SPIRIT ENERGY

# PL 747 & 747B - Relinquishment Report

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# 1 Key license history

The PL 747/ 747 B license is located in the northern North Sea, in the southern Sogn Graben and west of the Ryggsteinen Ridge. The license outline and nearby fields and discoveries are shown in Fig. 1.1.

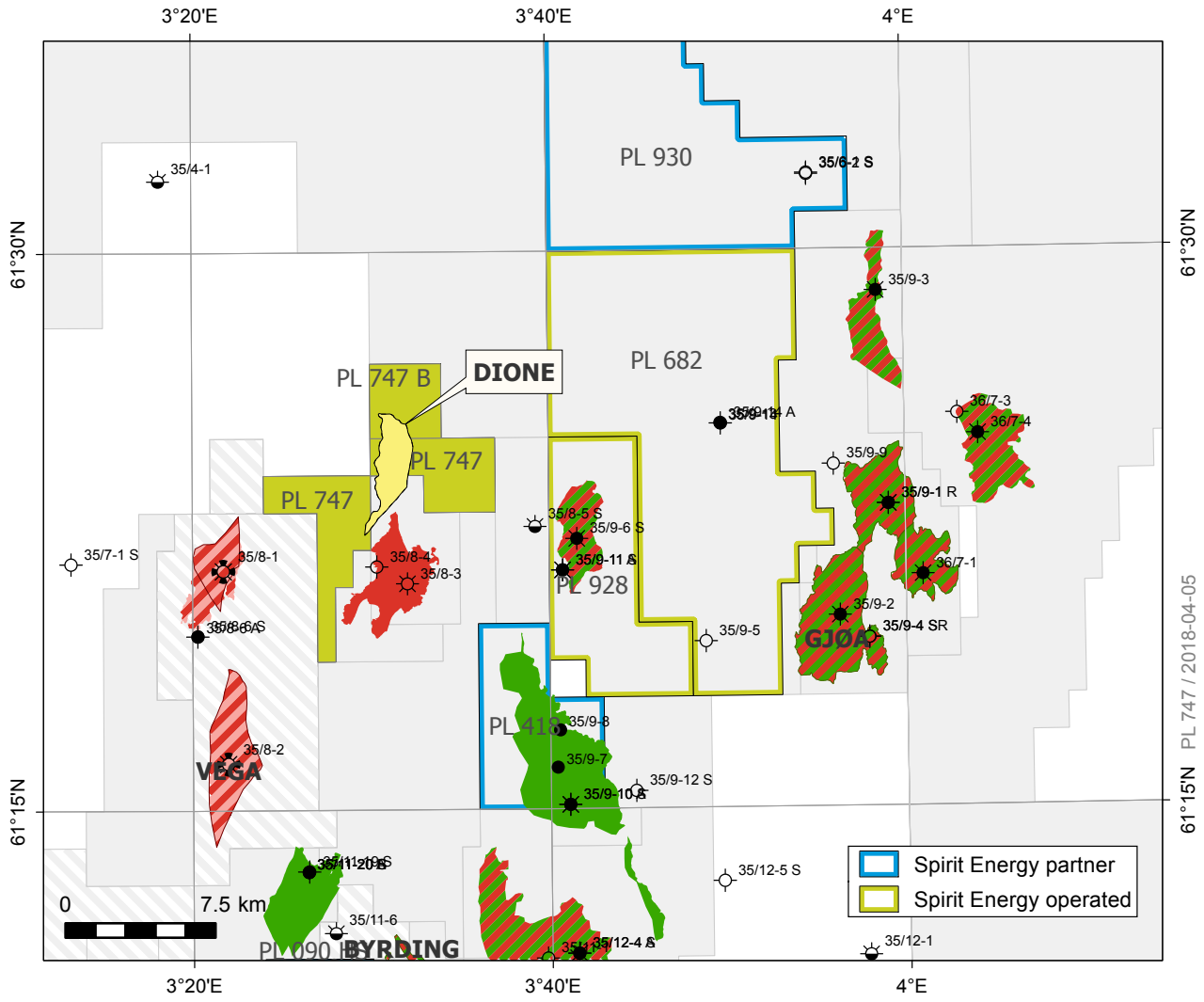


*Fig. 1.1 PL 747/747 B License map*

**Summary of award and participants**
PL 747 date granted: 07.02.2014 (APA 2013)

PL 747 B date granted: 05.02.2016 (APA 2015)

Owner of PL 747/747 B:

- Spirit Energy, 60% (Operator)
- Capricorn Norge AS, 40% (partner)

Voting rules: minimum 2 parties and 50% equity

**Work obligations**
PL 747 license was awarded 07.02.2014 (APA 2013). The work obligations were to reprocess and merge 3D seismic and perform geology and geophysics studies in order to reach an agreement for a drill or drop decision of the license. PL 747 B license was awarded 05.02.2016 (APA 2015) as an extension to PL 747, with work obligations as for PL 747 license. The work obligations are summarized in Table 1.1.

*Table 1.1 PL 747/747 B Work obligations*

| Period | Phase | Duration [years] | Work Obligation | Descision | Expiry date | Extended expiry date (per 12/10/2015) | Extended expiry date (per 30/11/2016) |
|---|---|---|---|---|---|---|---|
| Initial period: | 1 | 2,0 | Reprocess and merge 3D seismic | Drill or Drop (DoD) | 07.02.2016 | 07.02.2017 | 07.02.2018 |
| | 2 | 2,0 | Drill exploration well | Concretize (BoK) | 07.02.2018 | 07.02.2019 | 07.02.2020 |
| | 3 | 2,0 | Conceptual studies | Continue (BoV) | 07.02.2020 | 07.02.2020 | 07.02.2020 |
| | 4 | 1,0 | Prepare development plan | Submit plan for development PDO | 07.02.2021 | 07.02.2021 | 07.02.2021 |
| | Sum | 7,0 | Extension period [years] | 20 | | | |

License extension:

- Det Kongelige Olje- og Energidepartement approved the `application for an extension` in a letter dated 17th of September 2015. The new drill or drop decision was set to 7th of February 2017. The main reason for an extension was to include the MCNV Horda survey in the license database, and to re-evaluate the prospectivity on new data.
- Det Kongelige Olje- og Energidepartement approved the `application for an extension` in a letter dated 1st of December 2016. The new drill or drop decision was set to 7th of Februrary 2018. The main reason for an extension was to harmonize the activity in the license with neighbouring licenses.

