Second Faroese Licensing Round

OLJUFYRISITINGIN
Faroese Petroleum Administration

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1. Introduction by the Minister Bjarni Djurholm

Mr. Bjarni Djurholm
Minister of Trade and
Industry

This August will see the launching of the Second Licensing Round on the Faroese Continental Shelf. With this brochure we want to give oil companies interested in petroleum exploration on the Atlantic Margin a broad introduction to the Faroe Islands' licensing and fiscal regimes, the results of exploration activities to date and an overview of the exploration opportunities of our area.

Seven exploration licenses were granted in the First Licensing Round on the Faroe Shelf, with a total of eight well commitments. Four wells have been drilled until now, and although the results did not meet the very high pre-spud expectations, the result is encouraging in that it has been established that the Faroese subsoil holds an active hydrocarbon system and that one of the wells discovered a significant hydrocarbon bearing column with a gross thickness of approx 170 m.

All four wells targeted the same geological play in the Judd basin and with the unexpected results exploration focus in the Faroes has widened to also include structural sub-basalt plays outside the Judd basin. Oil companies familiar with the Faroese area know that most of our area is covered by basalts and are therefore well aware of the consequent challenges of sub-basalt imaging and exploration. It is however important to mention that mapping has been carried out in these areas over the last 10 years revealing a number of significant exploration opportunities within the area now open for licensing. With the recent advances in sub-basalt imaging these opportunities can be matured further to warrant drilling of exploration wells.

With a view to the varying complexity of the area offered for licensing the petroleum authorities have introduced a flexible licensing regime which in addition to the work programme allows negotiation of the length of the license period and sub-periods with corresponding decision points.

We wish to continue the activities started four years ago with the First Licensing Round, the main objective being to identify commercial quantities of hydrocarbons in our subsoil and to test various play types to widen the scope for future exploration.

With our competitive licensing and fiscal regimes we believe that the Faroese area is attractive to oil companies not deterred by its frontier nature but encouraged by the vast opportunities that hydrocarbon exploration on the Faroese continental shelf offers.

2. Second Licensing Round

The Second Licensing Round on the Faroese Continental Shelf opens on 17 August 2004. Applications for exploration licenses shall be submitted to the Faroese Petroleum Administration no later than on 17 November 2004. The Minister of Trade and Industry is expected to issue licenses in the Second Faroese Licensing Round in January 2005.

The strategy behind the new licensing round is to provide a framework for continued activities aimed at identifying hydrocarbon resources in the subsoil of the Faroese continental shelf. Furthermore, the petroleum authorities wish to encourage license holders to apply various exploration models in order to secure a diversified future hydrocarbon exploration.

There are two criteria for the license awards:

- The geological understanding and the extent of the work commitments that the applicant is willing to undertake with a view to thoroughly investigate the prospectivity and to explore for hydrocarbons in the area to be covered by the license, and especially whether the licensee is committed to drill exploration wells. In addition to this, to which extent the applicant is committed to contribute to investigations of relevance to future exploration in the Faroese area.

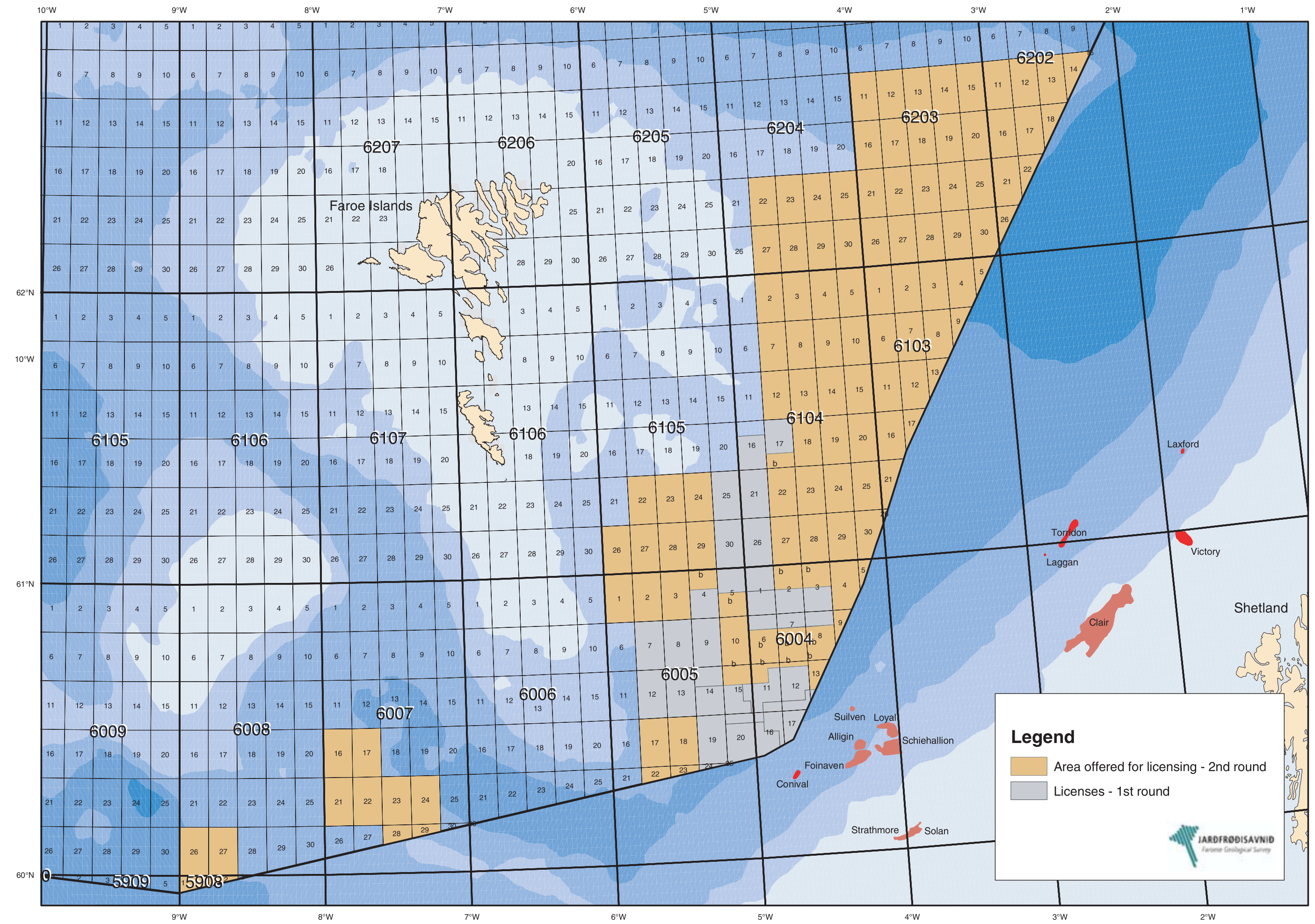
- How and to which extent the applicant is willing to commit to developing Faroese competence and to secure genuine opportunities for Faroese participation in the hydrocarbon activities.

