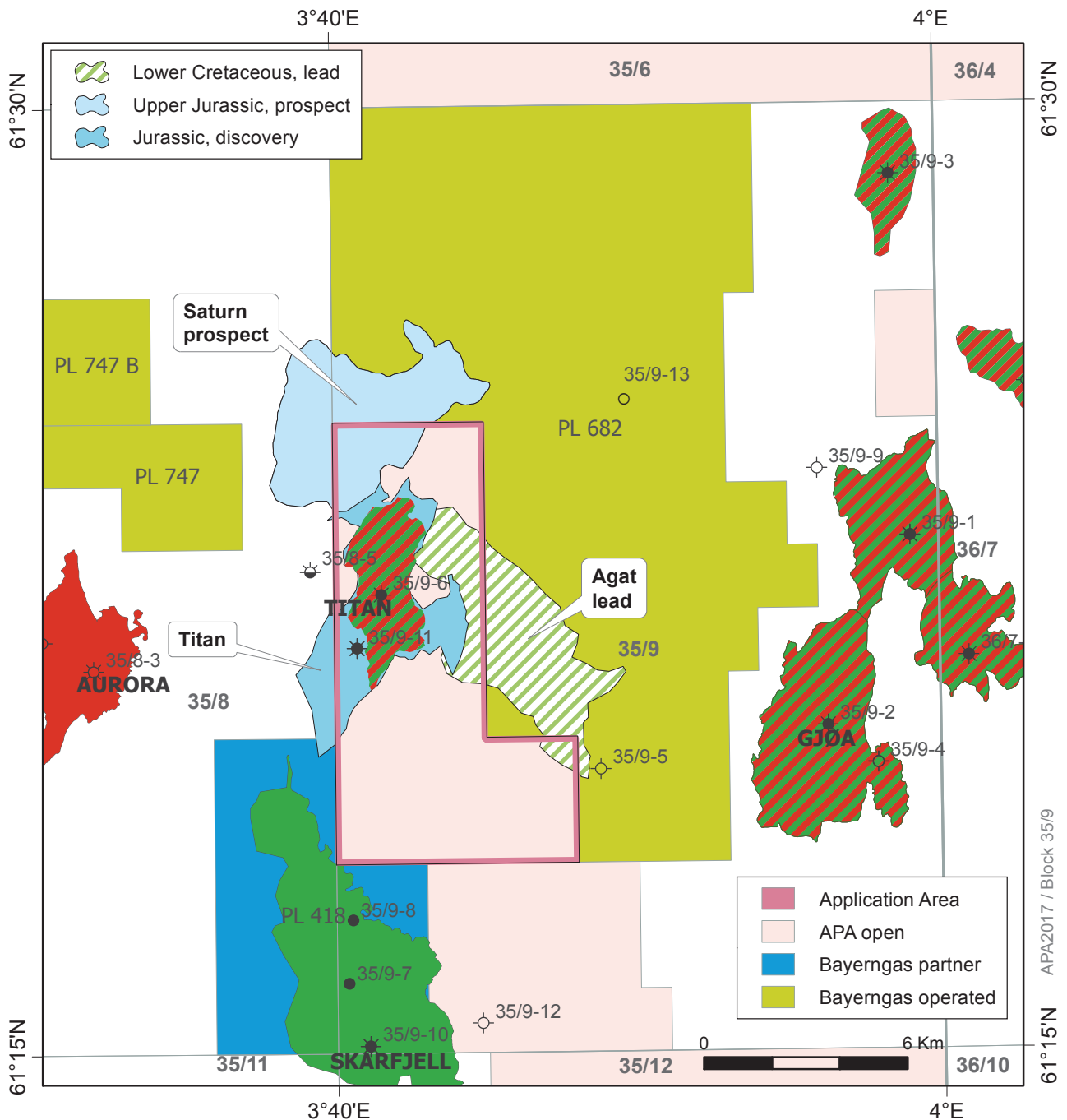


Fig. 1.2 Identified prospects and leads applied for in APA 2017

Summary of award and participants

The PL928 license was awarded 02.03.2018 as part of APA 2017 to the following licensees:

- Spirit Energy Norway AS - 50% (Operator)
- Capricorn Norge AS - 50%

Voting rules are 2 parties and minimum of 50%.

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The license applicants had an interest in prospects and leads identified in the neighbouring license PL682 at Upper Jurassic and Lower Cretaceous levels. The pre-license discovery Titan was considered to have a possible upside, see Fig. 1.2. The main prospect was Saturn, regarded to contain a volume potential worthwhile to pursue. The Titan discovery, already relinquished by the licensees in PL420 on 16.02.2016, constitutes of a very complex reservoir where hydrocarbons are found at 5 different levels with different pressure regimes and fluid compositions throughout. A postulated fault separating the discovery well and appraisal well was used in explaining observations and used for basis of the volumetric estimates.

Initial work obligation

At the date of award, phase 1 of the work program leading to a Drill or Drop (DoD) decision was valid to 02.03.2019. The work program for the initial period is shown in Table 1.1.

Table 1.1 Initial work obligation

Period	Phase (>0)	Duration [year] (>0.0)	Work program	Decision at milestone
Initial period:	1	1,0	G&G studies	Drill or Drop
	2	2,0	Drill exploration well	Concretize (BoK) or Drop
	3	2,0	Conceptual studies	Continuation (BoV) or Drop
	4	1,0	Prepare for development plan	Submit PDO or Drop
	Sum	6	Extension period [years] (>0.0): 25,0	

License meetings

MC/EC meetings:

- EC/MC meeting No. 1 - 08.05.2018
- EC/MC meeting No. 2 - 29.11.2018

Other meetings

- EC status meeting - 20.06.2019

Applications and decisions on extension of deadlines

Extension of the original Drill-or-Drop decision was applied for one time:

- Operator's letter dated 27.02.2019 (SMIL ref. SPI -2019-1) with DoD extension to 02.09.2019, granted in letter from MPE dated 13.05.2019 (ref. 19/392-3).

Reason for Relinquishment

After drilling of the Tethys prospect in neighbouring license PL682, results from the drilling and subsequent studies proved the wells to have encountered hydrocarbons, but due to very poor reservoir properties, it was classified to be a technical discovery unlikely to be developed. Since Tethys and Saturn constitute the same play, and are situated at equal depths with a common spill point between them, reservoir properties are expected to be similar to what is observed in the Tethys wells, although Saturn is located in an even more distal position of deposition than Tethys.

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The Titan discovery show a complexity in fluid composition, reservoir connectivity and pressure communication making it difficult to both predict and to produce within a sound economic frame. Remaining prospectivity in the license is considered to be limited and not worthwhile to pursue.

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2 DATABASE

The seismic and well database was adopted from the neighbouring license PL682 as Saturn was the main prospect applied for in APA 2017. The Saturn prospect was first identified during APA 2012 on MC3D-Marflo2007, and re-interpreted during license work on BGN14M01 and further on the BroadSeis Horda 3D survey (MC3D-CGG14003) during APA 2017 work.

Seismic Database

The seismic database as used in the APA 2017 application is listed in Table 2.1 and shown in Fig. 2.1. Seismic coverage in the area is very good, the Horda 3D survey (MC3D-CGG14003) covers the entire license with surrounding areas and the seismic quality of the survey is good to very good. A merged dataset (MC3D-CGG17M01) of the multi-client Horda 3D PSTM (merge of MC3D-CGG14003 and MC3D-CGG15003) was included in the seismic database. A newer PSDM version of the Horda 3D (MC3D-CGG18M01) was used by the Operator to mitigate uncertainty in fault definition south of the Titan structure. This seismic volume is not part of the common seismic database in PL928.

Table 2.1 APA 2017, Seismic database

3D seismic	Quality
BGN14M01	Good
CGG14003	Good - Very Good
CGG15003	Good - Very Good

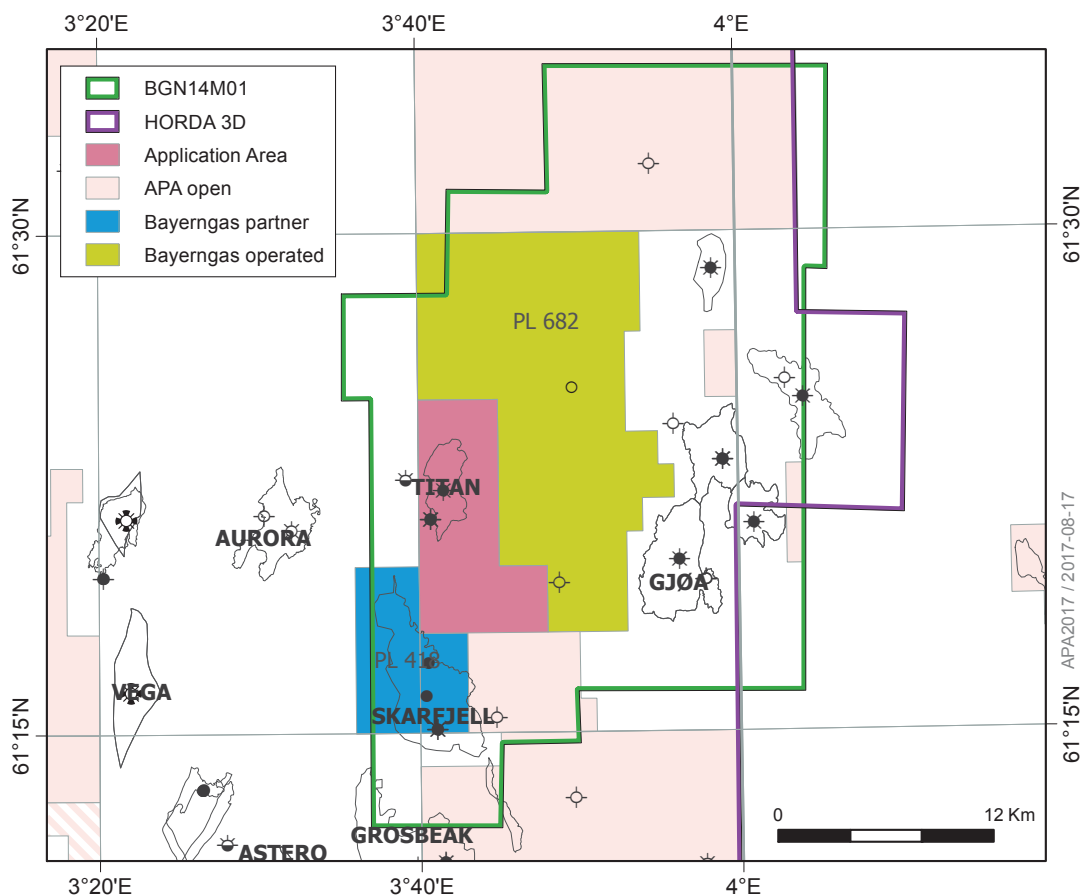


Fig. 2.1 Initial seismic database Seismic coverage in APA 2017 application

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Well Database

The well database as used in the APA 2017 is listed in Table 2.2 and shown in Fig. 2.2. All relevant public data in the DISKOS database was utilised.

Table 2.2 Well database, APA 2017

Well name	Data/Models used for this application						Basic database					Utilization: Saturn prospect and/or Agat lead and/or Titan evaluation
	Depositional model	Reservoir parameters	Trap integrity	Migration/source study	Depth conversion model	Well tie	Checkshots	Relevant cores	Biostratigraphy	Geochemistry	Petrophysical CPI	
35/4-1	•			•			•		•	•	•	
35/6-2 S				•	•		•		•	•	•	Saturn, Agat
35/7-1 S				•					•	•	•	
35/8-1				•			•		•	•	•	
35/8-2				•			•	•	•	•	•	
35/8-3				•			•	•	•	•	•	
35/8-4				•					•	•	•	
35/8-5 S	•			•	•	•	•	•	•	•	•	Saturn, Titan
35/9-1	•			•	•		•	•	•	•	•	
35/9-2	•			•	•		•	•	•	•	•	Saturn
35/9-3 T2				•			•	•	•	•	•	Agat
35/9-5	•		•	•	•	•	•		•	•	•	Saturn, Agat
35/9-6 S	•		•	•	•	•	•	•	•		•	Saturn, Titan
35/9-7	•	•		•	•		•	•	•	•	•	Saturn
35/9-8	•	•		•	•		•	•	•	•	•	Saturn
35/9-9			•		•		•		•		•	Saturn
35/9-10 A	•	•			•	•	•	•	•	•	•	Saturn
35/9-10 S	•				•		•	•	•	•	•	Saturn
35/9-11 A	•				•		•		•	•	•	Saturn, Titan
35/9-11 S	•								•		•	
35/9-12 S	•				•		•		•		•	Saturn
35/12-1							•	•	•	•	•	
35/12-2							•	•	•	•	•	
35/12-4 A	•						•				•	
35/12-4 S	•						•	•	•		•	
35/12-5 S	•						•				•	Saturn
36/7-1	•			•				•	•	•	•	
36/7-3				•					•		•	Agat
Key wells in bold												