**License Meetings**
Combined MC/EC meetings:

- EC/MC meeting No. 1, 2014/03/19
- EC/MC meeting No. 2, 2014/11/25
- EC/MC meeting No. 3, 2015/10/28
- EC/MC meeting No. 4, 2016/11/15
- EC/MC meeting No. 5, 2017/11/27

There have been several work meetings in the license.

**Reason for relinquishment**
The work obligations have been fulfilled. We have not identified a commercially attractive prospect and have therefore made a decision to relinquish the license acreage.

The Dione prospect from the APA 2013 application could not be matured to a drilling candidate, and there is no additional prospectivity identified within the license acreage.

The PL 747/747 B outline is not optimal for prospectivity. G&G studies performed during license work have indicated potential prospectivity within the greater area. The license committee agreed that the area remains attractive for further exploration, and agreed to keep this as a potential opportunity for future cooperation.

# 2 Database

**Seismic database**

During APA 2013 the interpretation was mainly based on the PGS MC3D Mega-merge survey. Reprocessing 3D seismic was part of the work program in the license. The reprocessed dataset (BGN14M02) covers approximately 300 km² with ties to Vega Nord and the Aurora and Titan discoveries. The reprocessed dataset shows uplift with enhanced frequency content and improved fault definition compared to vintage surveys and the MegaMerge. The reprocessing was completed in December 2014. The Broadseis 3D data, MCNV Horda survey, was included in the seismic database and used in the prospect evaluation of PL 747/747 B.

The license database is shown in Fig. 2.1 and Table 2.1.

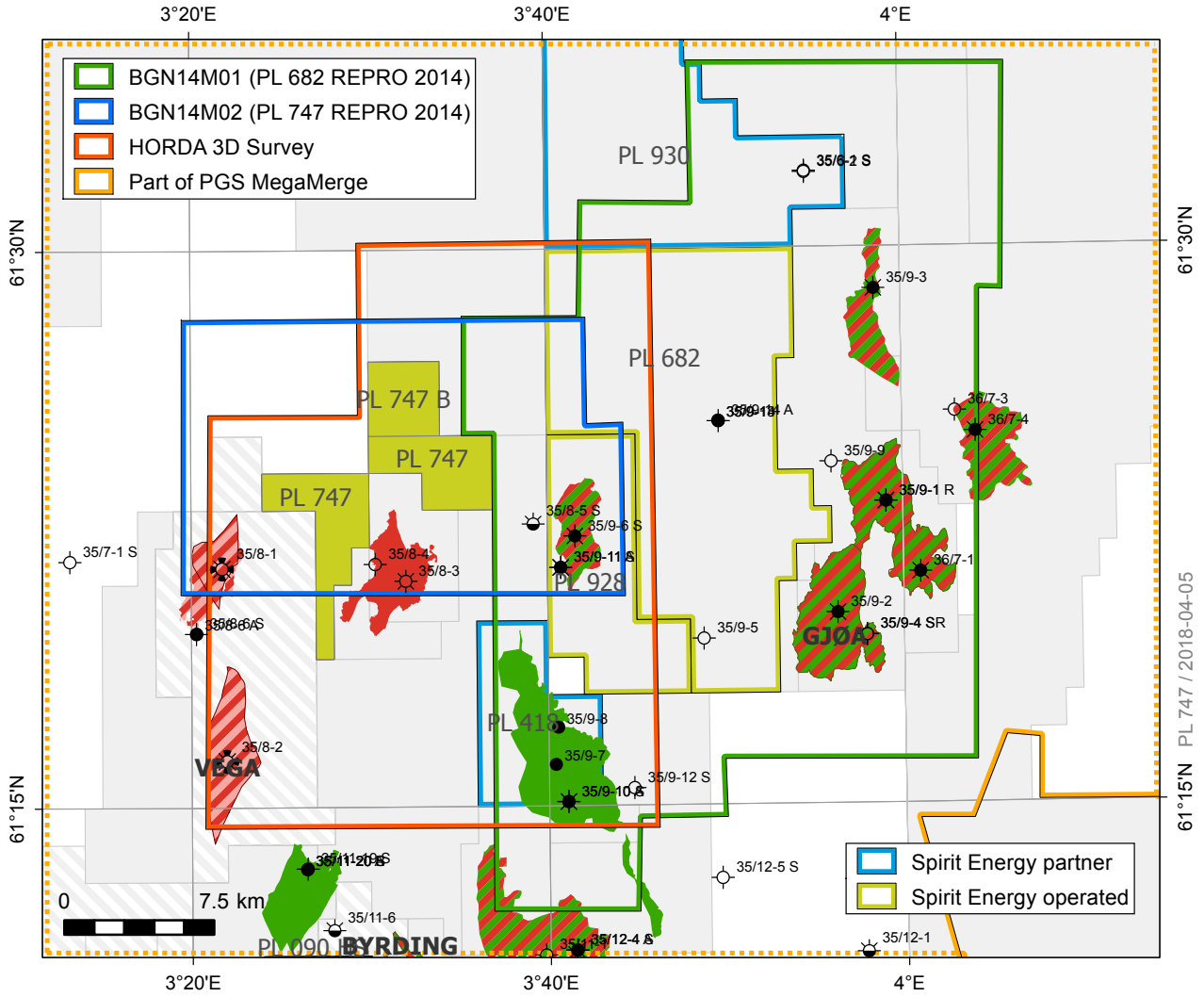


*Fig. 2.1 PL 747/747 B Seismic database*

*Table 2.1 PL 747/747 B Seismic database*

| 3D seismic | Category | NPDID |
|---|---|---|
| BGN14M01 | Licence owned, PL 682 | Merged |
| *RD1201* | | 7581 |
| *NH9405* | | 3676 |
| *BPN9301* | | 3635 |
| *ST0703* | | 4484 |
| BGN14M02 | Licence owned, PL 747 | Merged |
| *BPN9301* | | 3635 |
| *NH9202* | | 3529 |
| MCNV Horda, CGG14003 | Multiclient | 7984 |
| PGS MegaSurvey | Multiclient | Merged |

**Well database**

The license well database is shown in Fig. 2.2 and Table 2.2.