The following blocks are offered for licensing:

6004/2b, 3b, 4, 5, 6b, 7b, 8b, 9, 11b, 12b, 13b;
6005/1-3, 4b, 5b, 10, 15b, 17, 18, 22, 23;
6103/1-9, 11-13, 16, 17, 21, 26;
6104/2-5, 7-10, 12-15, 17b, 18-20, 22-25, 27-30;
6105/22-24, 26-29;
6202/11-14, 16-18, 21, 22, 26;
6203/11-30;
6204/22-25, 27-30;
6007/16, 17, 21-24, 28-29;
5908/1, 2;
6008/26, 27.

Further information is available in the Invitation to apply for Petroleum Licenses in the Second Licensing Round issued by the Faroese Petroleum Administration and on the Administration's webpage: www.ofs.fo

Area Offered for Licensing in the Second Faroese Licensing Round.



The area open for licensing in the Second Faroes Licensing Round is approximately 19,000 square kilometres to the north east and west of the areas licensed in the first licensing round.

3. Legislation Governing Hydrocarbon Activities in the Faroe Islands

Acts

Act No 31 of 16 March 1998 on Hydrocarbon Activities

Act No 26 of 21 April 1999 on Taxation of Revenues relating to Hydrocarbon Activities

Act No 5 of 8 February 2000 on the First Licensing Round

Act No 16 of 14 February on Hydrocarbon Tax Administration

Act No 27 of 17 May 2004 on the Second Licensing Round

Executive Orders

Executive Order on Geological and Geophysical Matters in Connection with Approval of Deep Drilling 20 November 2003

Executive Order concerning Health, Safety and the Environment during all Phases of the Hydrocarbon Activities

Executive Order on data etc. from geological and geophysical investigations in connection with hydrocarbon activities

4. Licensing Regime

The framework for the Faroese licensing regime is laid down in the Parliamentary Act No 31 from 16 March 1998 on Hydrocarbon Activities. The Act provides the legal basis for the licensing system and authorises the granting of exclusive licenses as regards exploration for and production of hydrocarbons within a specific area.

Exploration and production licenses are granted on the basis of objective, non-discriminatory and published criteria. According to the Hydrocarbon Act, such licenses can only be granted to applicants which are considered to have the requisite expertise, experience, resources and financial capacity. An additional criterion in determining to whom a license is granted is the extent to which the Faroe Islands will gain insight into and benefit from the activities carried out by virtue of the license. In effect it is stipulated, that any transport of equipment and passengers to and from Faroese territory shall be conducted via Faroese quay or airport.

The area on offer for the second licensing round and the general conditions under which the exploration and production activities are to be carried out are laid down in the Parliamentary Act No 27 of 17 May 2004 on the Second Licensing Round for Exploration for and Production of Hydrocarbons. The work programmes and the licensee's commitment to cater for Faroese participation in the activities are competitive parameters and will be agreed on an individual basis prior to the granting of a license.

The exploration and/or production activities shall be carried out according to the Executive Order concerning Health, Safety and Environment in all Phases of the Hydrocarbon Activities. The order provides for goal-setting requirements and takes a holistic approach to HSE-issues.

The geological data requirements in relation to exploration drilling are laid down in the Executive Order on Geological and Geophysical Matters in connection with Approval of Deep Drilling. The order stipulates the type of geological information needed in an application for an approval to drill and requirements to measurements and sampling during the drilling activity.

Finally, there is an Executive Order on Reimbursement of Expenses in connection with Hydrocarbon Activities. The order stipulates, that the Licensee shall pay the expenses incurred by the authorities in connection with the administration of the licenses, inspections, consultancy services, etc. The hourly rate is DKK 740.00.

Besides the legislative framework mentioned above, the licensee shall comply with other national legislation such as environmental law, tax and custom law, etc. which are administered by other authorities and agencies.

5. Fiscal Regime

Tax Liability and Royalty

All activities related to exploration and production of hydrocarbons within the Faroese continental shelf area are tax liable under the Hydrocarbon Tax Act. In addition to the income taxation set out in the Hydrocarbon Tax Act, the licensees are also liable to a production royalty.

Licensees

Exploration and production license holders are liable to production royalty, company income tax and special tax.

Production Royalty
The licenses impose a royalty of 2% of landed value, which is deductible in the calculation of both company income tax as well as in the special tax.

Company Income Tax
The company income tax rate is 27% of taxable income.

Costs related to activity prior to production may be deducted the year they have been incurred or they may be deducted with 20% per year for the first five years after start of production. Fixed assets can be depreciated with 30% per year on a declining balance basis. Losses can be carried forward for 20 years.

Special Tax
The special tax applies in addition to the company income tax. The special tax is a rate-of-return based type. The calculation of taxable income is based on cash flow from individual fields on a ring-fence basis.

Royalty and company income tax are deductible in the taxable income basis. Interests are not included in the cash flow. Instead licensees are allowed an up-lift of incurred costs and investments.

The special tax rates vary with the rate-of-return as follows:

Rate of Return	Special Tax
< 20%	0%
20 - 25%	10%
25 - 30%	25%
>30%	40%

In total the highest marginal tax rate including royalty is 57,1%, applicable to fields with a return-on-investment exceeding 30%.

Employees

The Hydrocarbon Tax Act stipulates that employees liable to tax according to this law pay a tax rate of 35% on earned wages. Liable to taxation in accordance with the Hydrocarbon Tax Act are employees not liable to pay tax in accordance with the General Tax Act, e.g. non-residents in the Faroes.

Subcontractors

Subcontractor companies are liable to a company income tax rate of 20% on taxable income.

Administration

In addition to the administrative conditions of the General Tax Act a number of special conditions apply according to the Hydrocarbon Tax Administration Act and its executive order.

One important stipulation in the Hydrocarbon Tax Administration Act is that the licensees are liable for taxes not paid by their subcontractors.

Tax treaties

The Faroe Islands have tax treaties with the Scandinavian countries only. The Minister of Finance is currently in the process of establishing tax treaties with other countries, e.g. UK.