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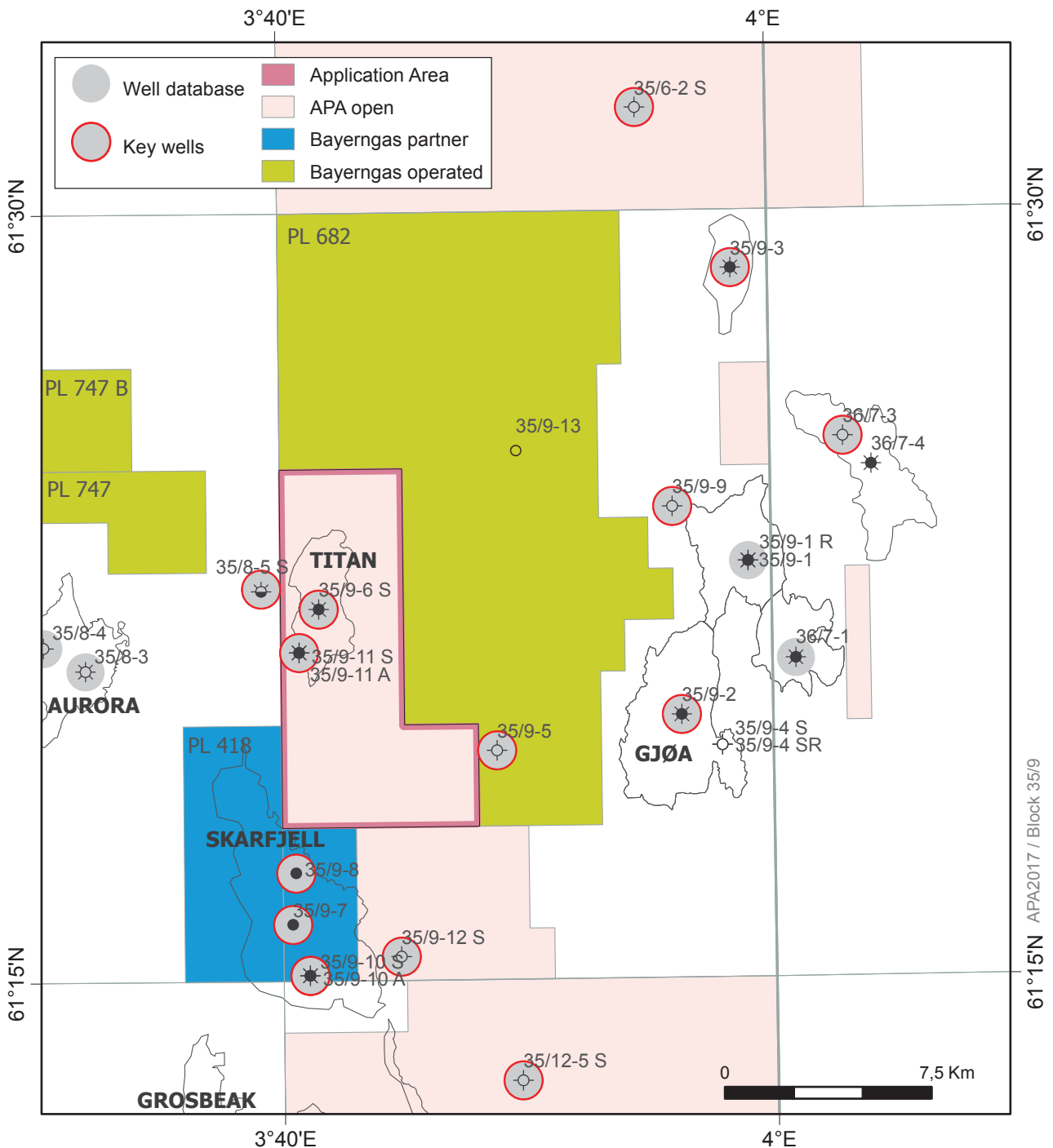


Fig. 2.2 PL928, initial well database Well coverage used in the APA 2017 application

In addition were the following wells traded and included in the license evaluation:

- 35/9-6 S
- 35/9-9
- 35/9-11 S & A
- 35/9-12 S

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- 35/12-5 S

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3 REVIEW OF GEOLOGICAL FRAMEWORK

Studies and evaluations

Initial focus in the license was to re-evaluate the Oxfordian, Intra Heather sandstone in the Saturn prospect, incorporating well results from the Tethys drilling in PL682. As wells 35/9-14 and 35/9-14 A proved the reservoir to be of very poor quality affecting the volume estimate and reservoir prediction of Saturn in a negative direction, further efforts was focussed on the upside potential of the Titan discovery.

Quadrant 35 geological model (In-house)

The geological model for the Late Jurassic has been continuously updated and improved by incorporating new seismic interpretations and well data when available. The latest update is shown in Fig. 3.1, but this is overestimating the amount of sand in Tethys/Saturn area as observed in wells 35/9-14 and 35/9-14 A.

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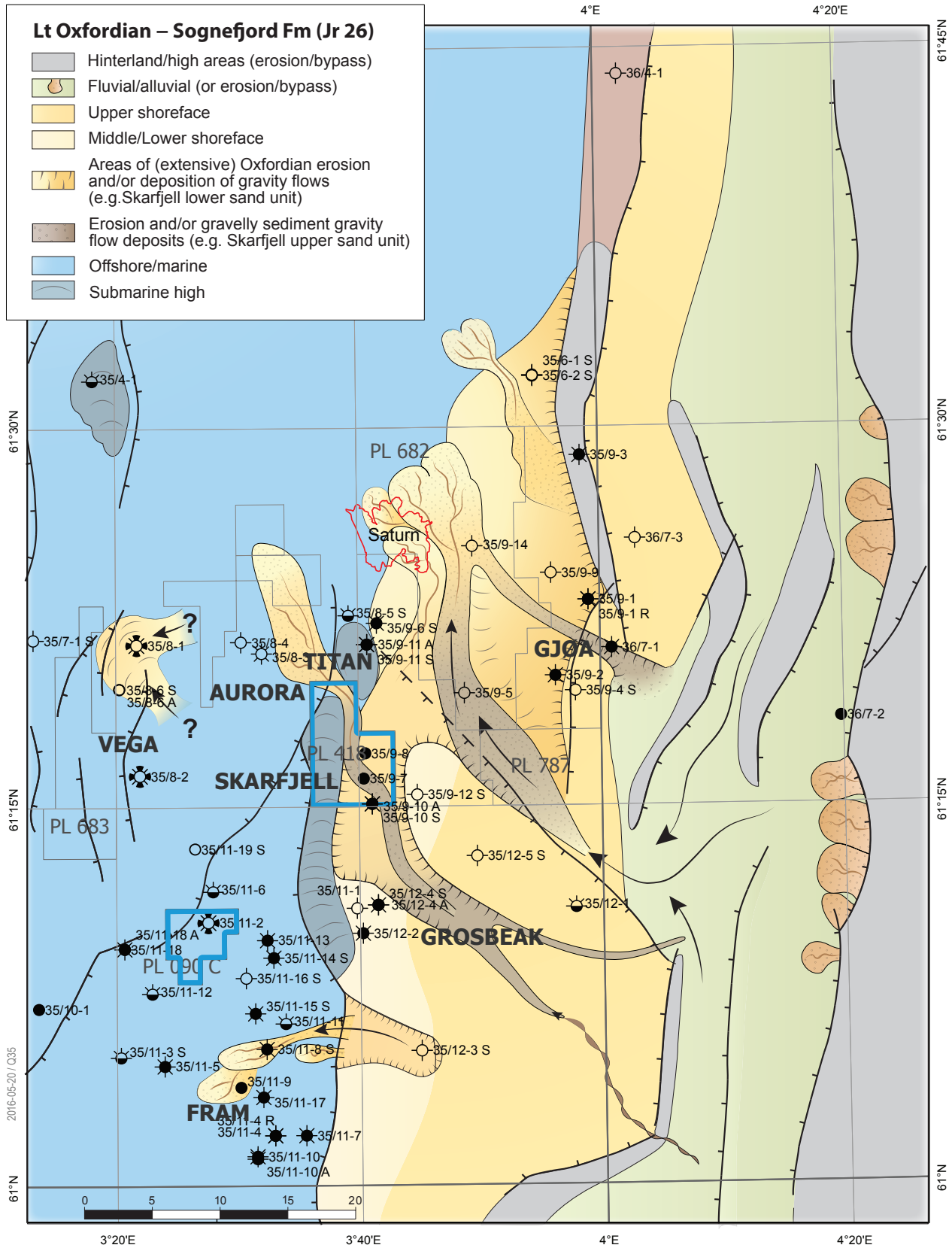


Fig. 3.1 Depositional model Oxfordian sandstones - Sognefjord Fm.

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Seismic evaluation

As Saturn was downgraded after incorporating the results from the Tethys wells, focus was put on remapping of the Titan structure in an effort to understand possible segmentation, and thus explain the differences in pressure and fluid composition seen between well 35/9-6 S and 35/9-11 S & A. An initial re-interpretation was done on the Horda 3D PSTM (MC3D-CGG17M01) indicating that the postulated fault in the APA 2017 work, placing the Titan discovery well (35/9-6 S) and appraisal wells (35/9-11 S & A) in separate segments S and C does not exist, see Fig. 3.2. This complicated the already hard to explain discovery. In addition did the mapping indicate a possible upside to the south of the Titan high, but dependent on sealing faults towards the Nova discovery Fig. 3.3. To mitigate fault placement uncertainty and interpretation, the best available PSDM seismic dataset in the area was used by the operator, MC3D-CGG18M01. The re-mapping on this dataset confirmed that the separating fault identified in APA 2017 does not exist and observed reservoir behaviour must be explained otherwise. Fig. 3.4 and Fig. 3.5 show the continuous reservoir interval between wells 35/9-6 S and 35/9-11 A as it appears on seismic and in map view. Fig. 3.6 and Fig. 3.7 show the open fault system south of Titan limiting the upside potential in the area. The latter figure minimizes the potential for added volumes outside of the Titan structure proper as this opens up the structure from the Titan spill point towards the Nova discovery.

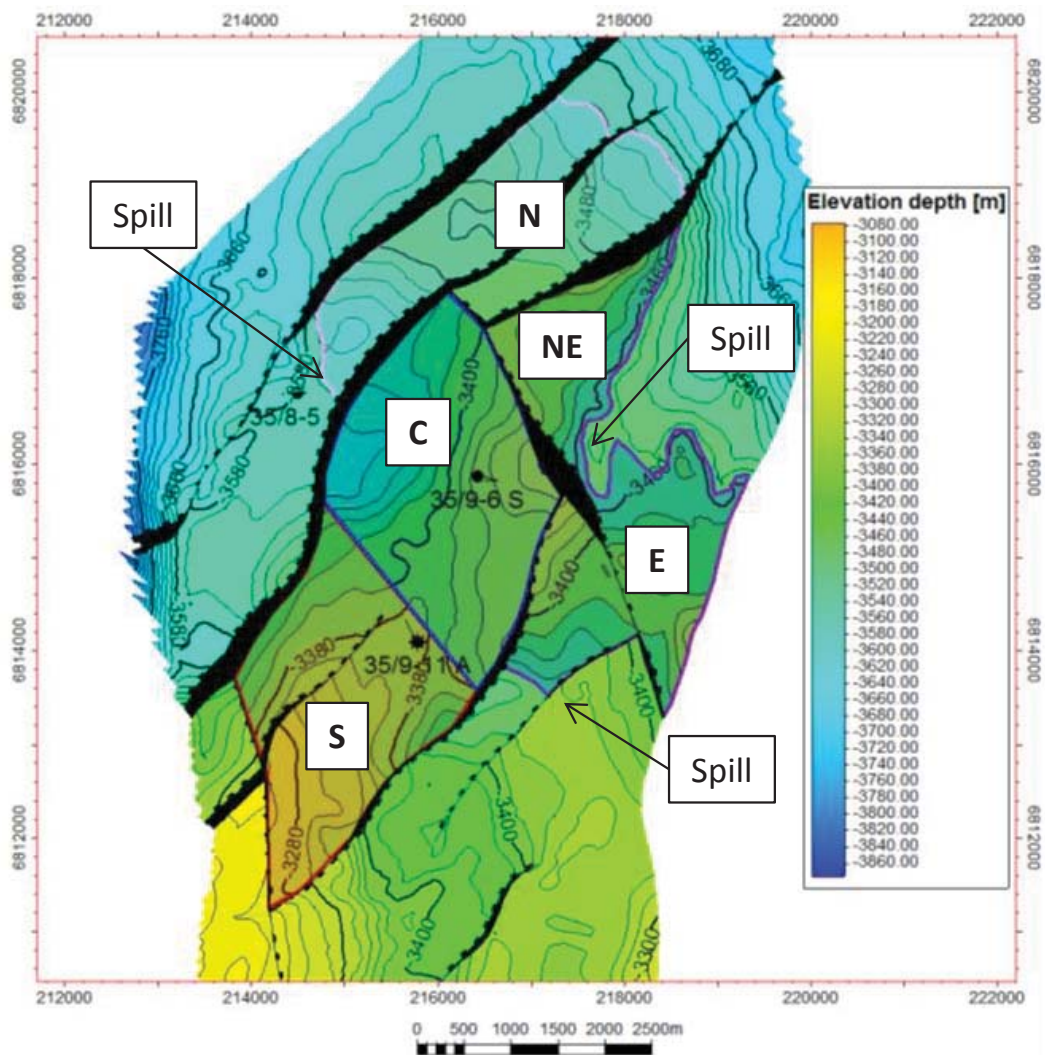


Fig. 3.2 Titan - structural segments Fault compartments and spill points used in volume estimation as defined in APA2017 (note blue northwest - southeast trending fault separating C and S segments).