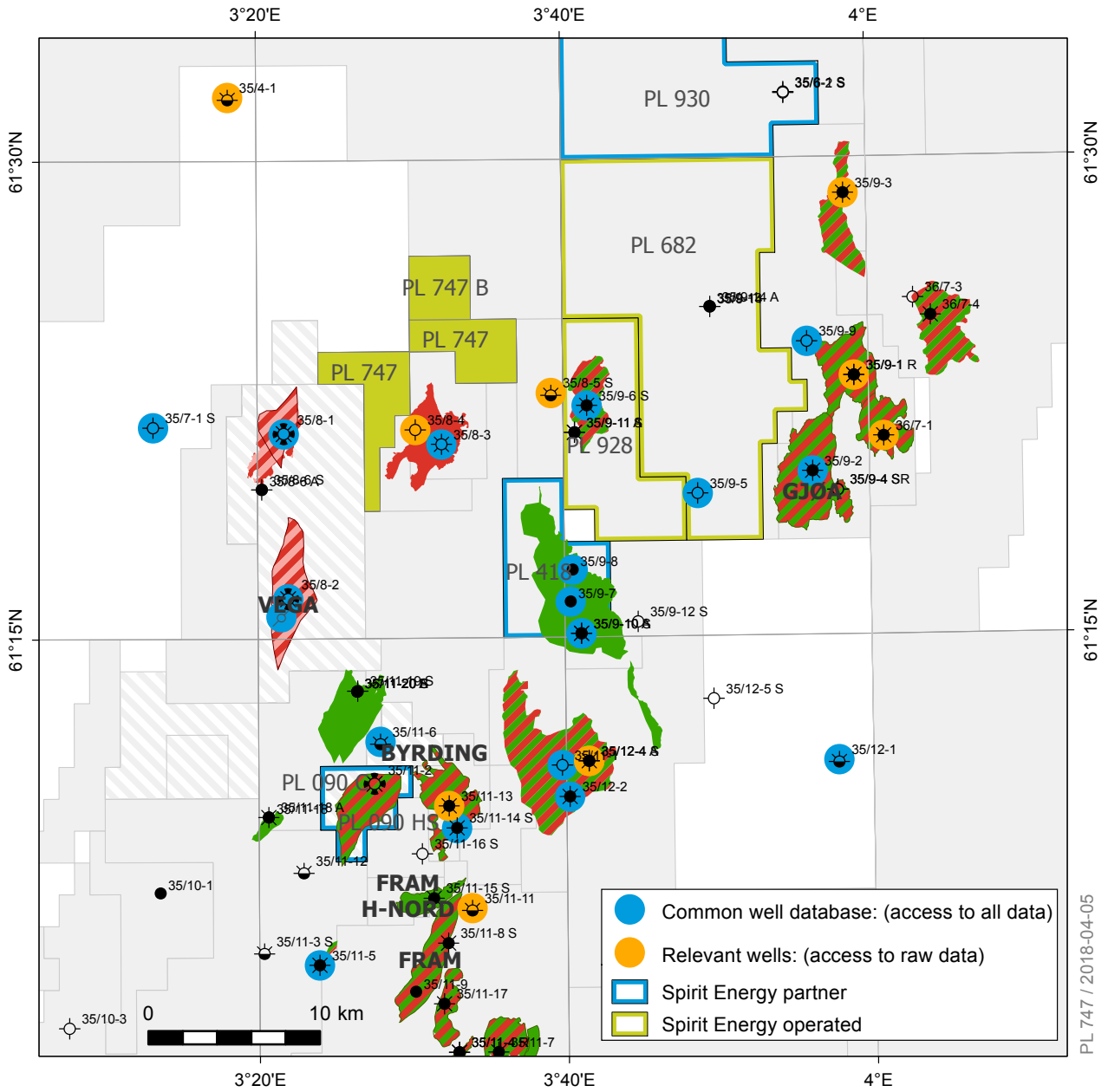


*Fig. 2.2 PL 747/747 B Well database*

*Table 2.2 PL 747/747 B Well database*

| Wellbore | Status | NPDID |
|---|---|---|
| 35/7-1 S | Common well database | 6599 |
| 35/8-1 | Common well database | 205 |
| 35/8-2 | Common well database | 434 |
| 35/8-3 | Common well database | 1288 |
| 35/8-Q-14 H | Common well database | 6435 |
| 35/9-2 | Common well database | 1600 |
| 35/9-5 | Common well database | 6293 |
| 35/9-6 S | Common well database | 6429 |
| 35/9-7 | Common well database | 6776 |
| 35/9-8 | Common well database | 7120 |
| 35/9-9 | Common well database | 7257 |
| 35/9-10 A | Common well database | 7321 |
| 35/9-10 S | Common well database | 7259 |
| 35/11-1 | Common well database | 128 |
| 35/11-5 | Common well database | 1780 |
| 35/11-6 | Common well database | 1879 |
| 35/11-14 S | Common well database | 5365 |
| 35/12-1 | Common well database | 1881 |
| 35/12-2 | Common well database | 6095 |
| 35/4-1 | Relevant wells | 2993 |
| 35/8-4 | Relevant wells | 3791 |
| 35/8-5 S | Relevant wells | 4761 |
| 35/9-1 | Relevant wells | 1375 |
| 35/9-3 | Relevant wells | 3206 |
| 35/11-11 | Relevant wells | 3356 |
| 35/11-13 | Relevant wells | 5063 |
| 35/12-4 A | Relevant wells | 6617 |
| 35/12-4 S | Relevant wells | 6589 |
| 36/7-1 | Relevant wells | 1794 |

# 3 Review of geological framework

**Special studies**
Several internal (in-house) and external special studies have been carried out to address the geological and geophysical understanding of the license prospectivity. These studies include:

- 3D seismic reprocessing and merging, BGN14M02, in-house study
- Seismic inversion study, BGN14M02, in-house study
- Seismic inversion study, 3D Horda survey, in-house study
- Reservoir quality study, Geocosm
- Chemostratigraphic study, Ichron
- Refinement of the geological model, in-house study
- Petroleum system and migration modelling, in-house study
- Dione/Aurora feasibility study, in-house study

**3D seismic reprocessing and merging, BGN14M02, in-house study**
The reprocessing was performed by PSS-Geo at BGN in-house processing centre. The reprocessed dataset shows uplift with enhanced frequency content and improved fault definition compared to vintage surveys and the MegaMerge. The reprocessing was completed December 2014.