6. Exploration History

In 1992 agreement was reached between the Danish and the Faroese governments on Faroese sovereignty over subsoil resources. Following this event the first steps towards preparations for hydrocarbon exploration on the Faroese continental shelf were taken with Parliament Resolution of September 1993 stating that the Faroese area should be opened for preliminary surveys, and in early 1994 seismic companies were invited to bid for licenses to carry out speculative regional seismic surveys. Western Geophysical were awarded the sole right to carry out seismic surveys for 2 years and the surveys were completed in 1994 and 1995. Figure 1 shows the navigation lines of the surveys.

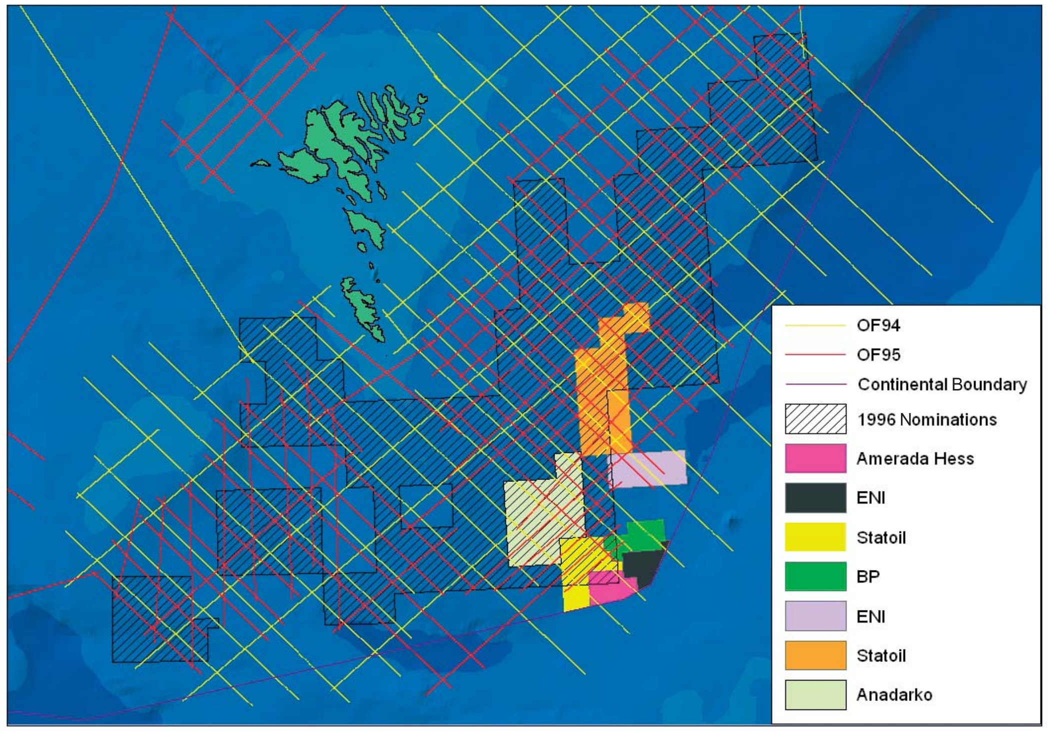


Figure 1.
The map illustrates the area nominated in 1996, the continental boundary established in 1999, navigation lines of the seismic surveys shot in 1994 - 95 and the 7 areas licensed in 2000.

The interest between oil companies to explore in the Faroes had been increasing following the Foinhaven and Schiehallion discoveries, but as the maritime boundary between UK and Faroes was in dispute it was decided not to initiate exploration before this matter was agreed.

In 1996 23 oil companies, upon request from Faroese authorities, joined forces in a consortium with the aim to deepen the Lopra well drilled by the Faroese government in 1981 to a depth of 2178 m without penetrating the base of the basalt. The aim of the 1996 project was to drill through the basalts in order to find evidence for the existence of hydrocarbons. The well was drilled to 3565 m when operations were stopped due to technical difficulties. At this depth the well had been extended below the flood basalt and into hyaloclastic layers.

Later the same year oil companies were invited to nominate areas of interest to be included in the first licensing round. 23 companies nominated a total of 108 blocks and 26 part blocks (Fig. 1).

First Licensing Round

In 1999 the maritime boundary between Faroe Islands and United Kingdom was established, and thereby the last obstacle for inviting companies to explore the Faroese subsoil was out of the way leading to the first licensing round. As a result of the first licensing round a total of 7 licenses were awarded on 17 August 2000 comprising a total area of some 4,200 km2 equal to 30% of the acreage on offer.

Four of them were awarded as 6 year licenses located in the Judd Basin in the south-eastern most parts of the area. This sediment basin is without or has only very limited basalt cover and is close to producing fields on the UK side of the border. Furthermore, it had a dense coverage of seismic data available to the industry prior to the round. It was consequently the most contested area. The combined work programme in these licenses covers 8 firm wells in addition to seismic surveys. The seismic surveys being part of the stipulated work for the 6 year licenses have now all been acquired and 4 of the 8 committed wells have been drilled.

The remaining three licenses were granted in areas with varying basalt cover outside the Judd Basin as 9 year licenses with an initial agreed work programme comprising acquisition of various geophysical data during the first three years of the license term. The initial 3 year period has expired and all licenses have been extended with updated work programmes comprising additional geological/geophysical studies within a specified timeframe prior to decisions on how to proceed including drilling of wells. Large structures have been identified below the basalt with possibilities to trap large hydrocarbon accumulations. The ongoing investigations are aimed at improving imaging and understanding of the geological conditions below the basalt in order to reduce the exploration risk.

Well Results

4 exploration wells have been drilled in the Faroese part of the Judd Basin, one by each licensee in the 6 year licenses. Three wells were drilled in 2001 and one in 2003. The results of the drilling campaign were mixed. All wells were targeting objectives of late Paleocene age based on an exploration model, which already was proven successful in the Foinaven/Schiehallion area to the east. The 2 first wells drilled by Statoil and BP encountered good reservoir quality sandstones in the objective zones with minor shows and with hydrocarbons in non-commercial quantities respectively. Well number three, the Marjun well drilled by Amerada Hess, was deepened below the commitment depth, and discovered a 170 m gross hydrocarbon bearing interval of early Paleocene age sandstone. The fourth exploration well drilled by ENI in 2003, was declared dry.

As a whole the 4 wells drilled have yielded encouraging results, although the immense expectations prior to the round did not materialize. The third well that was drilled, discovered an hydrocarbon accumulation in the lower Paleocene, T10, formations opening up a possible new play in the area. It is still uncertain whether or not the discovery can be commercialised, but new seismic surveys have been carried out in order to assist further decisionmaking.