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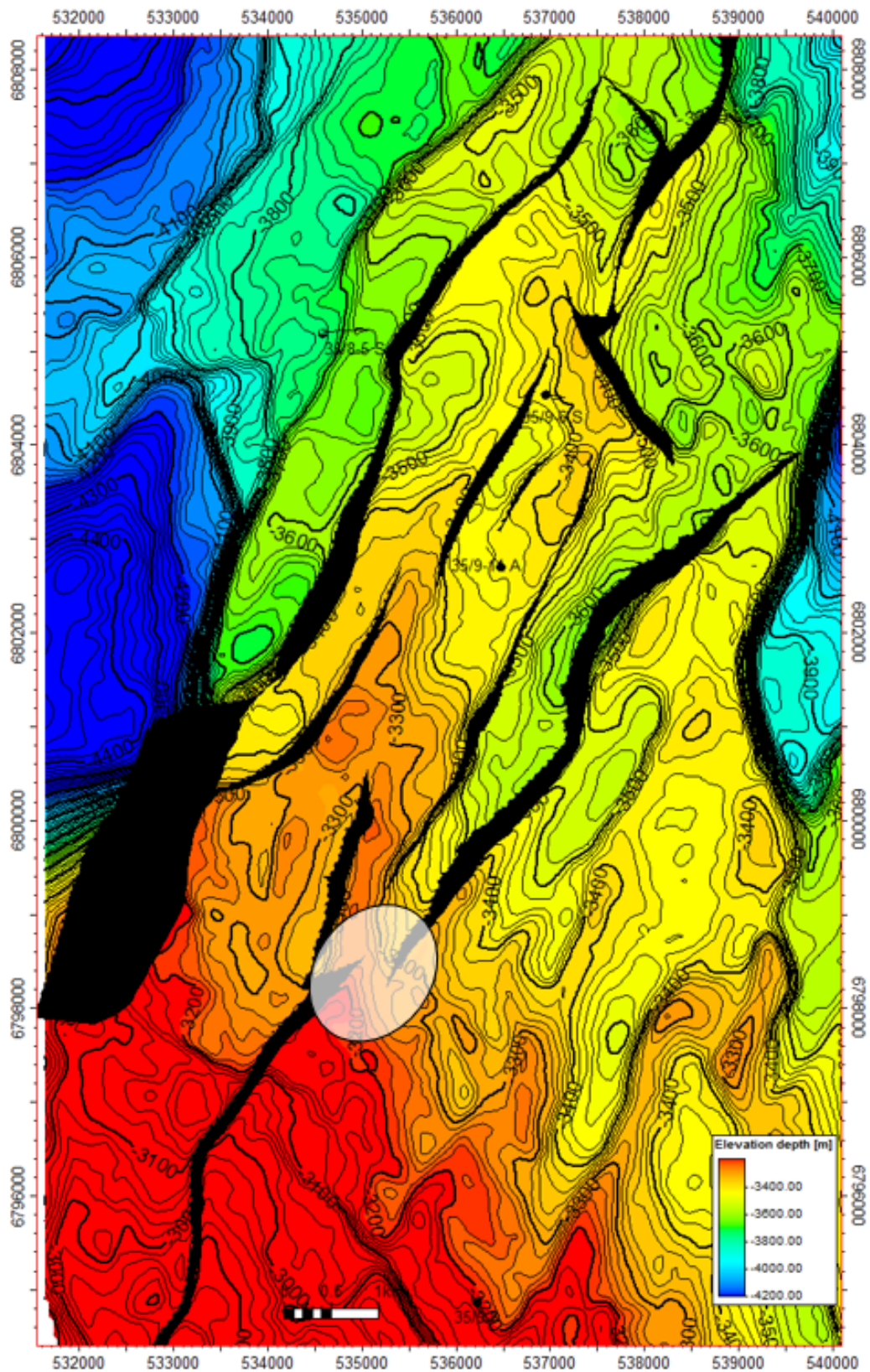


Fig. 3.3 Titan structural depth map Mapped @ NT Etive level, fault patterns indicate communication between wells on Titan but also opens up towards the Nova field in the south (grey circle)

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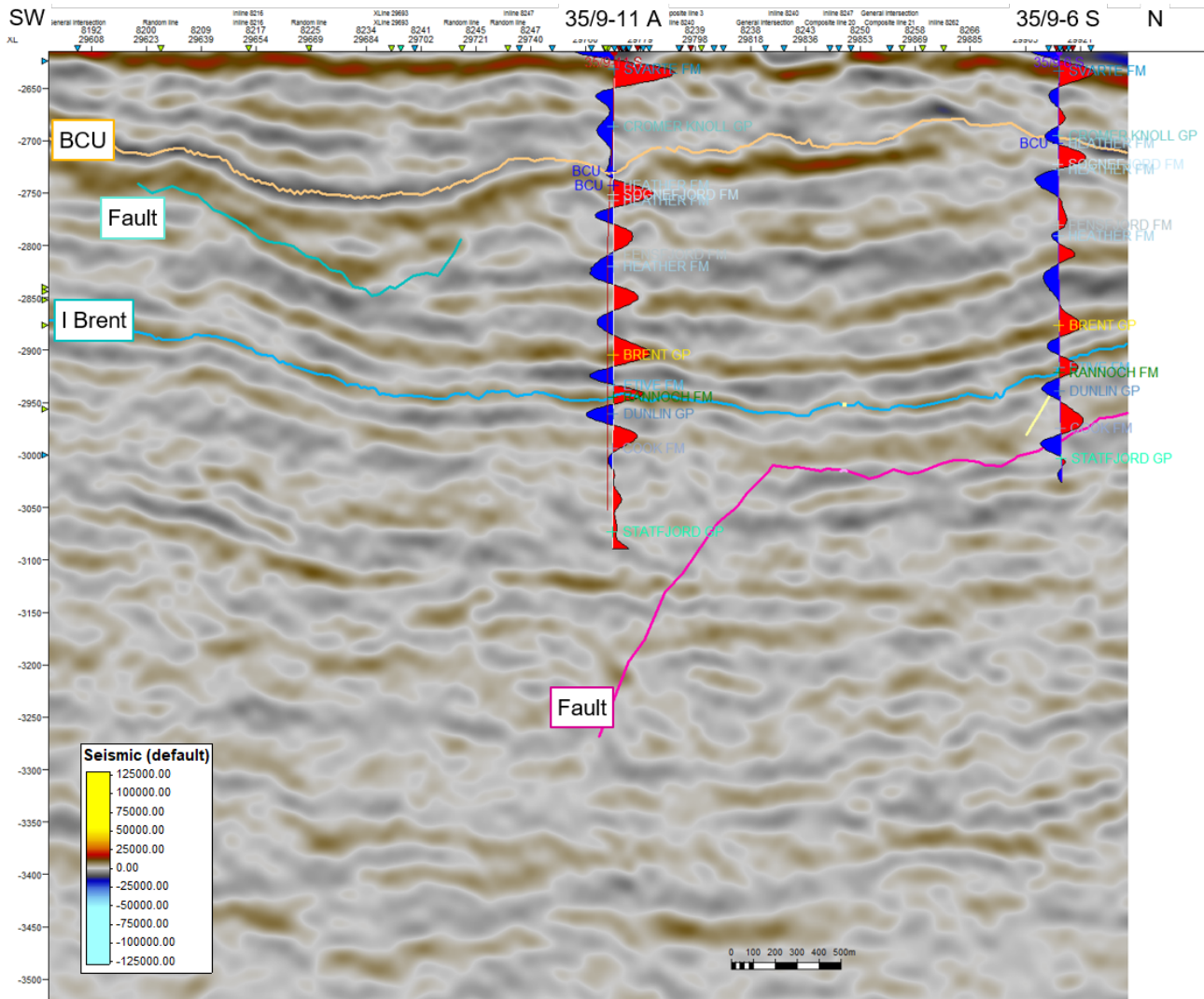


Fig. 3.4 Seismic line between Titan wells Random line showing the continuous seismic events between the discovery well, 35/9-6 S and appraisal well 35/9-11 A. Seismic orientation shown as red line in next figure.

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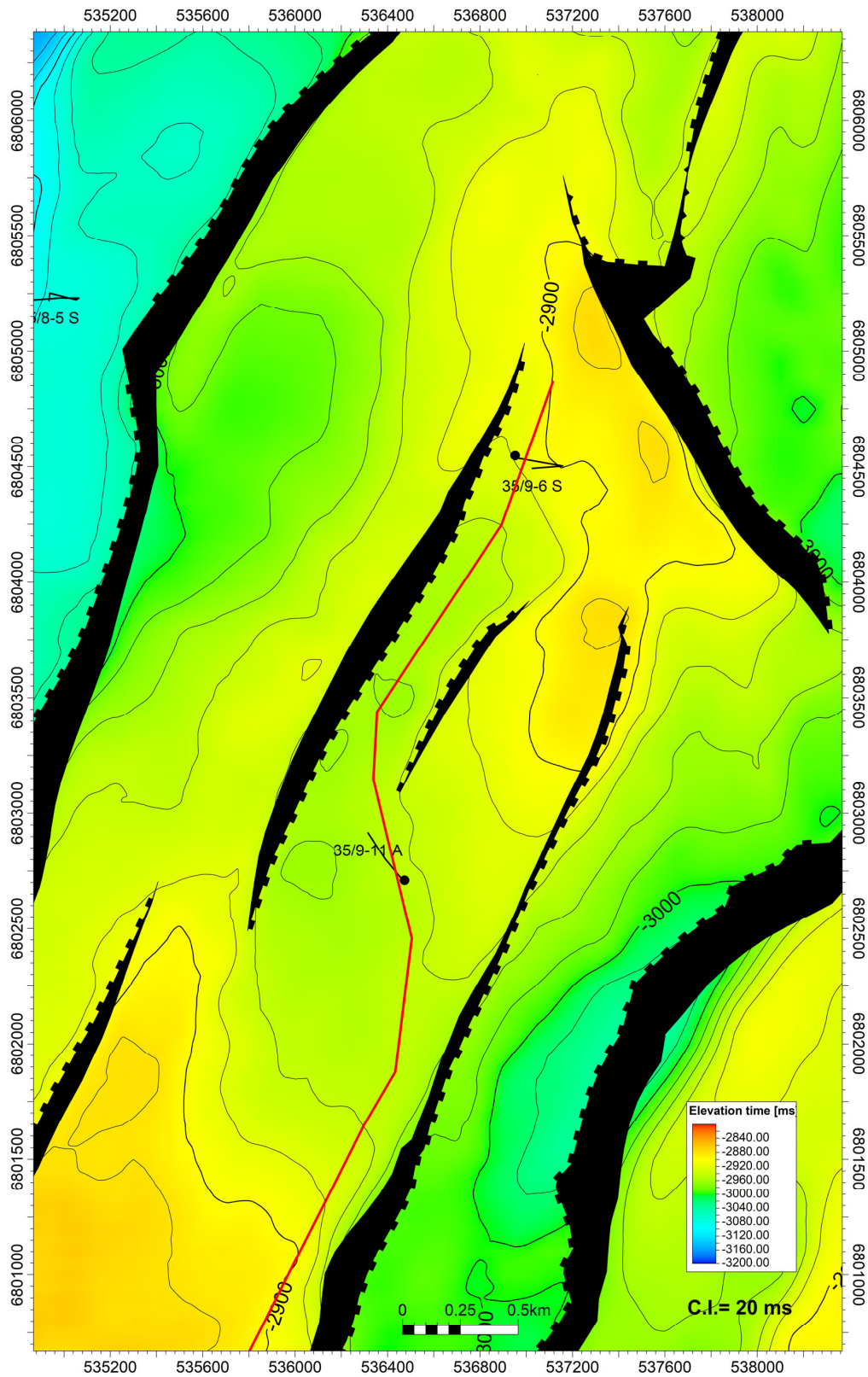


Fig. 3.5 Titan structure map @ Etive level The time map of Near Top Etive Fm. show no obvious fault separating the two wells penetrating the structure.