**Seismic inversion study, BGN14M02, in-house study**
An AVO feasibility study has been carried out in order to evaluate the sensitivity of the seismic data to fluid changes. The study focused on the Dione Prospect and included fluid replacement modelling and depth trend analysis. Acoustic and shear impedances and their combination provided the best water/hydrocarbon separation and could potentially be used as a fluid indicator. Finalized autumn 2015.

**Seismic inversion study, 3D Horda survey, in-house study**
Two Astero wells (35/11-13 and 35/11-14S) and the Aurora well (35/8-3) have been used for the analysis of the elastic attributes for Dione prospect. 100% brine and 80% gas cases have been modelled for all three wells. Acoustic (P-) impedance and Vp/Vs have been identified as the best elastic attributes for lithology and/or fluid separation. The Aurora sandstone is characterized by high P-impedance values. The Dione prospect has P-impedance and Vp/Vs values that indicate a high shale content. Finalized October 2017.

**Reservoir quality study, Geocosm**
A reservoir quality study focusing on the prediction of reservoir quality for both upper Jurassic sandstones and Brent sandstones. Forward modelling has been undertaken using TouchstoneTM technology including detailed burial history modelling, sampling of cores, preparation of thin sections and the production of a substantial petrographic database in the Q35 area. Forward modelling of the Dione Prospect and the Rhea Lead was finalized autumn 2015.

**Chemostratigraphic study, Ichron**
A chemostratigraphic study was performed to improve the understanding of the stratigraphic framework of the Upper Jurassic strata in Q35. Samples from sandstones and mudstones were taken from Callovian and Oxfordian strata. Links between geochemistry and source/provenance were investigated. The results indicated no significant differences between the different Heather Formation sandstone units. Local variations exist, but it was not possible to refine the scheme. It is suggested that this is due to active mixing and reworking of sediments in the shoreface environment. Finalized autumn 2015.

**Refinement of the geological model, in-house study**
The Upper Jurassic interval has been analysed with respect to sandstone presence within the Callovian,

Oxfordian, Kimmeridgian and Tithonian stages. Stratigraphy has been revised using litho- and biostratigraphic data over a semi-regional area. A biostratigraphic study was initiated, and performed by Ichron (2015). Biostratigraphic data have also been available from other vendors i.e Geolink and APT. The near top Callovian stage is a good log marker, and a very good seismic reflector providing a clear base to the studied Upper Jurassic interval.

**Petroleum system and migration modelling, in-house study**
A model (Trinity) was generated to assess maturity and migration. The maturity model shows a range of post mature, gas generating, and oil generating, source rocks with the post mature stage currently dominant. The spill-route(s) into the Dione prospect appear identical to the spill route to Aurora. A PVT model shows a likely gas/condensate composition in Dione. This is consistent with the observation in Aurora. Finalized autumn 2017.

**Dione/Aurora feasibility study, in-house study**
Assuming unitization between PL 747 and PL 195 (50/50), where PL 747 carries 70% of exploration and pre-sanction costs for Dione exploration, and 50% of all other costs and production, and PL 747 receive 50% of revenues from unit. Based on financial results, it is more economic for PL 747 to pursue a stand-alone Dione case than a joint development of Dione/Aurora case. The unit cost of producing 1 boe, is higher for a combined Dione/Aurora case. Finalized January 2017.

**The geological model for the Dione prospect**
The main target in PL 747/PL 747B was presented in the application for APA 2013. The play models comprised Upper Jurassic submarine fans and turbidite sandstones of Oxfordian age, a Sognefjord Formation equivalent, within the Heather Formation. The seismic interpretation at that time was based upon an assumed base Sognefjord Formation reflector. This is now interpreted to represent near top Callovian. Base and top reservoir is constructed based on the near top Callovian reflector. In addition to the Oxfordian interval, mapping of potential younger sandstones have been carried out.

The uncertainty in presence of sandstones, both of Oxfordian and Kimmeridgian/Tithonian ages have made the prospectivity unclear. The chemostratigraphic study did not reveal more certainty in where sand could come from so that a valid paleogeography was difficult to trust, and the seismic inversion study indicated less sandstone present than originally anticipated. The Dione prospect is further downflank than the Aurora appraisal well (35/8-4). The correlation from 35/8-3 to 35/8-4 indicated less presence of good quality sandstone in the northern well 35/8-4 than in the discovery well 35/8-3.

# 4 Prospect update

Fig. 4.1 shows top reservoir of the Dione prospect, in time and depth, as defined during the APA 2013 work.