Second Licensing Round

The results from the first exploration efforts combined with the knowledge gained from 30 years of exploration west of Shetland has led to exploration of the Faroese area now also encompassing the basalt-covered areas north and west of the present 6-year license areas. In these areas large structures have been mapped below the basalt representing significant opportunities for exploration companies.

To account for the large variability in complexity between blocks in the area that is open for licensing in the second round a more flexible licensing system has been adopted. In addition to the work programme it will also be possible to negotiate the length of the license period and sub-periods with corresponding decision points.

The strategy of the second licensing round is to provide a framework for continued activities aimed at identifying hydrocarbon resources in the subsoil of the Faroese continental shelf and to test various play types in order to broaden the scope for future exploration.

7. Regional Geology

Tectonic Setting

The basic tectonic framework on the Atlantic Margin was established during the Caledonian Orogenisis. The NE/SW trend, known from the orientation of the Faroe Shetland Channel, and intrabasinal ridges such as Rona, Corona, Flett and East Faroe High, is thought to be derived from reactivation of the pre-existing Caledonian trend. Intersecting Transfer zones segment these structures. There is an additional trend in the area, this is the N-S trend, which in the North Sea is indicative of Jurassic rifting, and this might also be the case in the Faroe Shetland Channel and adjacent areas, but it might also be a result of strike slip movements, which creates a rhomoboidal geometry. The N-S trend is exemplified by the Munkagrunnur Ridge.

A series of rift episodes during late Paleozoic – early Mesozoic resulted in the deposition of Aeolian-fluvial redbeds (Old Red Sandstone) of the Clair Group in intramontane basins. Subsequent relaxation of former Caledonian thrust faults was initiated in the Permo-Triassic, which resulted in the deposition of fluvial to aeolian sabkha deposits in the back basins during the Triassic.

Rifting in the middle Jurassic resulted in the creation of a major unconformity. Subsequent transgressions in the Upper Jurassic resulted in drowning of the area. The Kimmeridge Clay Formation was deposited at this time.

Rifting and subsidence were predominant activities during the Cretaceous, but subsidence did occur at various times in different locations, suggesting a complex rifting history. Most Paleohighs were drowned by the Late Cretaceous, thus preventing the influx of large volumes of coarse clastic sediments and allowing dominance of shale deposition during this time interval. Many pre Paleocene faults do terminate in the ductile upper Cretaceous Shales. Greenland has been suggested as a provenance area during the Cretaceous and Paleocene.

Initiation of Paleocene volcanism was preceded by regional uplift, which resulted in a subareal environment. A reworking of Cretaceous and Jurassic sediments during the early-mid Paleocene has been documented on the Shetland Platform. The Judd basin has experienced a massive influx of sediments in the early to mid Paleocene. There was a shift in the orientation of the depocentres in the Paleocene compared to the Cretaceous. The cause for the massive sediment influx in the Paleocene has been suggested to be a result of a new rifting episode or post-rift thermal subsidense associated with Cretaceous rifting.

Most of the Faroese area was covered by flow volcanics during early tertiary volcanism. The total stratigraphic thickness, established onshore Faroe Islands and in a stratigraphic test well is in excess of 6 km's. The flow volanics have been subdivided into Lower, Middle and Upper Formation. With the Lower and Middle Formation separated by a sedimentary section. The extent of the different formations is disputed, with some authors suggesting that the Lower Formation is most widespread, while others suggest that the Upper Formation is the most widespread.

Oligo-Miocene compression has been suggested as the cause of some of the large scale features such as Munkagrunnur Ridge and Wyville-Thomson Ridge. There are however indications of these features having an older core supporting the present day expression of the ridges.

8. Exploration Opportunities

Introduction

The thought of prospectivity and hydrocarbon exploration is an old dream in the Faroe Islands. Exploration did, however, not commence until after the rights to resources in the subsoil were handed over to the Faroese authorities in 1992. The first exploration related data were acquired in 1994, and the first licensing round was held in 2000. There have been drilled 4 wells to date on first round licenses with no obvious economic discovery being made so far.

The exploration effort has primarily targeted Foinaven/Schiehallion analogies in the Judd basin (Figure 1). This play has proven to be a risky adventure, with the primary target in all wells failing so far. This has by some been taken as a big setback, but a comparison of the exploration effort on the UK side versus the Faroes side of the Faroe Shetland Channel shows how big the difference is (Figure 2). The entire stratigraphic column has been explored on the UK side, while only the Paleocene has been explored on the Faroese side. All basins have been drilled on the UK side with discovery on several levels, while only the Judd basin has been drilled on the Faroes side, yet still a discovery has been announced.