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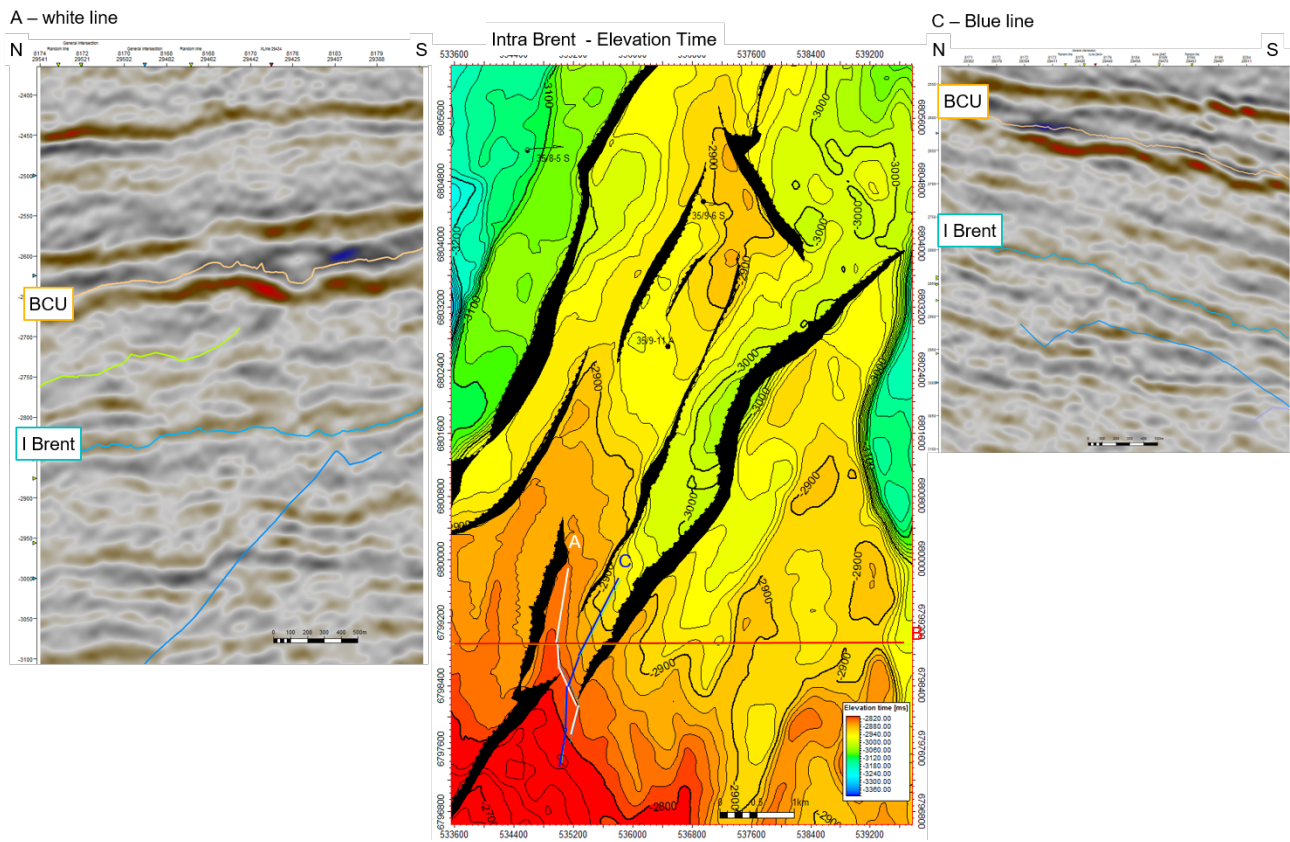


Fig. 3.6 Fault system south of Titan Potential closure by continuous fault system south of Titan appears to be open and thus leak towards the Nova discovery, North-South trending faults.

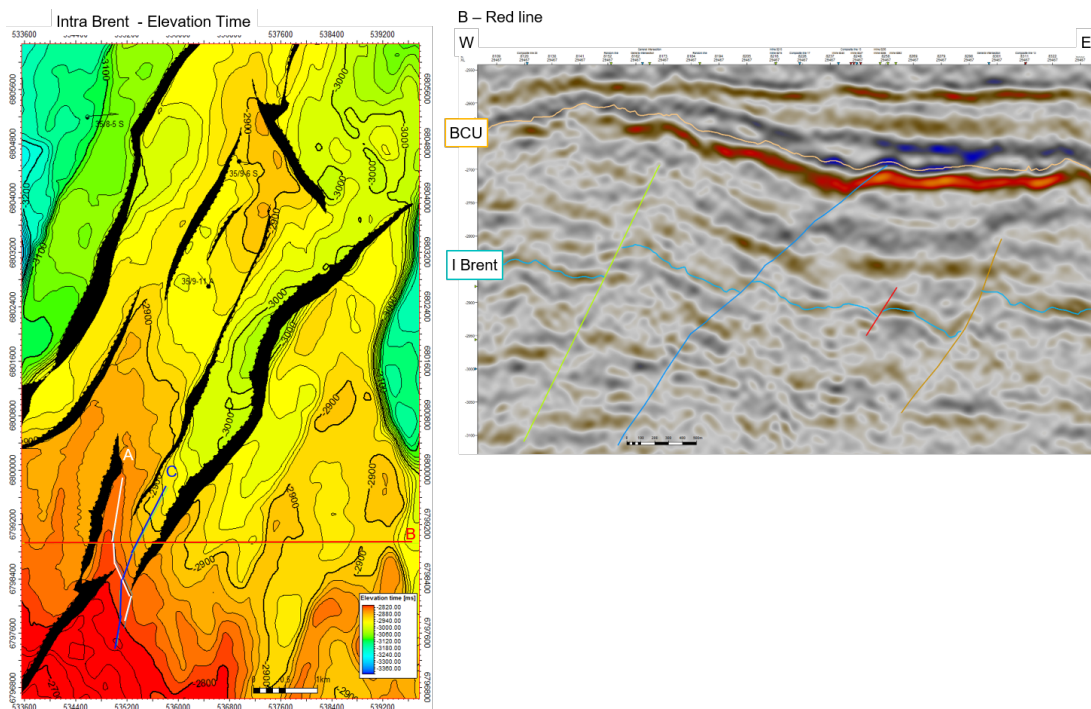


Fig. 3.7 Fault system south of Titan East-West trending seismic line showing the fault segment that just to the south of this location opens up and leaking towards the Nova discovery,

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4 PROSPECT UPDATE

Prospectivity in PL928 is directly influenced by the drilling results from the Tethys well in license PL682 (relinquished). The Saturn prospect, straddling the border between licenses PL928 and PL682, constitutes the same reservoir interval at the same depth as Tethys. Prospect evaluation shows that Saturn and Tethys have a common spill point, see Fig. 4.1. The current interpretation suggests Saturn is situated slightly more distal in the depositional model, see Fig. 3.1. Although some uncertainty exists, reservoir development is assumed to be similar to what was encountered in Tethys with quality equal to the discovery.

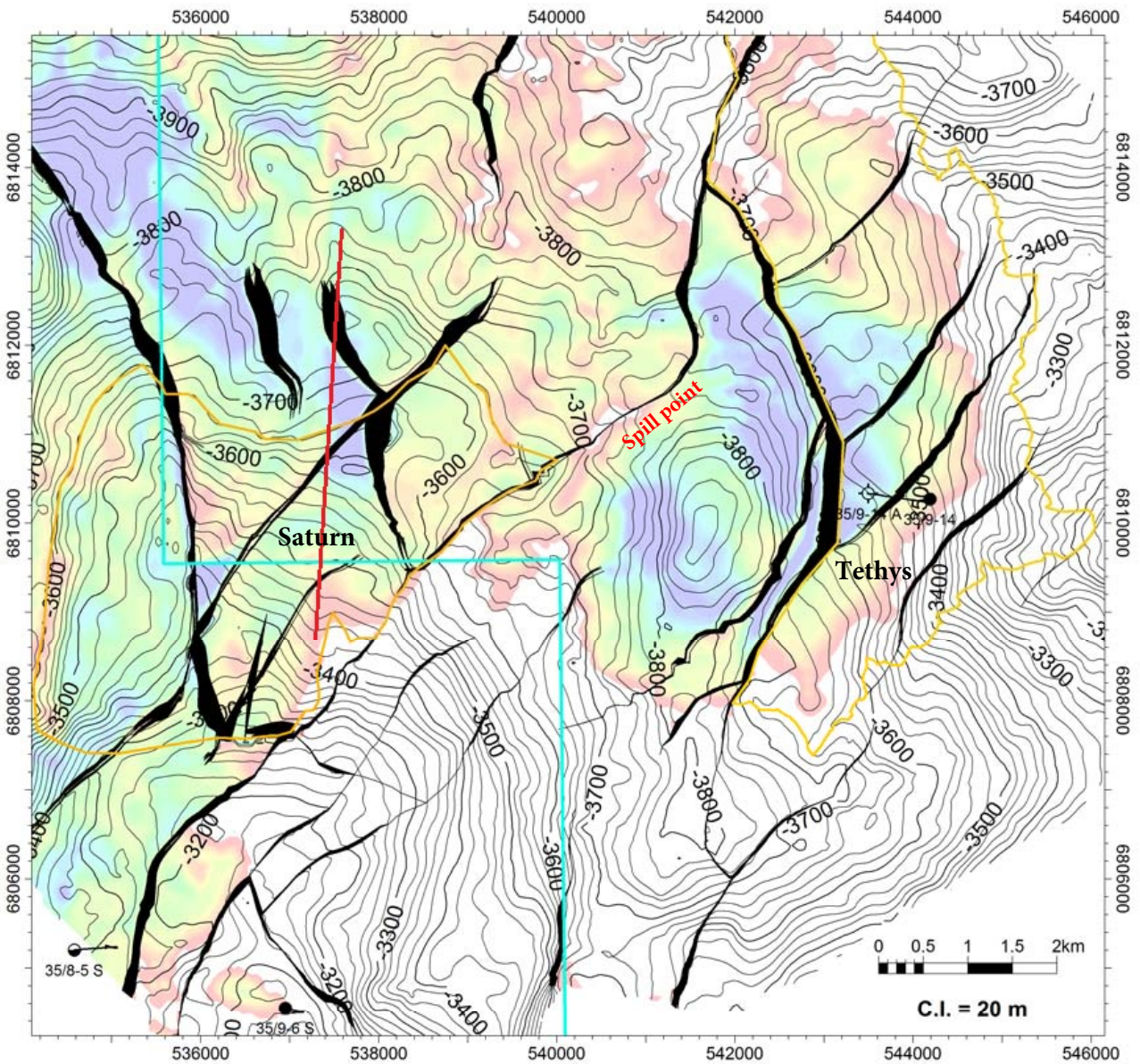


Fig. 4.1 Saturn - reservoir interval map Structural depth map (contours) with modeled reservoir thickness (colours)

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Wells 35/9-14 and 35/9-14 A encountered depositional settings in a slope with turbidite type sandstones where primary reservoir quality variations is controlled by the grain size, reservoir quality reduction by compaction, quartz cement, authigenic kaolinite and illitisation. The poor reservoir behaviour is mainly due to very low permeability, again due to very fine grain size and the effect of illite.

Saturn prospect

The Saturn prospect is downgraded by the results from wells 35/9-14 & 35/9-14 A. In the geological model where the turbidite type sandstone sediments are sourced from the south-east, Saturn is situated in a slightly more distal position than Tethys. Although uncertainty exist, reservoir development is assumed to be close to what was encountered in Tethys and the quality equal to the discovery, Fig. 4.1, and Fig. 4.2. Key data for Saturn is summarized in Table 4.1.

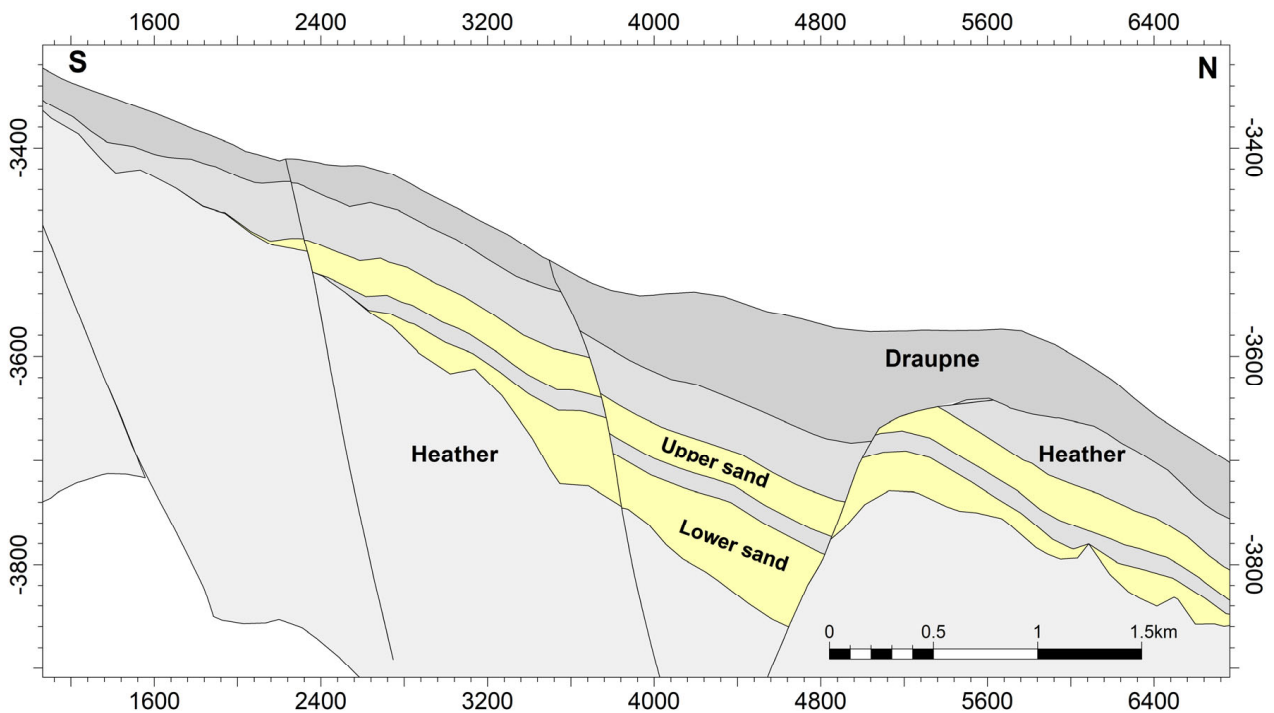


Fig. 4.2 Saturn - modeled reservoir Post drilling of Tethys, reservoir development is assumed similar in the Saturn prospect, with comparable quality as found in the wells (orientation of section seen as red line in previous figure).