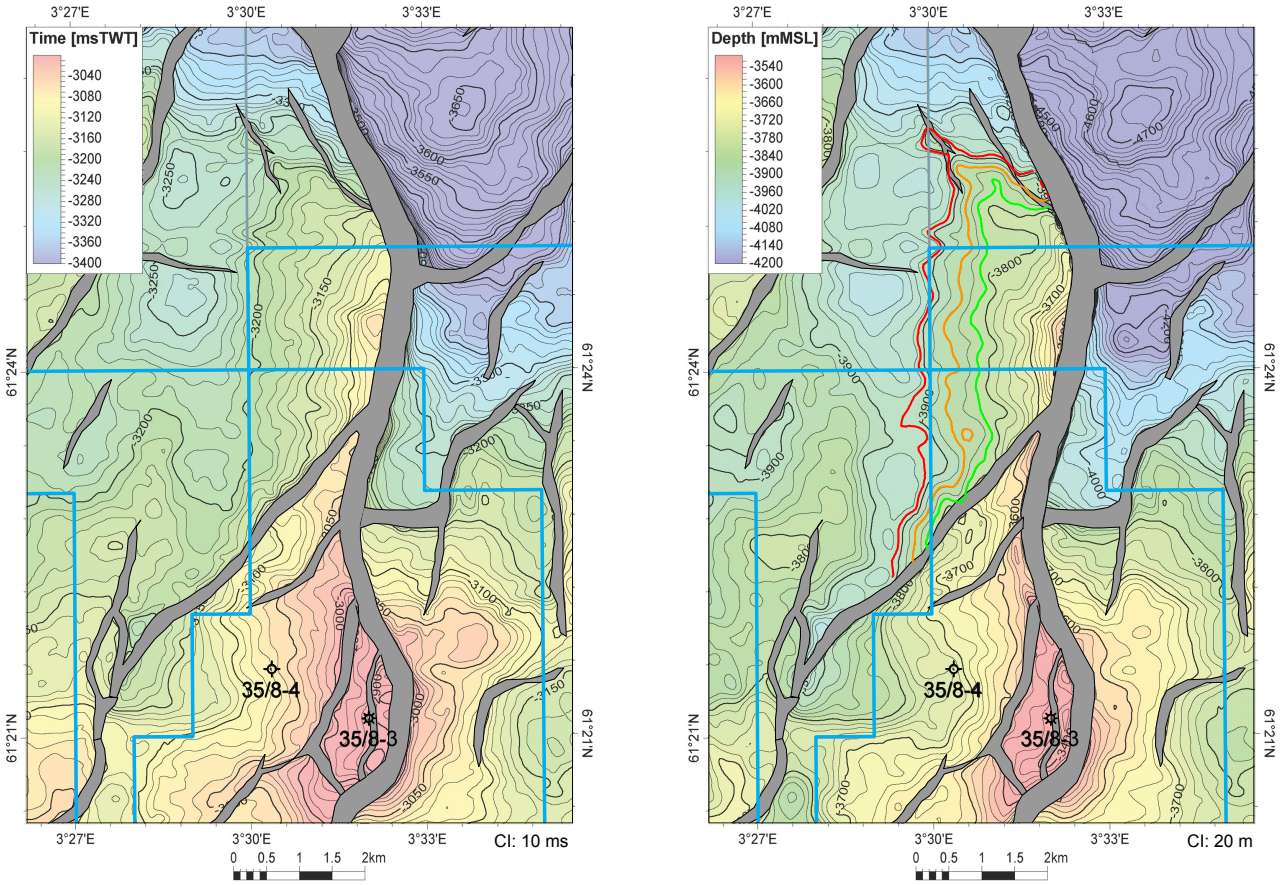


*Fig. 4.1 Top reservoir map (APA 2013), in time (left) and depth (right)*

During APA 2013 the interpretation was mainly based on the PGS MC3D Mega-merge survey. Reprocessing 3D seismic was part of the license work obligations, and the main focus for the first phase of the license was to improve the seismic imaging of the main prospect. The reprocessed dataset (BGN14M02) covers approximately 300 km² with ties to Vega Nord and the Aurora and Titan discoveries. The reprocessing was completed in December 2014. The reprocessed dataset shows uplift with enhanced frequency content and improved fault definition compared to vintage surveys and the MegaMerge. However, the imaging of the top and base reservoir was still uncertain and picking the top Sognefjord reflector was difficult in the prospect area. The Broadseis 3D data, MCNV Horda survey, was included in the seismic database and used in the prospect evaluation.

The Horda survey has good seismic quality, and well ties to the 35/8-3, 35/8-4, 35/8-1 and 35/9-6 S wells are good. Near top Callovian is a strong reflector in the license area, and has a good well tie to the surrounding wells. However, Top Sognefjord tie is inconsistent and the reservoir section cannot be interpreted with confidence. Base and top reservoir is constructed based on the near top Callovian reflector (Fig. 4.2). The Dione prospect is not very sensitive to depth conversion.

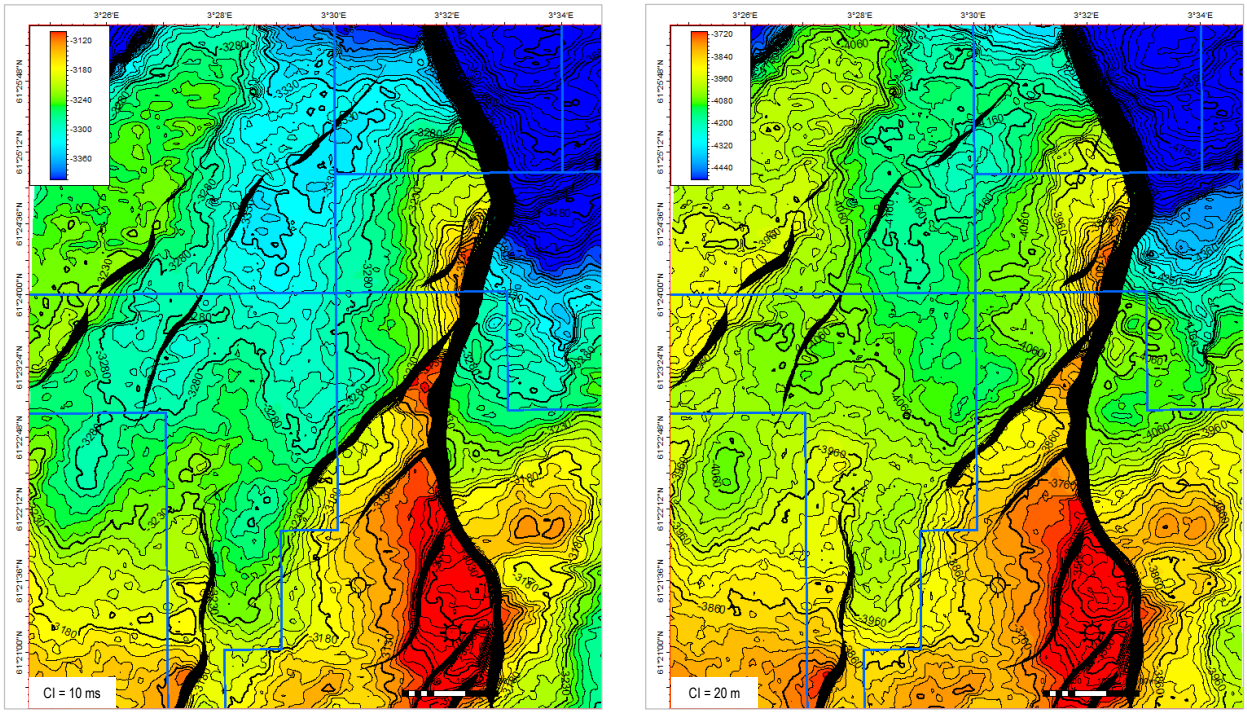


*Fig. 4.2 Near top Callovian map, in time (left) and depth (right)*

The Dione Prospect reservoir comprises submarine fans and turbidite sandstones of Oxfordian to Kimmeridgian age. The reservoir sequence was proposed to be similar to the time-equivalent deposits seen in the nearby Aurora discovery (wells 35/8-3, and -4), and the wells 35/11-6, 35/11-13 and 35/11-14 located to the south of the prospect. Data from these wells were used to estimate reservoir parameters. The sandstones was expected to have good to fair reservoir properties with high net to gross ratios.