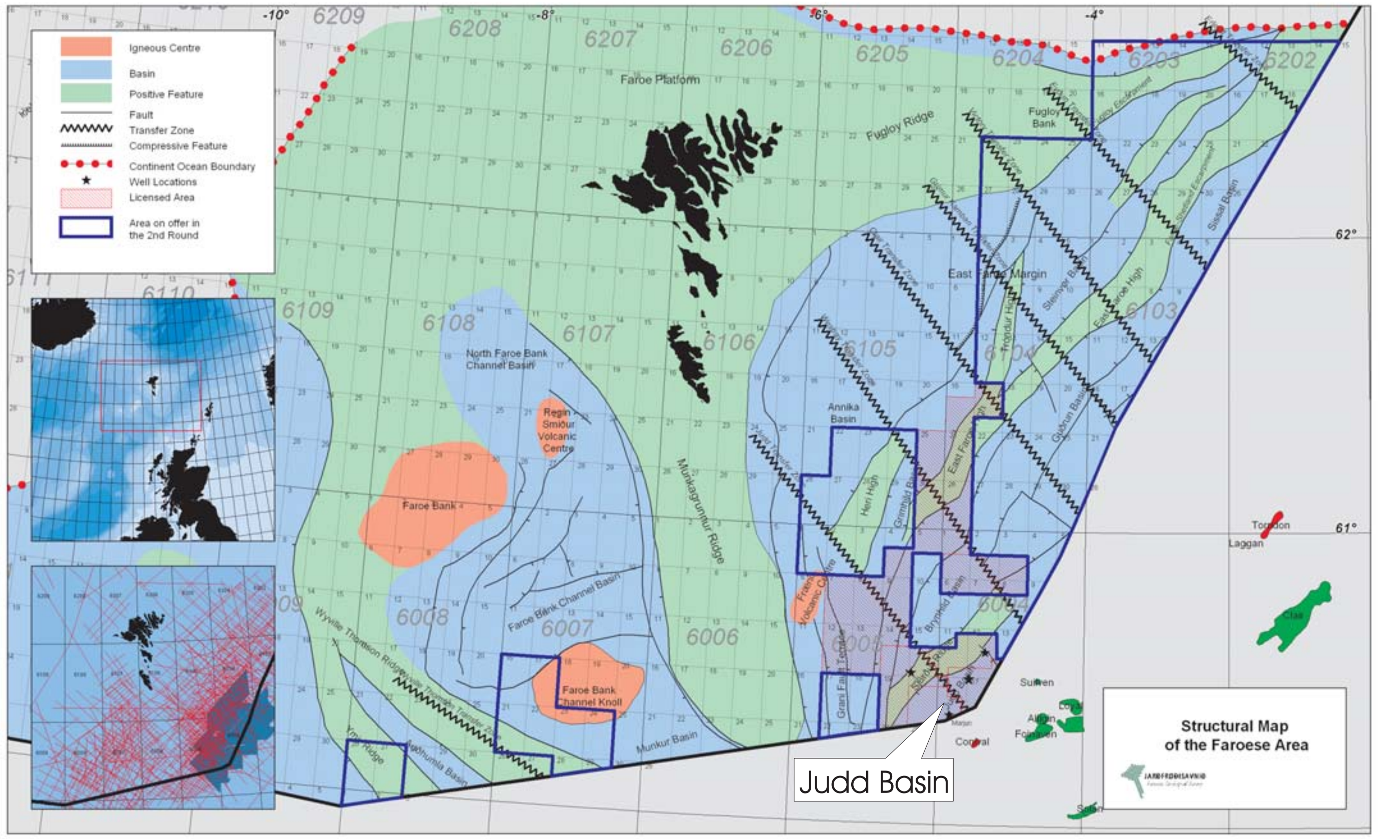


Figure 1: *Structural map of the Faroese Continental Shelf with seismic data coverage map inset.*

There is now almost 50,000 km's of 2D seismic data and 10,000 km^2 of 3D seismic data available for explorationists to work on when exploring on the Faroese Continental Shelf (FoCS) (Figure 1; inset). The exploration effort so far has demonstrated that there is a sedimentary column between the base of the flow basalts and igneous basement (Figure 3).

No wells have been drilled on the FoCS with the exception of the Judd basin, where the basalt cover is thin to absent. The lack of well ties means that the nature and age of the mapped sedimentary column is only speculative at present. Knowledge of fault detachments between Cretaceous and Paleocene, and pre- versus post rift structures can be used to infer ages of different units. But what kind of possibilities does that leave the explorationist with regarding sourcing, reservoir presence and quality and sealing? Those and other question will be attempted answered here.

Source Potential

The primary source rocks in the Faroe Shetland Channel and adjacent areas are the Kimmeridge Clay Formation (KCF) equivalent and a lacustral-marine middle Jurassic shale. The KCF was deposited during a series of marine transgressions, and is therefore quite widespread, and has a very high TOC. The Middle Jurassic shale might be less widespread, partly due to the different depositional environment, and partly due to later erosion. The middle Jurassic shale is rich in organic matter where it is present.

Other source rocks have been speculated on the Atlantic margin. These include upper Cretaceous and Paleocene shales. None of these have however been proven to have sourced any discoveries, but there is circumstantial evidence for one of these having sourced the Elida discovery in Norway, which is an oil discovery in a gas province.

The charging history in the Faroe Shetland Channel has proven to be enigmatic, with multiple charging being demonstrated in the producing fields. There has been an early charge that has subsequently been biodegraded. A later refill of oil of mixed source origin has resulted in the present day mix of hydrocarbons in the fields. A mix of source rock has also been found in the Faroes wells.

The present day depth to the source rock suggests that the source rock is either gas mature or over mature, but large volumes of oil have been generated, presumably in late Cretaceous to early Paleocene, and thus prior to the deposition of the upper Paleocene reservoir rocks in amongst others Foinaven and Schiehallion. Different mechanisms have been suggested for the presence of oil in the Judd basin fields despite the assumed gas-over mature source rock. The models include the “Motel model” and the “Whoopsie-Cushion model”. Recent modelling of vitrinite reflectance in the Judd basin suggest that overpressure, resulting from highly overpressured Mesozoic sediments, might retard maturation, and keep the KCF mature for oil generation at a depth of 8 km below mud line.

The extent of the source rocks in the Faroes area is speculative due to the absence of well penetrations, and lack of reliable well ties due to a relatively poor seismic data quality. Seep data have been acquired in the Faroe Shetland Channel and the Faroe Bank channel, and these have indicated the presence of hydrocarbons. This has been supported by geochemical analyses of seabed samples which have demonstrated thermogenic hydrocarbons in basalt covered areas.