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Agat Fm. Lobe Lead

The Agat Fm. lobe lead is seismically defined, situated downflank of well 35/9-5 (Brand) that appears as a channel ending in a lobe morphology down-dip that stretches partly into PL928, see Fig. 4.3. Apart from limited volumes sitting inside of the license is the main risk associated with trap definition and a working seal as well 35/9-5 is situated on the edge of the channel feature and consists of 4 metres of reservoir quality at the base.

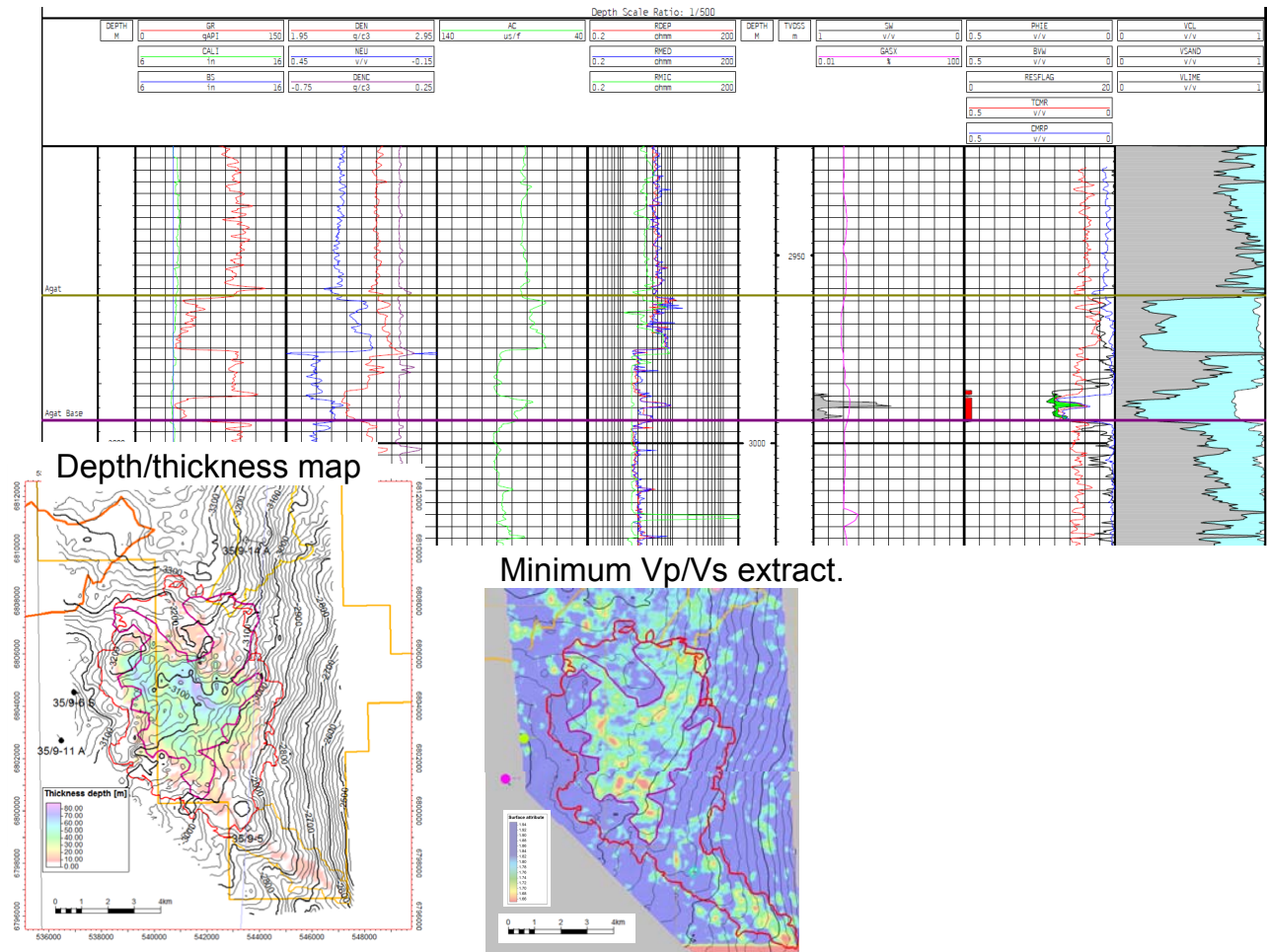


Fig. 4.3 Agat Fm. Lobe Lead CPI from well 35/9-5, 4 meters good reservoir interval at the base of the Agat Fm. interval. Depth (contours) and thickness (colours) map and minimum Vp/Vs extraction map

Titan discovery

The Titan discovery evaluation made for the APA 2017 application is used as basis for further work, to conform or disprove of the model used in volumetric simulations, Fig. 3.2 and Fig. 4.4. As seen in the cross section, hydrocarbon fill and pressure differences as observed in the Titan wells are explained by the NW-SE trending fault (blue fault in the index map) separating the wells. Based on the latest interpretation of the PSDM seismic volume CGG18M01, this fault does not appear on the seismic, Fig. 3.4. Thus, pressure differences as observed in Titan, Fig. 4.5 and Fig. 4.6 must be explained by baffles, lithological variations or sub-seismic faults not identified in the current interpretation. The latest structural map is shown in Fig. 4.7 and Fig. 4.8 shows a cross section through the geo-model as used in resource estimates, where no identified barriers between the wells are modelled.

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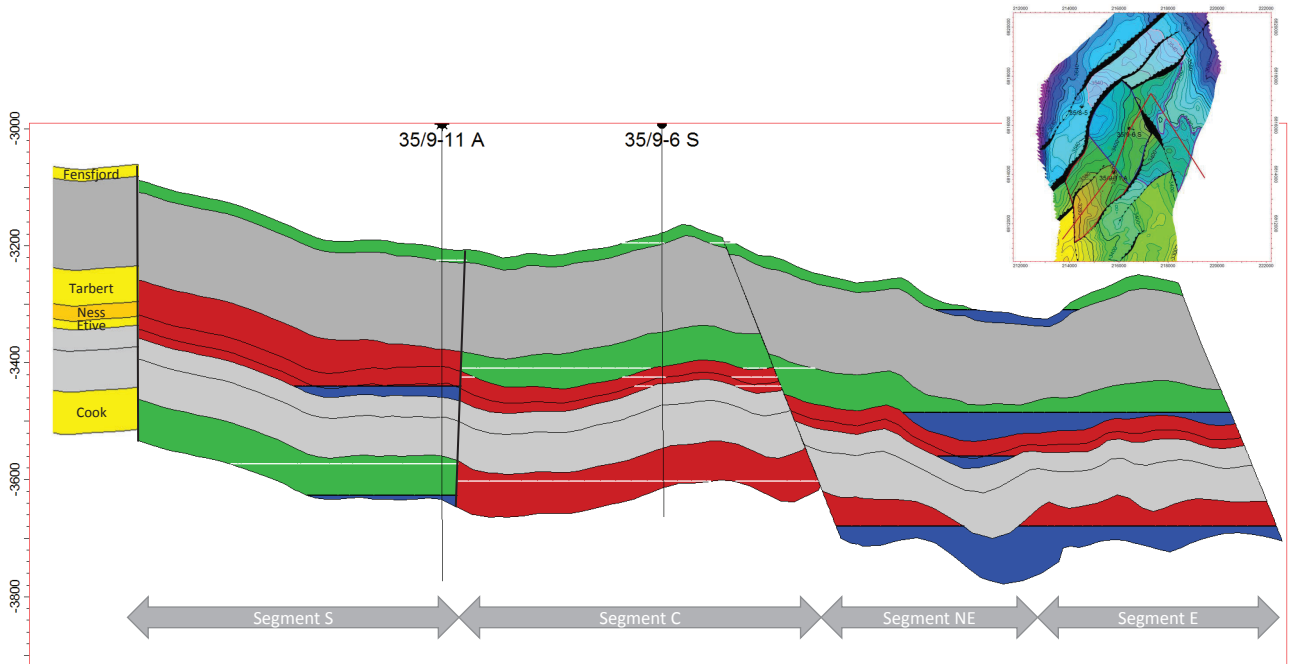


Fig. 4.4 Cross-section with HC-down-to and spill, APA 2017 The cross section through segments defined in APA 2017 shows the uncertainty range at the time of fluid contacts in wells (white lines) down to possible spill depths (colored).

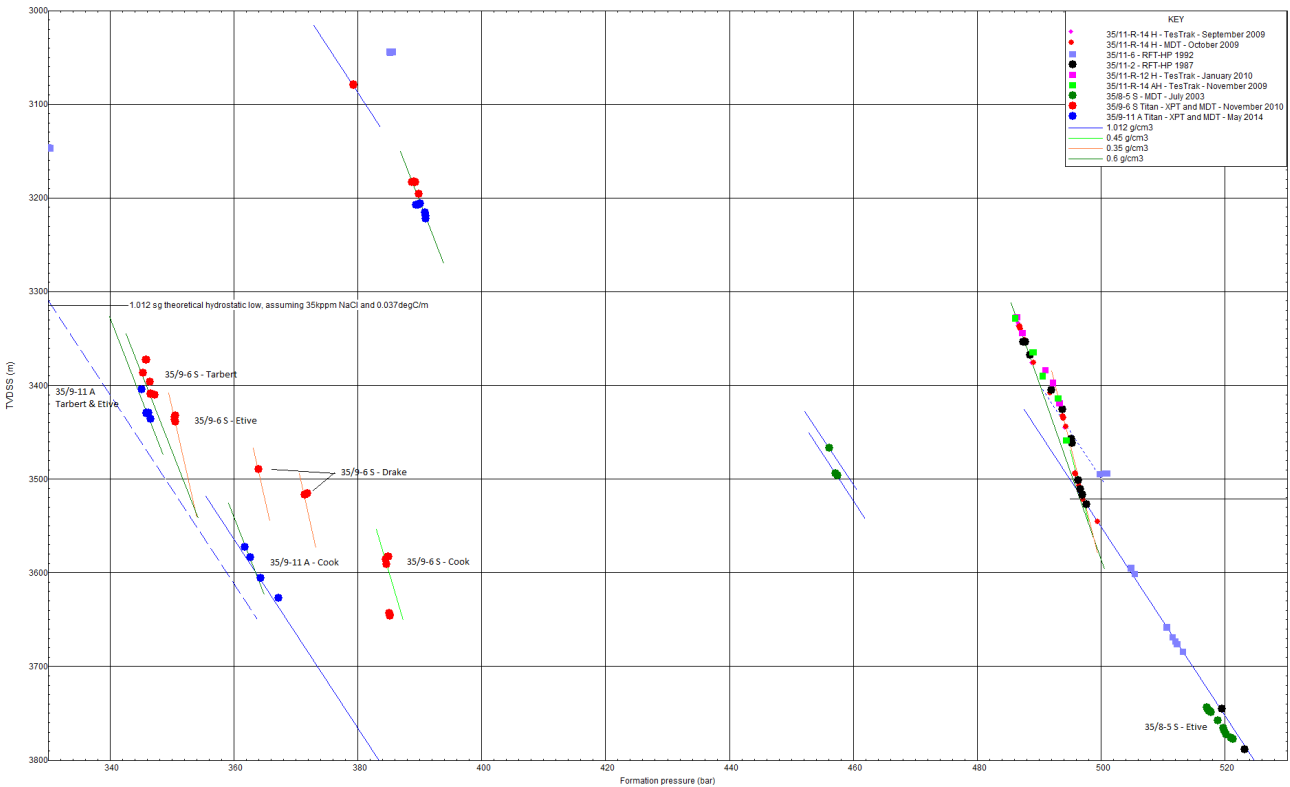


Fig. 4.5 Pressure plot Pressures observed in Titan and surrounding wells, including Vega Sør.