As described in the Special studies section, 2 Database, an elastic inversion study has been generated for the Horda survey using Astero wells (35/11-13 and 35/11-14S) and the Aurora well (35/8-3) as reference for the analysis of the results. Acoustic (P-) impedance and Vp/Vs have been identified as the best elastic attributes for lithology and/or fluid separation. The prospect was characterized by Vp/Vs values mainly above 1.7 that indicated a high shale content (Fig. 4.3). At the same time, the low Vp/Vs values at Aurora discovery indicate sandstone lithology in accordance with the well observations. Therefore, there was no geophysical support for sand presence within the Dione prospect. Combining this observation with the chemostratigraphical analysis, that found difficulty to pin-point a provenance direction for the potential sand deposit, and the negative trend in amount of good facies and reservoir quality in the two Aurora wells (35/8-3 to 35/8-4), it was found less likely to interpret the probability of good sandstone development in the Dione prospect.

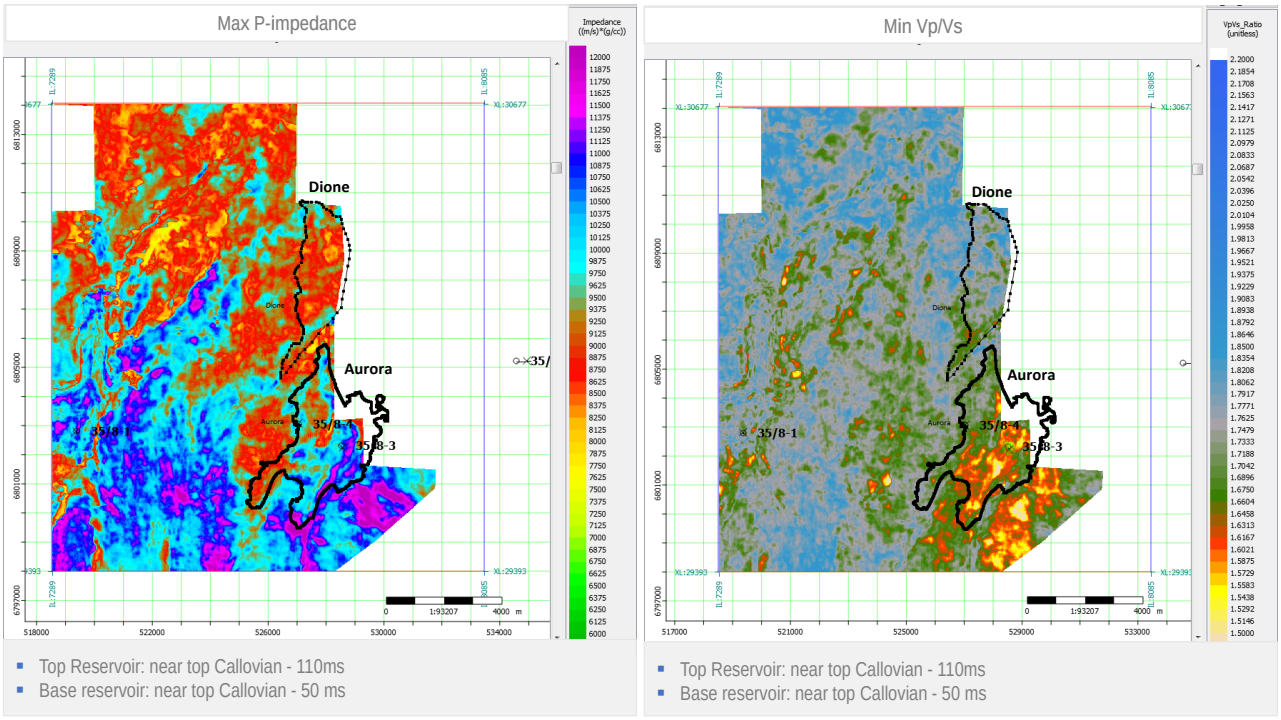


*Fig. 4.3 P-impedance (left) and Vp/Vs (right) for the constructed reservoir interval*

The trap is a structural, fault-dependent closure with an apex at 3560m MSL. To the east, the prospect is delineated by a significant eastward dipping, north-south trending fault that totally offsets the reservoir section. Base case is set at the structural spill towards south-east at 3890m MSL, and at the position on the fault where complete offset of the reservoir section is interpreted to be maintained. Towards the Aurora structure, the prospect needs to be sealed by a NE-SW oriented fault. The main trap risk is that the reservoir section is not sealed against the Aurora structure to the south because full offset is not maintained, and/or older intra Heather sandstones are present. There are uncertainties related to the constructed base and top reservoir, giving a risk for intra Heather sandstones juxtaposed to the reservoir.

The basin modelling shows encouraging results for migration and hydrocarbon charge. Dione reservoir is interpreted to be adjacent to the Draupne Formation source rocks. Intra-Heather Formation sandstone stringers provide potential migration paths from the surrounding basin, and the available catchment area to the north is extensive. Migration will be focused up-slope into the Dione prospect. Following Late Miocene uplift, hydrocarbon generation might have ceased in the prospect drainage areas. Burial depths following the Miocene uplift were not sufficient for hydrocarbon generation to resume in order to refill the prospect if leakage had occurred. The hydrocarbons must therefore have been retained in the reservoir since Late Miocene. The Dione prospect is surrounded by discoveries and fields that have experienced the same tectonic history. The retention risk is therefore low.

Reference to APA 2013, the recoverable volumes of the Dione prospect was calculated to be 7.9 $MSm^3$ (total o.e.) and the risk evaluation gave a POS of 19%. In the new evaluation, the recoverable volumes of the Dione prospect is calculated to be 6.1 $MSm^3$ (total o.e.) and the risk evaluation a POS of 12% where the main risk is related to the reservoir presence. The revised geological model suggests the presence of Oxfordian to Kimmeridgian submarine fans and turbidite sandstones to be unlikely in the prospect area.