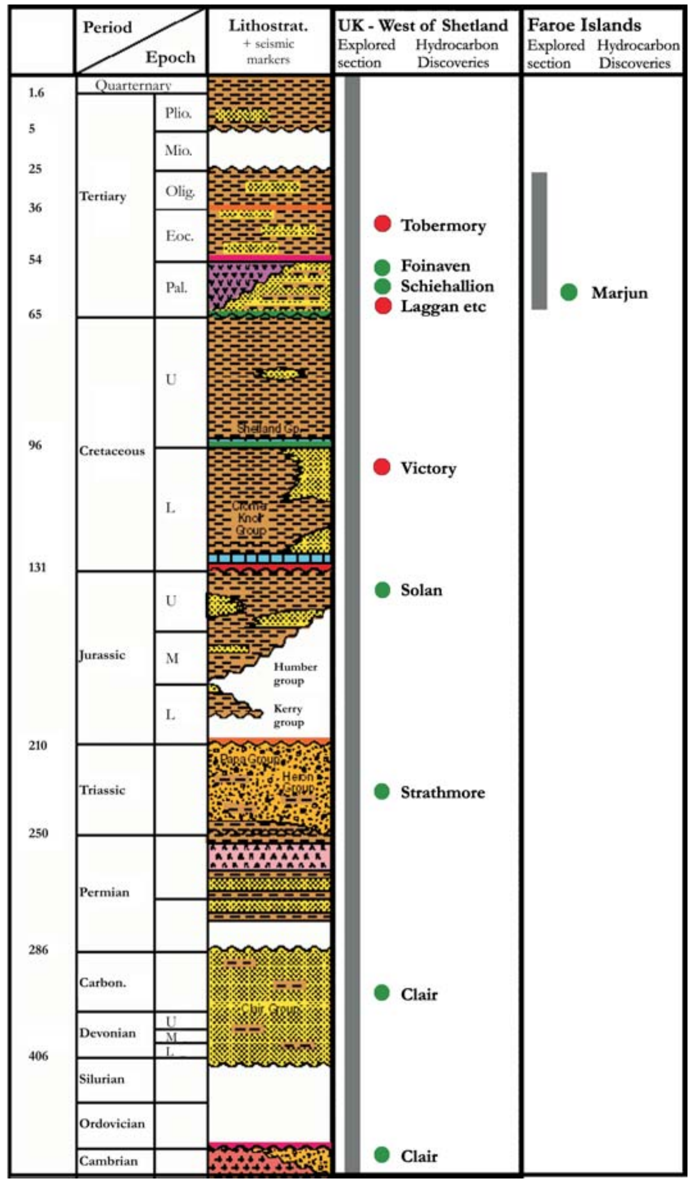
Structures/Traps

The primary focus in the 1st licensing round was a mid – upper Paleocene stratigraphic play in the Judd Basin. This is very dissimilar to what has been experienced in most other frontier areas, where large structures are the focus of the first phase of exploration.

The presence of large structures at top and post basalt levels has been known for a long time. These include huge structures such as the Fugloy Bank and the Wyville-Thomson Ridge. It has, however, been more of a challenge to confidently map structures under the flow basalts. Progress in sub basalt imaging has led to better data being available to geo-scientists, and these new data have enabled the geo-scientists to confidently map structures under the flow basalts.

The most prominent sub basalt structure, which incidentally was identified on potential field data prior to being mapped using seismic data, is the East Faroe High (figure 1). This is a structure with the same orientation and style as other major ridges in the Faroe Shetland Basin. It is mapped to be the closest ridge to an inferred Faroese platform on sub basalt level. This would make it the mirror image of the Rona Ridge. The Devono-Carboniferous Clair discovery and the Cretaceous Victory discoveries are located on the Rona Ridge.

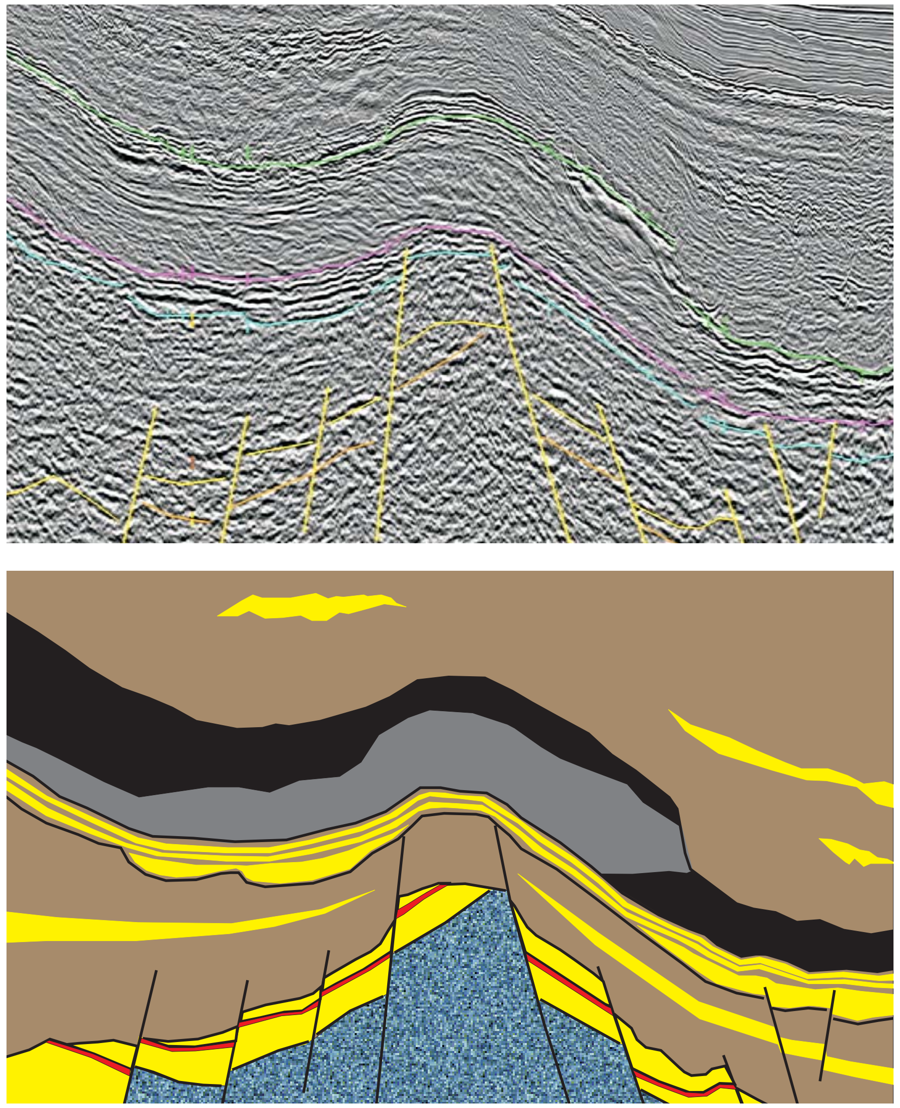
Figure 2:
Stratigraphic Column with explored section and discoveries in UK and Faroes



Other structures of varying sizes have been identified within the Faroese area, some very similar to recently drilled structures on the UK side, while others are very different. The structural range includes tilted fault blocks at depth which in turn generate closures at more shallow levels, sometimes into the Eocene, while other structures are depositional mounds, which have become positive features due to post depositional differential compaction.

There are still areas where imaging under the basalt has remained a hindrance for the development of leads and prospects. Some of these areas are, however, still interesting due to their sheer size. The Wyville-Thomson Ridge and the Fugloy Bank (Figure 1) each cover several blocks, and potential field modelling does give ambiguous results. Potential Field modelling of the Wyville-Thomson Ridge has given results which include shallow basement with little to no sedimentary cover to the presence of a deep sedimentary basin under the Ridge. These ambiguities do warrant further studies.

Figure 3: *Seismic line across East Faroe High with Geo-seismic cross section. Black/gray: volcanics, specled blue: basement; brown shales; yellow: sand/reservoir.*



Reservoirs

Presence and quality of reservoir is the primary risk factor when exploring under the flow basalts. The units can be inferred to be of a certain age based on depositional style and structural differences between the different units. The question that still remains is whether there is a reservoir section present, and what the quality of that reservoir section is.