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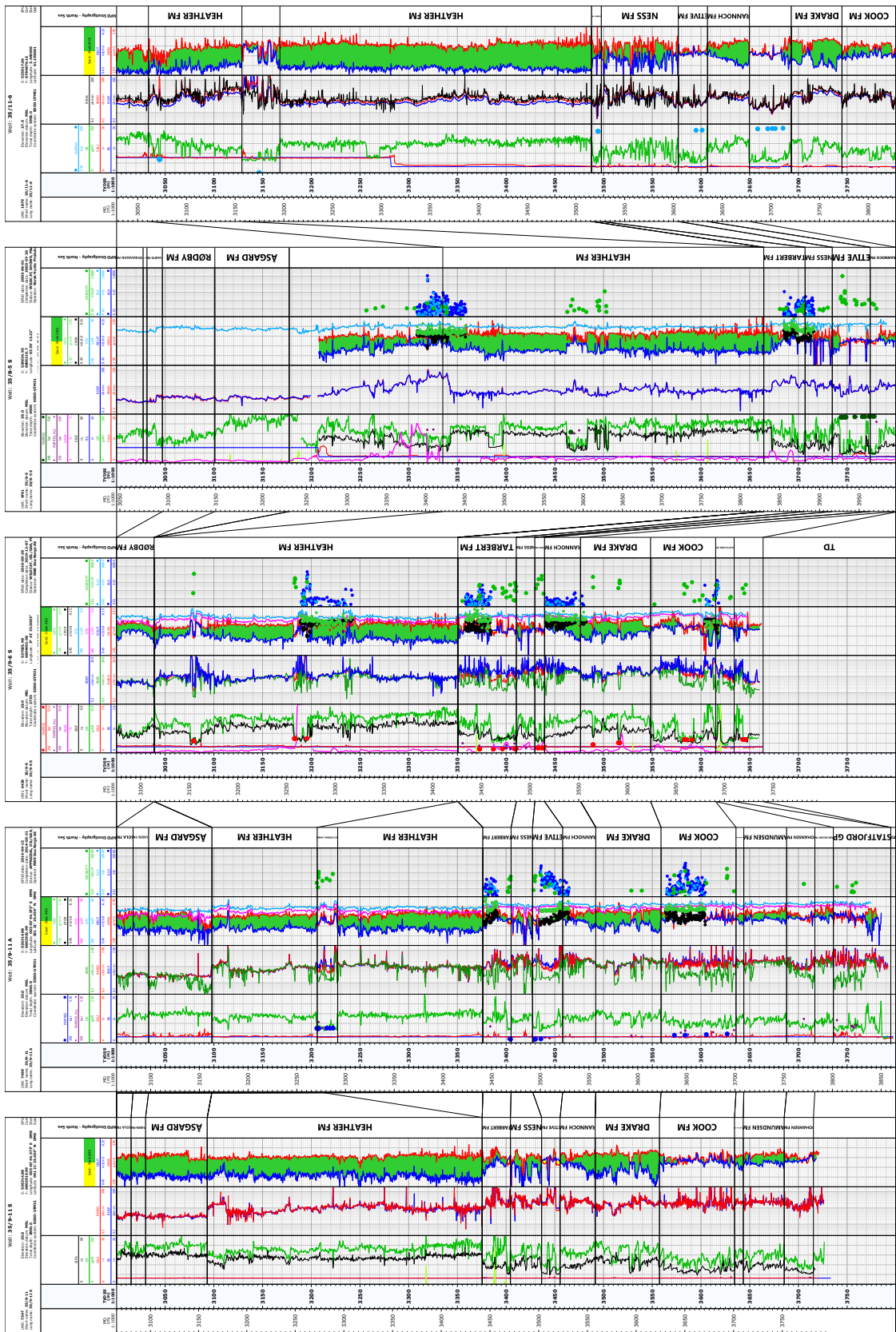


Fig. 4.6 Well correlation Titan and surrounding wells



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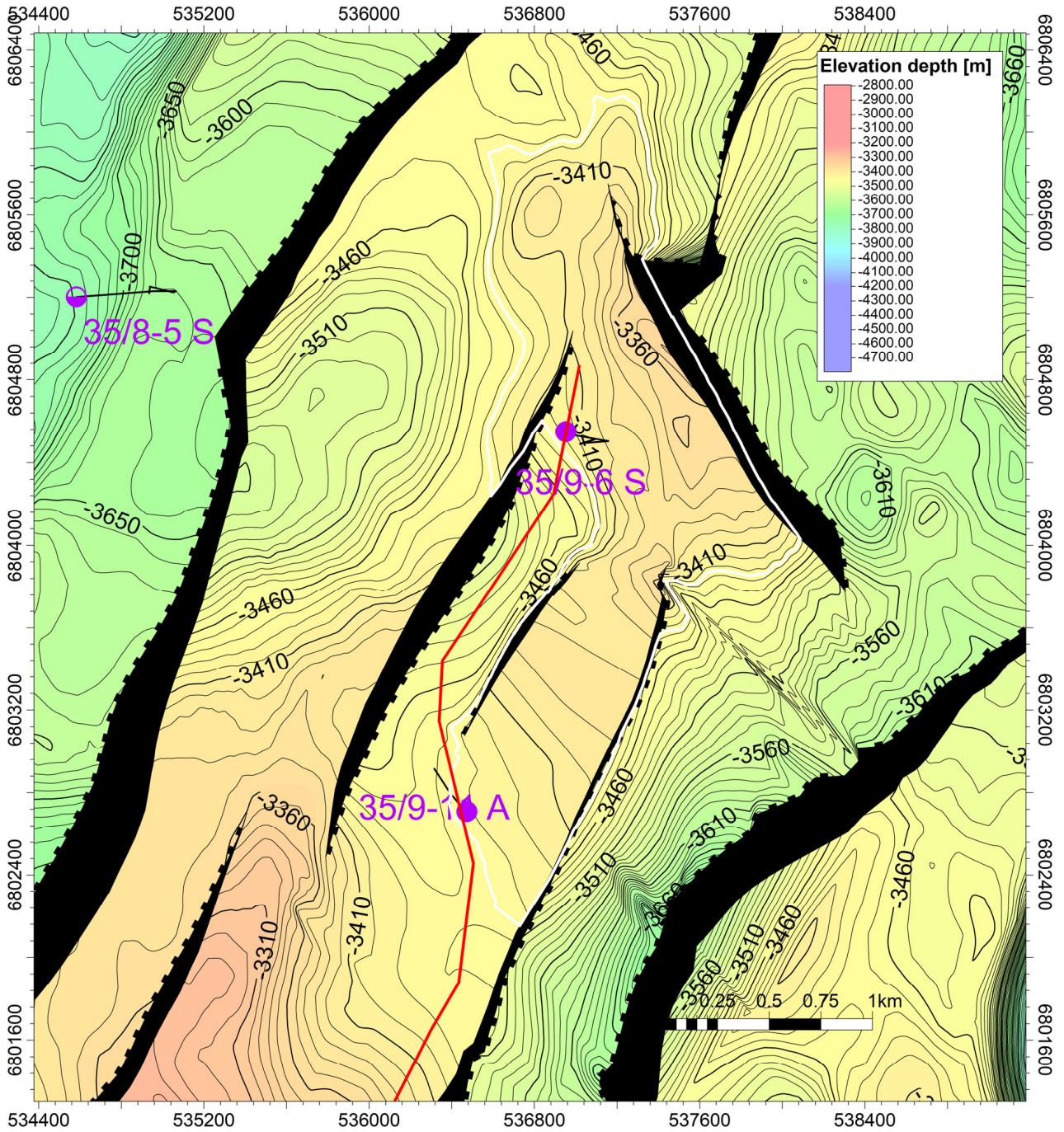


Fig. 4.7 Titan - Structural depth map Map showing the structural picture at Etive level. Observe the open faults between Titan discovery well, 35/9-6 S and appraisal well 35/9-11 A.

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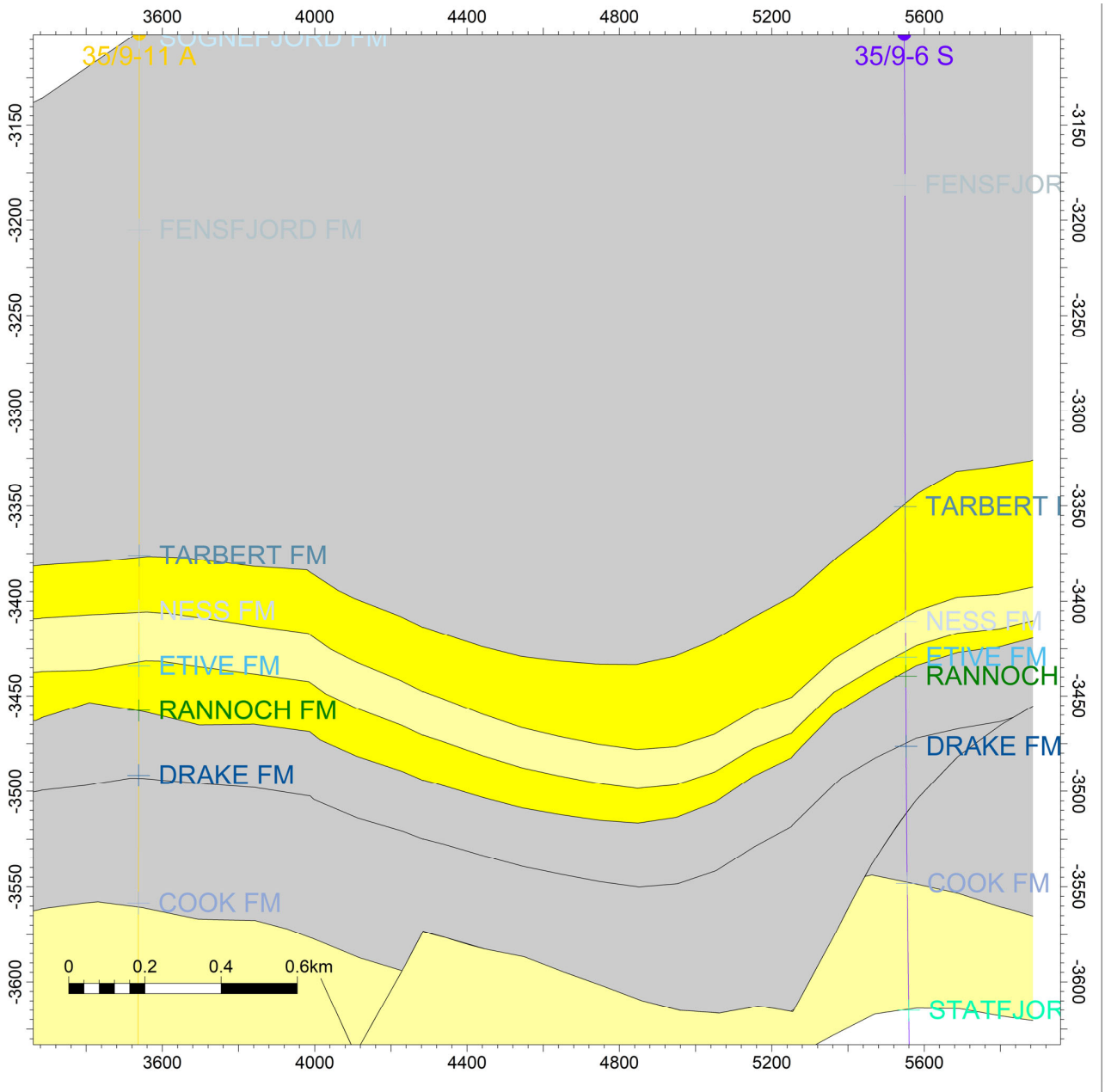


Fig. 4.8 Cross section between Titan wells Section through geomodel used as input for volume calculation. Orientation is shown in the previous figure.

Estimation of volumes in the Titan structure are calculated for individual reservoir intervals using a stochastic simulation in GeoX. Input parameters are shown in Table 4.2.

Table 4.2 Volumetric input parameters

Zone	FLUID	Contact	NTG	PHIE	Se/Sg	Bo (m ³ /Sm ³)	Eg (Sm ³ /m ³)	GOR (Sm ³ /Sm ³)	CGR (Sm ³ /MSm ³)	RF oil	RF assoc gas	RF gas	RF cond
Fensfjord	Oil	Triang ODT to max fill	0.20 - 0.40 - 0.60	0.13 - 0.171 - 0.21	0.40 - 0.63 - 0.80	1.90 - 2.00 - 2.10	-	285 - 315 - 345	-	0.20 - 0.30 - 0.40	0.20 - 0.30 - 0.40	-	-
Tarbert	Oil	Unif ODT to OWC	0.15 - 0.37 - 0.55	0.12 - 0.152 - 0.19	0.35 - 0.57 - 0.75	1.85 - 1.95 - 2.10	-	250 - 280 - 310	-	0.20 - 0.30 - 0.40	0.20 - 0.30 - 0.40	-	-
Ness	Gas	Unif GDT to GWC	0.00 - 0.06 - 0.20	0.10 - 0.114 - 0.15	0.40 - 0.62 - 0.80	-	240 - 250 - 260	1575 - 1750 - 1925	519 - 571 - 635	-	-	0.35 - 0.50 - 0.65	0.25 - 0.35 - 0.45
Etive	Gas	Unif GDT to GWC	0.40 - 0.75 - 0.90	0.11 - 0.139 - 0.18	0.45 - 0.69 - 0.85	-	240 - 250 - 260	1575 - 1750 - 1925	520 - 571 - 635	-	-	0.35 - 0.50 - 0.65	0.25 - 0.35 - 0.45
Cook	Gas	Triang GDT to max fill	0.05 - 0.20 - 0.35	0.10 - 0.133 - 0.17	0.35 - 0.58 - 0.75	-	240 - 250 - 260	550 - 620 - 680	1471 - 1613 - 1786	-	-	0.35 - 0.50 - 0.65	0.25 - 0.35 - 0.45

Map at Tarbert level is shown in Fig. 4.9, sections through Titan in Fig. 4.10 and Fig. 4.11. In-place volumes for Tarbert is found in Table 4.3, recoverable volumes in Table 4.4.