**Additional prospectivity**

The license has evaluated additional prospectivity at all stratigraphic levels with focus on the Cook Formation, Brent Group, upper Jurassic sandstones and Paleogene sandstones. There were no other prospects of attractive volumes identified within the license acreage.

The Cook Formation is well developed as a classic shallow marine sandstone in the PL747/PL747B area. Seismic mapping indicates small closures, but basin modelling shows that these closures are not favourably positioned with respect to migration. There is also an uncertainty related to depositional facies since tidal channel facies is not much seen in wells around.

The Brent Group is present in the area, well developed as a classic Brent Delta as seen in 35/8-1, 35/8-3 and 35/7-1S T2. The reservoir quality is most likely poor to moderate. The confidence in mapping the Top Brent reflector is good to very good. The seismic mapping indicates several small closures. A fault dependent structural closure of reasonable size is mapped directly beneath the main prospect. The potential reservoir interval is at 4000 - 4500 m, and there will be a high risk on reservoir quality.

The Operator has completed a lot of studies with focus on the Upper Jurassic section, see 3 Review of geological framework. Biostratigraphic studies combined with data from new wells indicate that Kimmeridgian sandstones might be more common than anticipated, and seismic interpretation suggests potential for thicker Kimmeridgian sandstones units. The mapped closures within the license acreage have no geophysical support, and there will be a high risk on reservoir presence. There is an interesting fan shaped feature characterized by high P-impedance and low Vp/Vs east of Aurora, outside the PL 747/747 B acreage.

Paleogene sandstones are well developed in several stratigraphic levels. There are no closures identified at these levels and, hence, no possible Paleogene prospects within the licence acreage.

# 5 Technical evaluations

Dione is  located approximately 22 km west of the Gjøa Field. A tie-back to the Gjøa via an existing In-line tee on the pipeline from Vega N to Gjøa was selected for concept development, ref Fig. 5.1. Dione hence assumed to make use of the Gjøa platform's gas and oil production and export systems. Necessary available processing capacity and tie-ins at the Gjøa platform was foreseen with limited upgrades in 2022. The Wintershall operated Nova license is planned to be tied back to Gjøa and in production prior to Dione project execution.

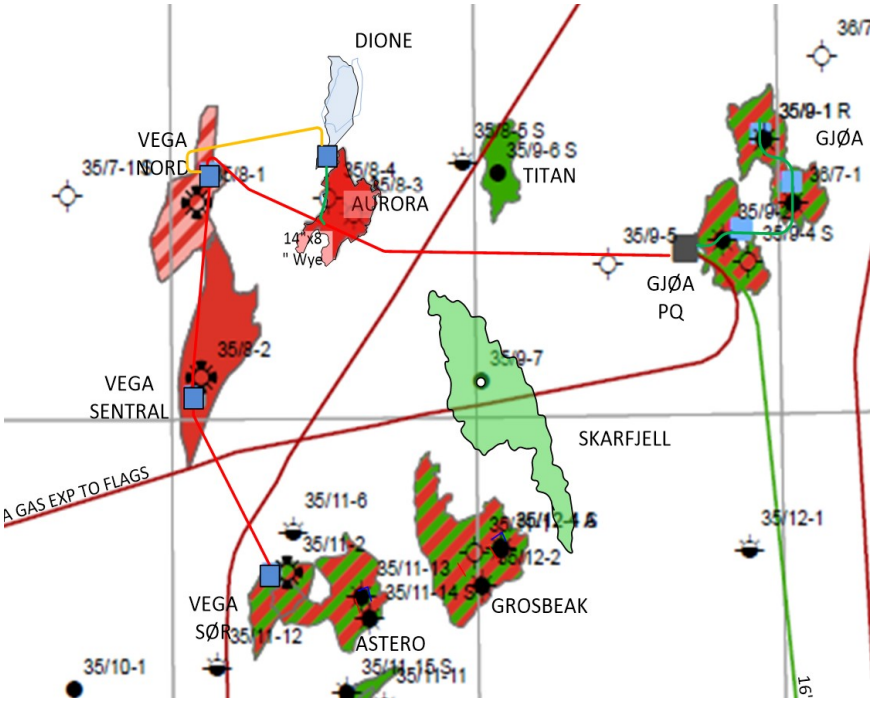


*Fig. 5.1 PL 747/747 B area map*

Two concepts were evaluated for development of Dione:

1. Stand-alone with tie in to Gjøa via Vega existing In-Line tee
2. Development in conjunction with the adjacent Aurora discovery tied back to Gjøa in similar way as above

**Dione Stand-alone development**
Dione is situated at 370 m water depth. Tie-in to the Vega pipeline require to operate at Vega flowing conditions and that the pipeline is protected for excessive pressure by use of HIPPS (High-Integrity Pressure Protection System).

As stand-alone, the Dione Prospect was planned to be developed with one single satellite subsea well with commissions for daisy chaining of one future satellite. The well would be tied back to the Vega-Gjøa 14" pipeline via an existing In-line tee located in the Aurora area (6.7 km from Vega North)  by a new 8"ID" buried flowline. An electro-hydraulic/chemicals umbilical would be connected via an Umbilical Termination Assembly (UTA) to a spare well-slot on the Vega N template. See Fig. 5.2 for subsea layout.