Provenance Areas

The discussion about reservoir provenance for the Faroe Islands usually focuses on two different scenarios; the Shetland Platform and Greenland. Both of these are valid, but there is a third option which is the Faroe Islands. The reason that the discussion is either the Shetland Platform or Greenland is primarily heavy mineral analyses. Heavy mineral analysis do require a number of samples in the provenance area to be analysed in order to set a base level for the heavy minerals in question. This is obviously not possible for the Faroe Islands as igneous basement is covered by a thick pile of basalts, and possibly also sediments. And the lack of samples means that the Faroe Islands does not figure in the analyses and is therefore non-existent as a provenance area if this method is the only one being used. The other primary method used is palynology. This method has demonstrated that a North American Flora is present in some of the Lower Paleocene rocks in the Faroe Shetland Channel. It should, however, be kept in mind that the Faroe Islands were part of the North American continent prior to continental breakup in Late Paleocene.

It is not possible to say with any certainty when the Faroese platform became emergent, or even if it did. But a substantial uplift was documented in the North Atlantic in connection with the initiation of volcanism. Modelling has suggested up to 4 km of uplift. And it is very likely that this has been enough to make the Faroese platform and the present intra-basinal ridges act at provenance areas for sediments in a similar manner as it has been demonstrated on the UKCS where the Shetland platform and the intra-basinal ridges have provided sediments for the discoveries that have been made on the UK side of the boundary.

The question that still needs to be answered for the Faroese platform to emerge as a viable provenance area is the presence of shallow continental crust under the flow basalts. It has been suggested several times that there is shallow basement under the flow basalts on the Faroese platform. The basis for these suggestions include: gravity modelling, refraction velocities, magnetic data and findings that suggest the flow basalts are contaminated by continental crust which it has flowed through prior to extrusion.

Greenland might have been a provenance area for sediments on the FoCS prior to continental breakup. There is ample support for this in the shape of heavy minerals analyses and palynological data. Greenland was prior to continental breakup only about 100 km's from the Faroe Shetland Channel. Transportation of sediments from Greenland across these 100 km's of possible lowlands has induced some discussion about transport mechanisms across the lowlands. Transfer zones have been suggested based on evidence from onshore Greenland. There is however a present day analogy in the Ganges-Brahmaputra drainage system, which transports sediments from the Himalaya across more than 100 km's of lowlands before they are deposited in a delta in the Bay of Bengal.

The Shetland Islands have been sourcing most of the UK side of the Faroe Shetland Channel, but intra-basinal ridges along with long distances have acted as barriers for sedimentations on the FoCS. But the central parts of the channel are likely to have been sourced from both sides.

Proven Reservoirs

The first four wells drilled in the Faroese area did encounter a very thick section of high quality reservoir rocks in the mid-upper Paleocene in the Judd Basin. The extent of other reservoir rocks in the Faroese area is unknown, but structural mapping suggests that the basin is sub-symmetric (Figure 4). This is supported by the inference of shallow basement under the Flow basalts on the Faroese platform. The implication of this is that similar plays to those on the UK side of the Faroe Shetland Channel can be expected on the Faroese side of the Channel.

A symmetric basin does mean that there is a chance that reservoir rocks found on the UK side of the Channel are also likely to be found on the Faroese side of the Channel. It is in this respect that the presence of different reservoir sections found on the UK side of the Faroe Shetland Channel becomes interesting when exploring the FoCS

The oldest proven reservoir is the Old Red Sandstone (ORS) from the Devonian – Carboniferous. It is the primary reservoir in the Clair field on the Rona Ridge, which was discovered in 1977, and is coming onstream in 2004. The ORS sequence on the Rona Ridge ranges from absent to more than 1000 m. The presence of the ORS further out in the basin is not well constrained, but it is likely that a similar section can be found on the East Faroe High and possible other highs within a depth which makes it an interesting target when exploring for Hydrocarbons.

The Early Triassic Otter Bank Sandstone is the reservoir in the Strathmore discovery, which was discovered between the East and South Solan basins in 1990. This demonstrated that the Triassic has provided reservoir sand in the back basins of the Faroe Shetland Channel. The question that remains is the presence of this sandstone reservoir further out in the basin, and especially on the ridges where the likelihood of finding it at a reasonable depth are higher. There are large differences in the reservoir quality in the Strathmore discovery, with the difference being attributed to variations in the maturity of the sand and chlorite coating.

The Jurassic has so far demonstrated two possible reservoir configurations. One is a pre-rift structural play, where the reservoir section can be found on tilted faultblocks (Brent analogy), while the other option is a stratigraphic trap in a syn-rift setting. The latter is exemplified by the Solan discovery, which found high quality upper Jurassic reservoir rocks. The reservoir quality in the Solan discovery is very good in the discovery well, which is also farthest up on the structure. Down-dip wells have shown a decrease in reservoir quality with depth. This is thought to be a result of early charge preserving the reservoir quality.

The Cretaceous has so far yielded two plays, one of which is exemplified by the Victory discovery on the Rona Ridge. The latter is shallow to marginal marine sands in a structural trap, with the provenance area being partly the Rona Ridge and partly the Shetland Platform. The reservoir quality is consistently good, with depositional environment and depth of burial controlling the observed variations in reservoir quality. Basin slope and Basin floor fans deposited in the upper Cretaceous constitute the reservoir in the Turonian play, which is the other established Cretaceous play. The Turonian play is a stratigraphic play, and the Turonian sands have been found as far west as on the Corona ridge.
The Paleocene has to date been the most prolific play in the Faroe Shetland Channel with several discoveries and two producing fields in the Judd Basin. There is presently an attempt to test the Laggan discovery in the Flett basin with a view to production. A success would mean that there is production from Paleocene discoveries in two basins.

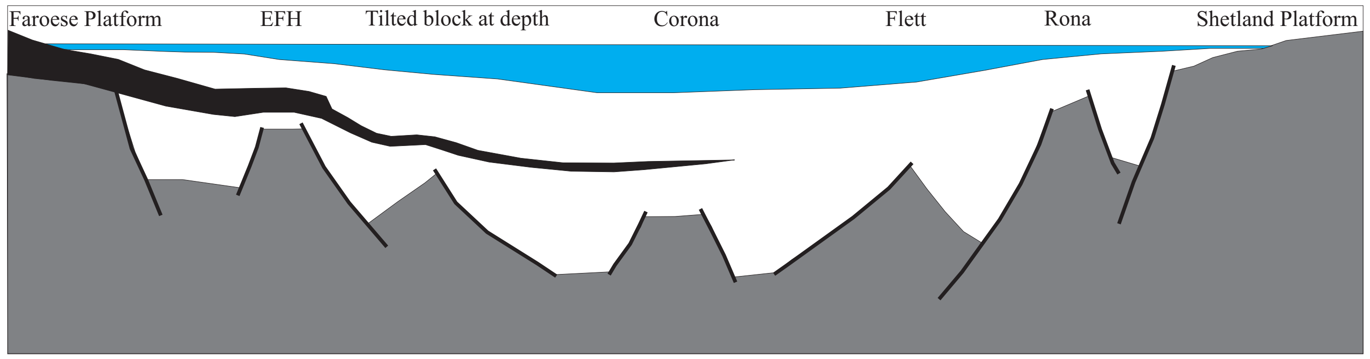


Figure 4: *Basin wide conceptual cross section demonstrating basin symmetry.*

The discoveries have been found in slope to deep marine fans with very good reservoir qualities.