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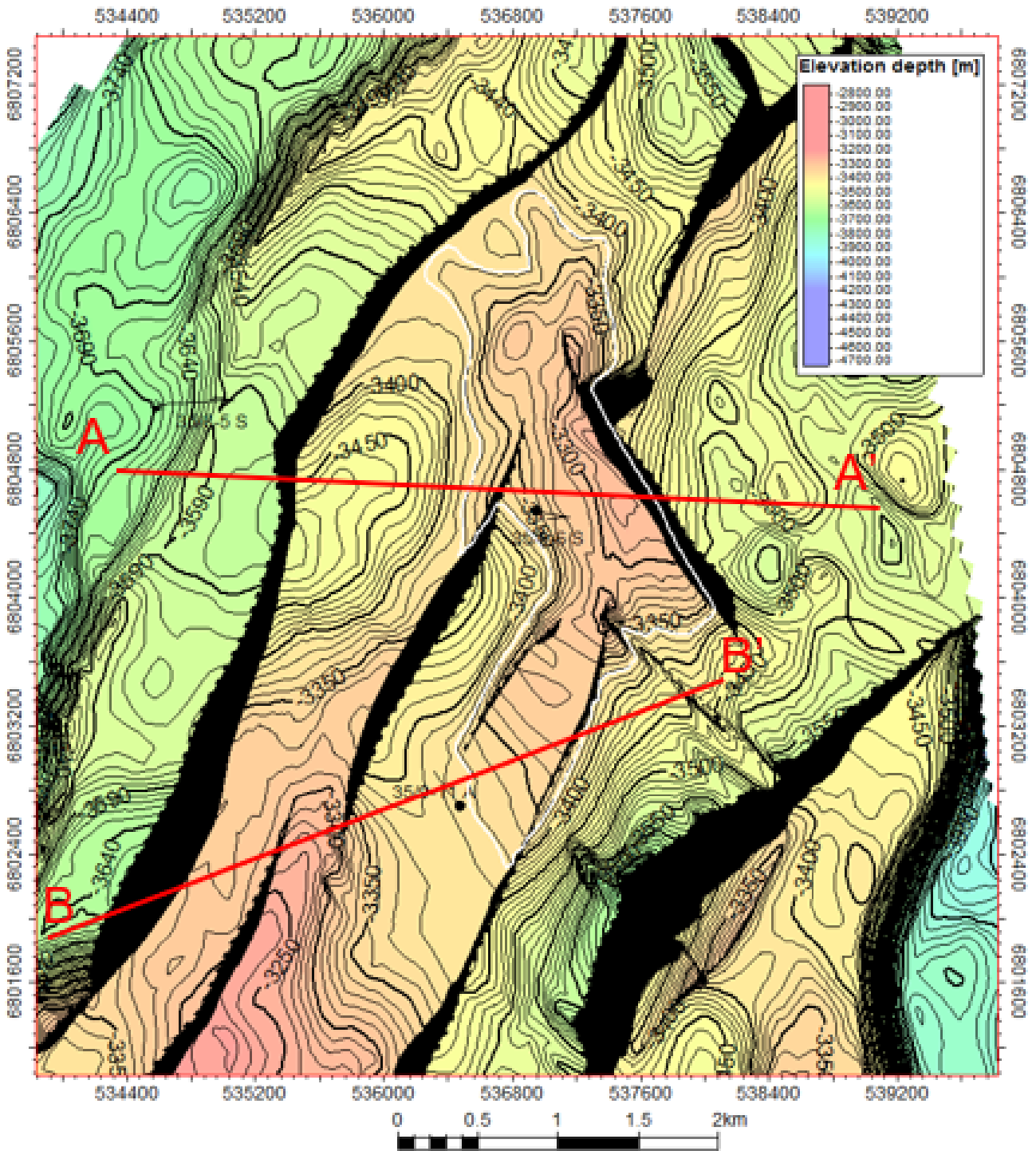


Fig. 4.9 Top Tarbert Structural depth map @ Top Tarbert. Sections marked as red lines shown in the following figures.

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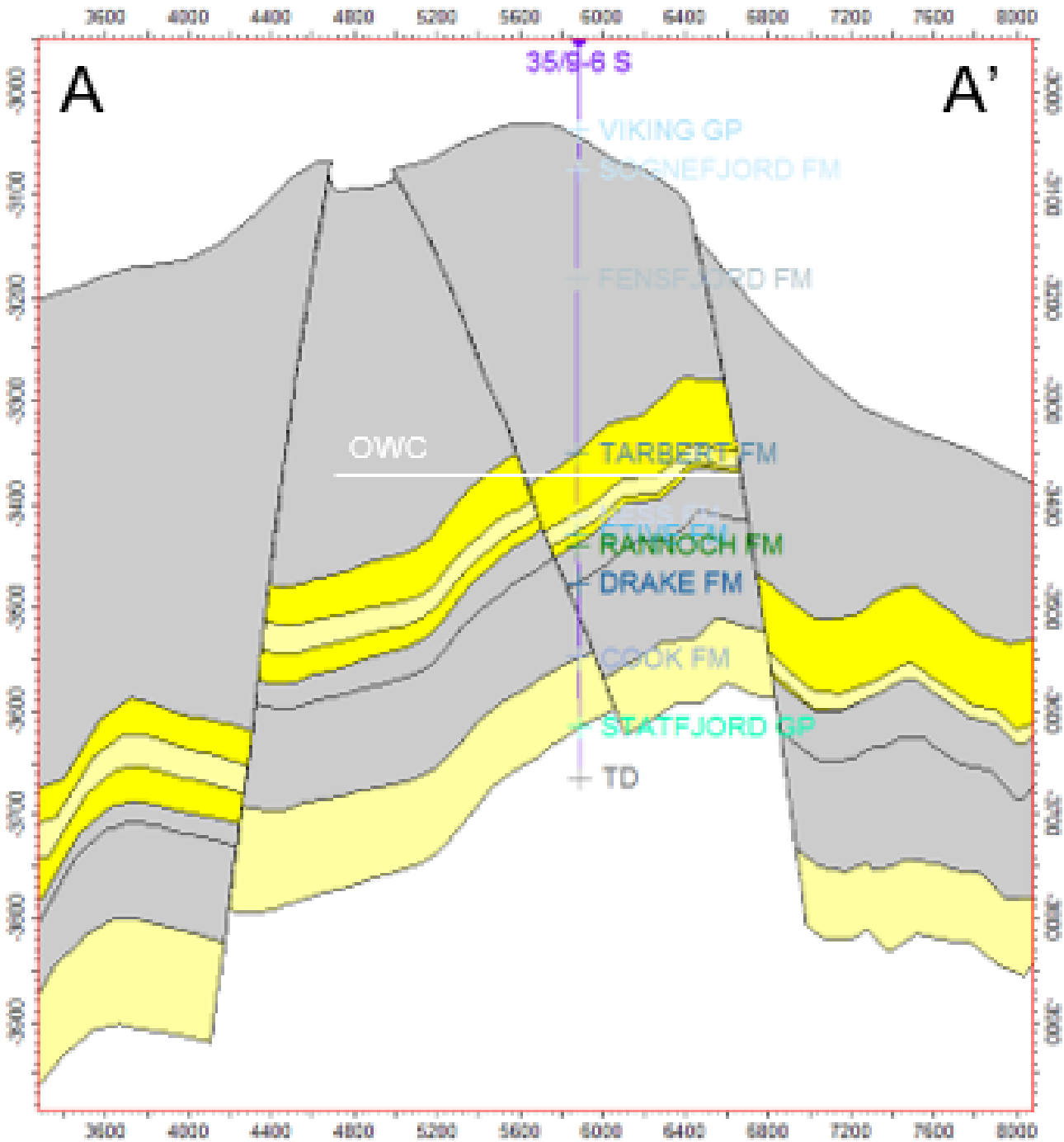


Fig. 4.10 Section through well 35/9-6 S A - A' section in previous map

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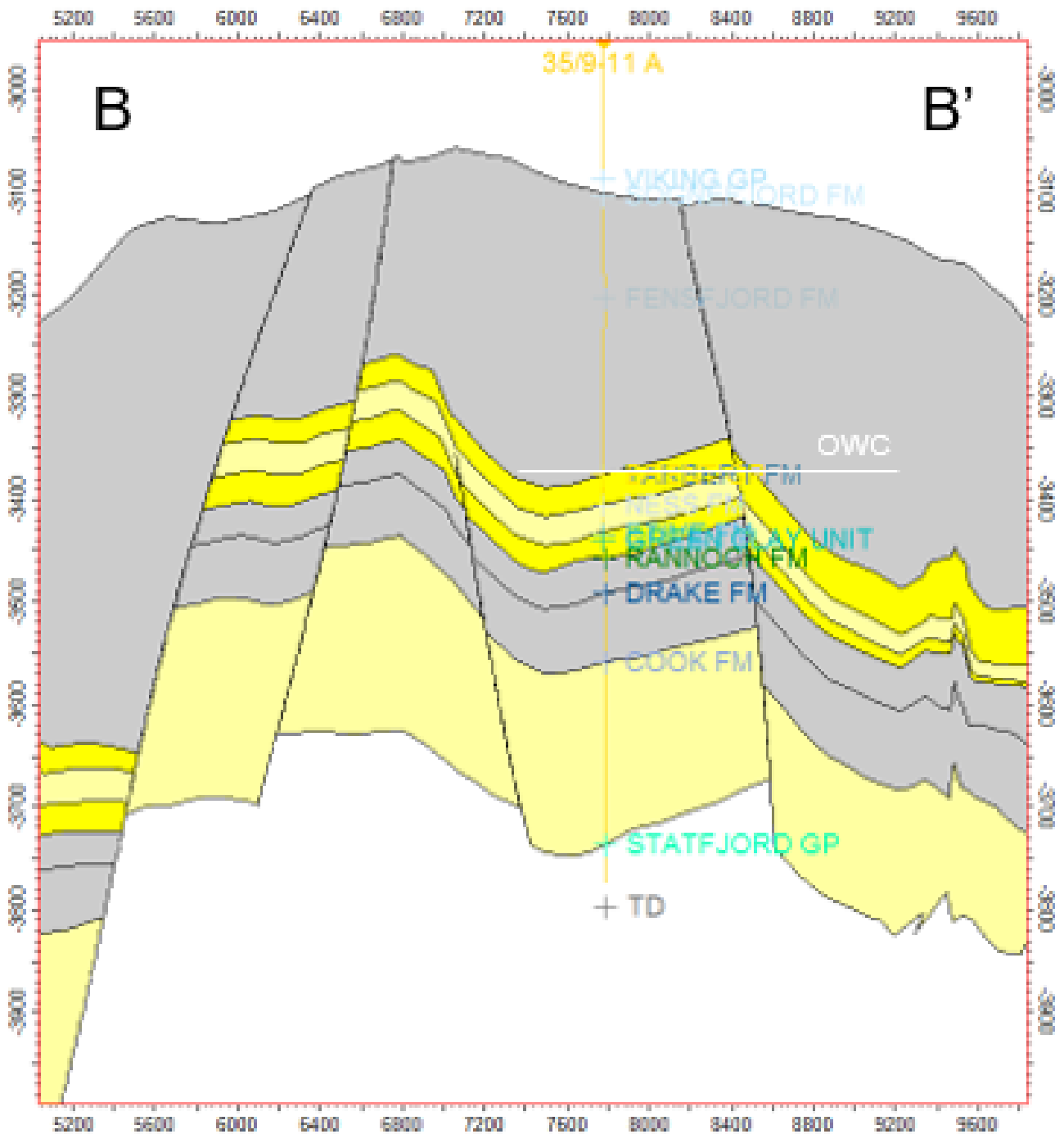


Fig. 4.11 Section through well 35/9-11 A B - B' section in previous map

Table 4.3 Estimation of In-place volumes - Etive Fm.

HC liquid [1e6 Sm ³]							
Accumulation size	MC(2000)	1.84	3.19	2.13	0.928	2.75	6.21
Cond. segment potential	MC(2000)-r	1.84	3.19	2.13	0.928	2.75	6.21
Uncond. segment potential	MC(2000)-r	1.84	3.19	2.13	0.928	2.75	6.21
Gas [1e9 Sm ³]							
Accumulation size	MC(2000)	0.455	0.894	0.602	0.258	0.764	1.72
Cond. segment potential	MC(2000)-r	0.455	0.894	0.602	0.258	0.764	1.72
Uncond. segment potential	MC(2000)-r	0.455	0.894	0.602	0.258	0.764	1.72

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Table 4.4 Estimation of recoverable volumes - Tarbert Fm.