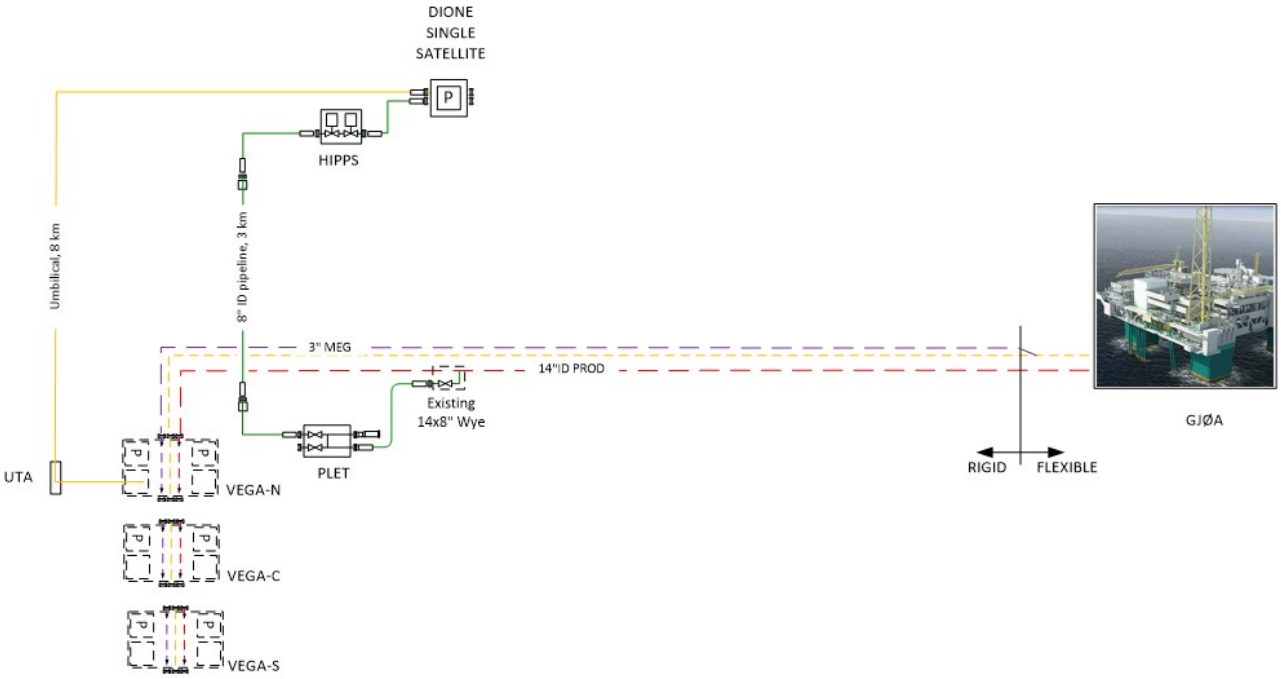


*Fig. 5.2 Dione subsea layout*

- The Xmas tree was to be equipped with multiphase meters for allocation and fiscal metering
- The 8" Dione flowline and the 14" Vega-Gjøa pipeline was to be protected against high pressure by subsea HIPPS located downstream the Dione satellite well. The satellite was designed with a flow-base for possible future "daisy chaining", allowing for additional finds in the area.
- Tie-in to Gjøa was planned by utilizing the existing Vega facilities. Only minor modifications with the control system would have been required on Gjøa.
- The expected project execution time was set to 24 months based on benchmarking of similar subsea tie-back projects.

**Dione developed in conjunction with Aurora**

Aurora is a discovery in the vincenity of Dione. Both fields would suffice with one production well, and the plan was to develop the two fields with one 4-slot subsea template tied back to Gjøa in similar manner as for the Dione stand-alone solution. 24 months was expected project execution time also for this development scenario. See Fig. 5.3 for subsea layout for the combined development.

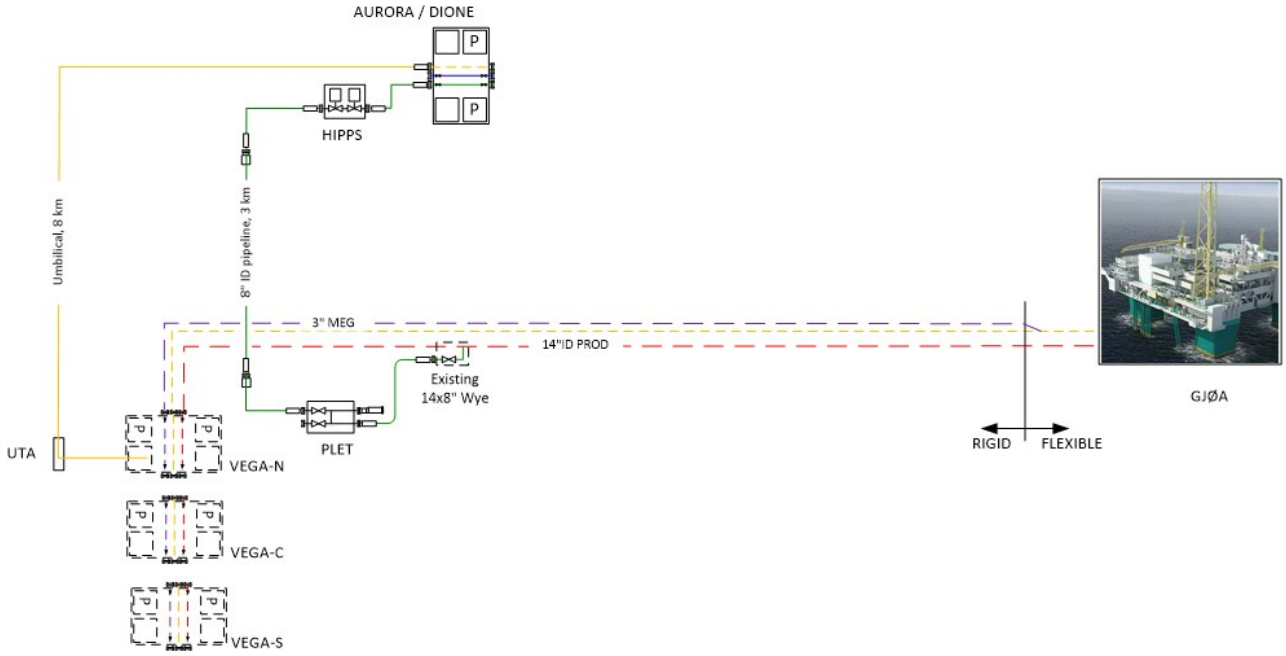


*Fig. 5.3 Dione and Aurora subsea layout*

# 6 Conclusions

Phase 1 of the work program, leading up to a Drill or Drop (DoD) decision, comprised geological and geophysical studies. Deadline for DoD was 7th of Febraury, 2018. The partners deicided to relinquish the license. The main reasons for relinquishment are realted to the uncertain presence of reservoir sandstones. The revised geological model suggests the presence of Oxfordian to Kimmeridgian submarine fans and turbidite sandstones to be unlikely in the prospect area. Furhter to this, there are no geophysical support, no indications of sands present within the Dione prospect. There are uncertainties related to the constructed base and top reservoir, and there is a risk that the resevoir section is not sealed against the Aurora stucture to the south, because full offset is not maintained and/or older intra Heather sandstones are present. Trap risk together with reservoir uncertainty cause a high risk to presence of commercial hydrocarbon volumes within the Dione prospect.