HC liquid [1e6 Sm ³]							
Accumulation size	MC(2000)	0.558	0.957	0.691	0.247	0.799	1.96
Cond. segment potential	MC(2000)-r	0.558	0.957	0.691	0.247	0.799	1.96
Uncond. segment potential	MC(2000)-r	0.558	0.957	0.691	0.247	0.799	1.96
Gas [1e9 Sm ³]							
Accumulation size	MC(2000)	0.134	0.268	0.196	0.0719	0.219	0.53
Cond. segment potential	MC(2000)-r	0.134	0.268	0.196	0.0719	0.219	0.53
Uncond. segment potential	MC(2000)-r	0.134	0.268	0.196	0.0719	0.219	0.53

Map at Etive level is shown in Fig. 4.12, sections through Titan is already shown in previous figures. In-place volumes for Etive is found in Table 4.5 and recoverable volumes in Table 4.6

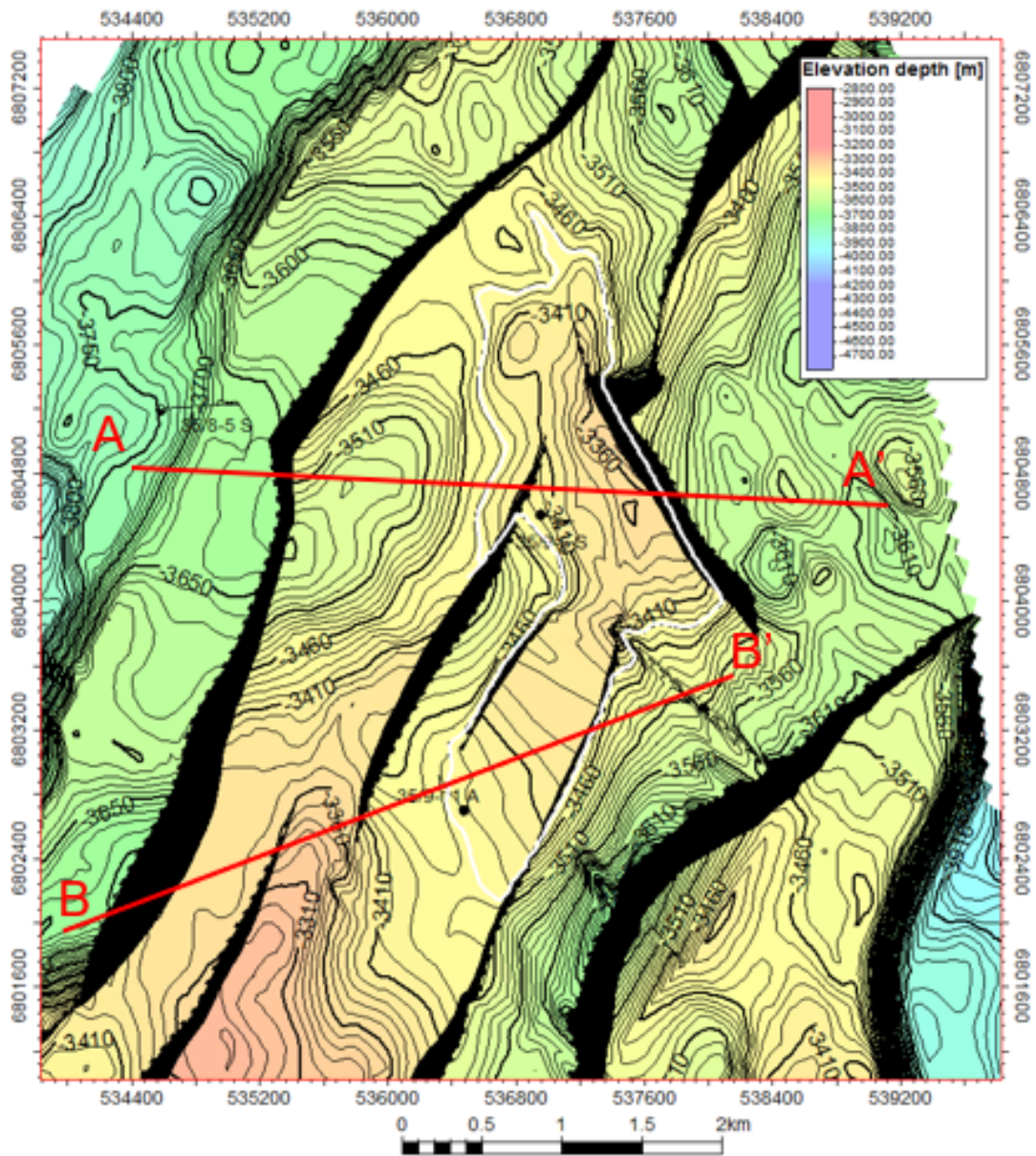


Fig. 4.12 Top Etive Structural depth map @ Top Etive level. Sections marked as red lines shown in previous figures.

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Table 4.5 Estimation of In-place volumes - Etive

HC liquid [1e6 Sm ³]							
Accumulation size	MC(2000)	0.0947	0.209	0.162	0.0332	0.171	0.439
Cond. segment potential	MC(2000)-r	0.0947	0.209	0.162	0.0332	0.171	0.439
Uncond. segment potential	MC(2000)-r	0.0947	0.209	0.162	0.0332	0.171	0.439
Gas [1e9 Sm ³]							
Accumulation size	MC(2000)	0.178	0.363	0.28	0.0589	0.3	0.764
Cond. segment potential	MC(2000)-r	0.178	0.363	0.28	0.0589	0.3	0.764
Uncond. segment potential	MC(2000)-r	0.178	0.363	0.28	0.0589	0.3	0.764

Table 4.6 Estimation of recoverable volumes - Etive

HC liquid [1e6 Sm ³]							
Accumulation size	MC(2000)	0.0304	0.0725	0.0598	0.011	0.0562	0.155
Cond. segment potential	MC(2000)-r	0.0304	0.0725	0.0598	0.011	0.0562	0.155
Uncond. segment potential	MC(2000)-r	0.0304	0.0725	0.0598	0.011	0.0562	0.155
Gas [1e9 Sm ³]							
Accumulation size	MC(2000)	0.0902	0.181	0.145	0.0278	0.144	0.382
Cond. segment potential	MC(2000)-r	0.0902	0.181	0.145	0.0278	0.144	0.382
Uncond. segment potential	MC(2000)-r	0.0902	0.181	0.145	0.0278	0.144	0.382

Map at Cook level is shown in Fig. 4.13, sections through Titan is already shown in previous figures. In-place volumes for Cook is found in Table 4.7 and recoverable volumes in Table 4.8.

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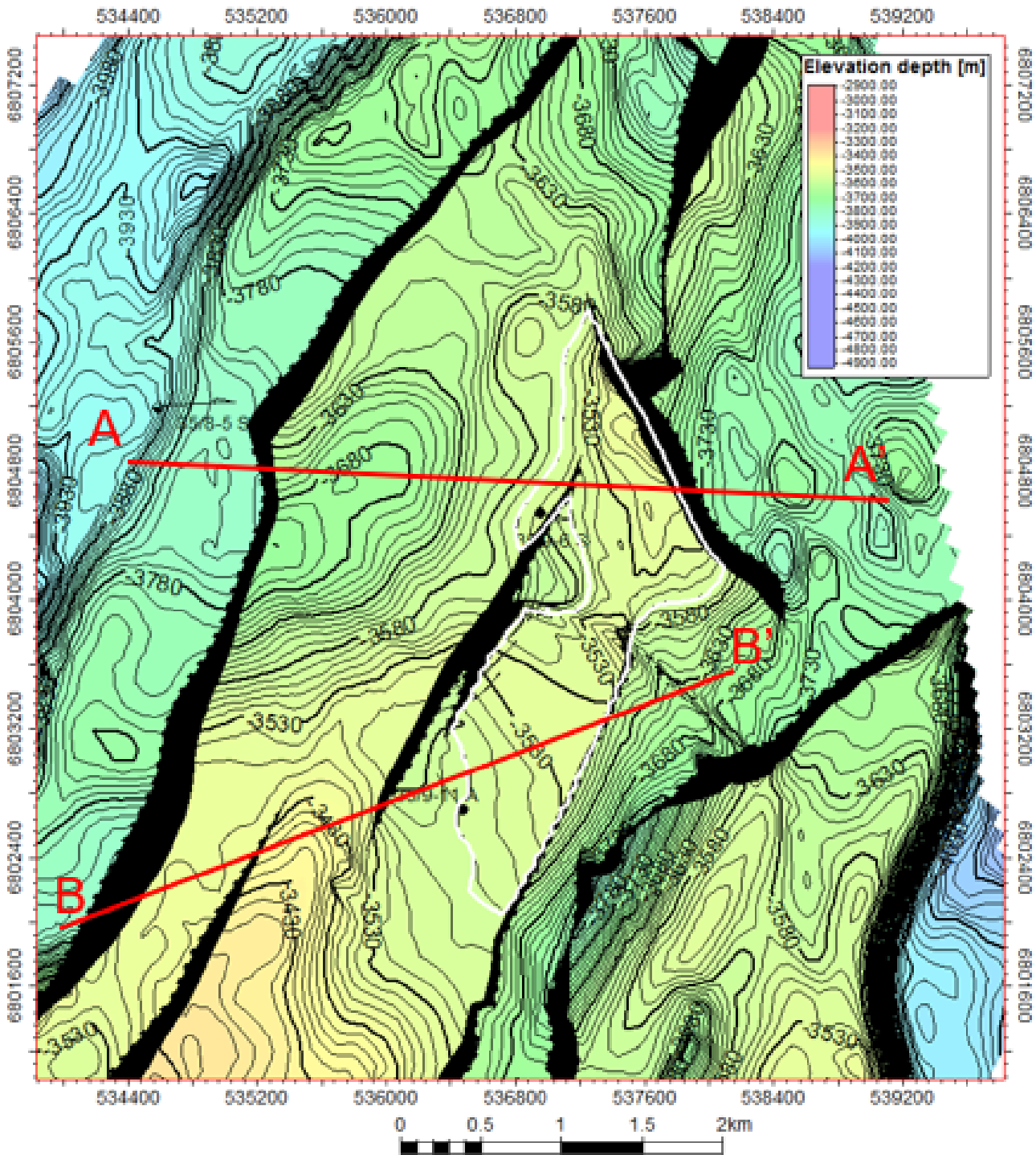


Fig. 4.13 Top Cook Structural depth map @ Top Cook level. Sections marked as red lines shown in previous figures

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Table 4.7 Estimation of In-place volumes - Cook Fm.

HC liquid [1e6 Sm3]							
Accumulation size	MC(2000)	0.102	0.321	0.324	0.0449	0.215	0.737
Cond. segment potential	MC(2000)-r	0.102	0.321	0.324	0.0449	0.215	0.737
Uncond. segment potential	MC(2000)-r	0.102	0.321	0.324	0.0449	0.215	0.737
Gas [1e9 Sm3]							
Accumulation size	MC(2000)	0.0346	0.198	0.199	0.0277	0.133	0.461
Cond. segment potential	MC(2000)-r	0.0346	0.198	0.199	0.0277	0.133	0.461
Uncond. segment potential	MC(2000)-r	0.0346	0.198	0.199	0.0277	0.133	0.461

Table 4.8 Estimation of recoverable volumes - Cook Fm.

HC liquid [1e6 Sm3]							
Accumulation size	MC(2000)	0.0168	0.111	0.119	0.0153	0.0713	0.262
Cond. segment potential	MC(2000)-r	0.0168	0.111	0.119	0.0153	0.0713	0.262
Uncond. segment potential	MC(2000)-r	0.0168	0.111	0.119	0.0153	0.0713	0.262
Gas [1e9 Sm3]							
Accumulation size	MC(2000)	0.0217	0.0981	0.101	0.0129	0.065	0.224
Cond. segment potential	MC(2000)-r	0.0217	0.0981	0.101	0.0129	0.065	0.224
Uncond. segment potential	MC(2000)-r	0.0217	0.0981	0.101	0.0129	0.065	0.224

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5 TECHNICAL EVALUATIONS

Based on the encountered reservoir quality and the calculated volumes, the Tethys technical discovery is not economic. Saturn is assumed to consist of equal reservoir quality and behaviour and thus volumes are estimated equivalent to the method and input as Tethys.

After drilling Tethys, a quick-look technical-economic evaluation was performed to define the additional volumes required in the area to make further exploration viable (MEFS). An oil discovery in a well drilled in 2021, leading to a field with 2 producers and 1 injector connected to the Nova subsea infrastructure, and delivering first oil in 2025 with end of field life in 2033, needs to contain at least $3.5 \times 10^6 \text{ Sm}^3$ o.e. Saturn is way below such a potential, and by simply summing the mean recoverable volumes for Tarbert, Etive and Cook in Titan, volumes are less than needed ($< 2 \times 10^6 \text{ Sm}^3$ o.e.) in addition to the complexity observed in pressure, fluid type and reservoir behaviour. Thus, the licensees do not believe that prospectivity in the license are economical viable.

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6 CONCLUSIONS

Phase 1 of the work program leading up to the Drill-or-Drop decision has been fulfilled by re-interpreting the CGG17M01 (and CGG18M01), in light of the results from drilling the Tethys well(s) 35/9-13, 35/9-14 & 35/9-14 A. The remaining prospectivity in the license is not economically viable to pursue any further based on the volume calculations and the minimum economic field size calculated for in the area. Complexity and uncertainty related to the Titan discovery makes it difficult to predict and to produce within an economic viable frame.