The Eocene play on the UK side of the Faroe Shetland Channel is centred around three large deep water fans originating from the Shetland Platform. Similar fans with a Northerly or Westerly provenance are not possible due to the flow basalts blanketing the entire area in Eocene times. Only the edges of the mapped fans extend into Faroese waters.

The presence of similar plays on the FoCS cannot be proven, but the similar structural development on both sides of the Faroe Shetland Channel does support the idea that any reservoir found on the UK side of the Faroe Shetland Channel is likely going to be present on the Faroese side of the Faroe Shetland Channel. And a geoseismic x-section on Figure 3 demonstrates this concept. The upper image shows an interpreted seismic section across the East Faroe High, the lower image shows the possible reservoir sections based on the seismic interpretation and the knowledge from the UK side of the Faroe Shetland Channel.

Seals

Sealing is, despite the setback in the Judd basin, not expected to be a significant risk in the Faroe Shetland Channel. There are several seals, which have been demonstrated on the UK side of the Faroe Shetland Channel. The most promising candidates for regional seals are the Kimmeridge Clay Formation, upper Cretaceous Shales and the T36/basalt section.

The KCF is a deep marine shale, which has been penetrated in a number of wells in the Faroe Shetland basin, and it is expected to be present in most parts of the Faroe Shetland channel and adjacent areas as discussed previously. The sealing capacity of the KCF is demonstrated in the Solan discovery.

The entire area was drowned in the upper Cretaceous. This resulted in the deposition of deep marine shales, which in places reach thicknesses in excess of one kilometre. These shales are expected to be the primary seal for any pre-tertiary structural play, and also for the Turionian stratigraphic play. The upper Cretaceous shales do amongst others seal the Victory and Clair discoveries.

The upper Paleocene Stratigraphic play was the most sought after play in the first Faroese licensing round, and all wells drilled on this concept failed due to lack of seal. The wells did however demonstrate that the T36 shales acted as a basin wide seal, as it has previously been demonstrated in the Flett basin. The T36 is, according to some authors, contemporaneous with the Faroese Lower Basalt Formation. The basalt formation has at times been suggested as a seal, but sills in Japan do act as reservoir and live oil has been found in basalt in West Greenland. These observations do cast some doubt on the validity of the basalts themselves as possible seals. The Lower Basalt Formation does, however, have an increasing abundance of tuffs separating the flow units towards the upper part of the formation. The sealing capacity of these shales is unknown, but tuffs are known to be sealing in other places, such as the Kettla member in the Judd Basin.

Conclusion

Work done to date by amongst many others the Faroese Geological Survey does highlight some issues which work to reduce the risk when exploring on the FoCS. A working Hydrocarbon System is present, and the nature of this system does provide different charging scenarios. Large structures are present in many areas, and the size of these is such that a Clair field, without biodegraded oil, is possible. Reservoir has often been quoted as the primary risk when exploring under the basalt, and this might well be the case considering the lack of hard evidence for the presence of reservoir. But the symmetry of the basin coupled with the knowledge of the position of Greenland and the probable nature of the basement underlying the Faroese platform means that the same reservoir sections which have been found on the UK side of the Channel can be expected to be present under the flow basalts.

The big questions that remain to be asked are

- What is the likelihood of all the possible source scenarios failing simultaneously?
- What is the likelihood that none of the reservoirs are present?
- What is the likelihood that none of the seals are present?

And these questions should be asked in all the different locations, both on the East Faroe High trend, and other ridges as well as on the more immature structures like the Wyville-Thomson Ridge and Fugloy Bank.

9. Data Acquired in the Faroe Islands

There were only limited geological and geophysical data acquired in the Faroese area prior to the Faroese government getting the right to any resources found in the subsoil.

Exclusive Surveys

The first period of data acquisition was one of exclusive surveys. The reason to give exclusive surveys initially was partly based on the knowledge that there was real competition between contractors to come in and acquire data. It was also partly on the premise that if a company got an exclusive license, then there could be more conditions tied to the license. These conditions were in the shape of commitments to acquire data over a larger area then what was at the time considered to be most prospective. Another condition was to acquire a minimum amount of data during the exclusive period. This approach was thought to be the only way that the Faroese Government could ensure that the entire continental shelf was explored thoroughly.

Western Geophysical (now part of WesternGeco) was given an exclusive license to acquire seismic data in 1994 and 1995, and did during this period acquire 13550 km's of 2D seismic data in a regional grid. Western Geophysical had some old seismic data which it had acquired in the 1970's. These were reprocessed as part of the license commitment.

Western Geophysical did acquire marine magnetic and gravity data simultaneously with the seismic data.

World Geoscience Corporation (now part of Fugro Airborne Services) was given an exclusive license to acquire airborne magnetic and airborne seep data in 1995 and 1996. World Geoscience acquired a total of 42,520 line km's of airborne magnetic data in 1995 and 19,600 line km's in 1996. The coverage of the data varies from 4500x9000 m in the West, through 1500x4500 m in the central part to 500x1500 in the East.

World Geoscience did also acquire 21,000 line km's of seep data with their proprietary Airborne Laser Fluroesensor (ALF) technique. These data covered the same area as the area covered by the magnetic data. The ALF data were only acquired in one direction with no tie lines. The line spacing was 3000 m.

Other Conventional Seismic

Many companies did apply for prospecting licenses after Western Geophysical's exclusive license expired. This resulted in a large amount of both 2D and 3D data being acquired in the areas which were at the time considered to be most prospective.

Companies like Geoteam (now Fugro Geoteam), Geco-Pracla (now part of Western Geco) TGS-Nopec, PGS and Veritas have acquired 2D and/or 3D data in the Faroese area, with Veritas being the most active company with in excess of 10,000 km's of 2D data and close to 5000 km2's of 3D data.

Most companies have focused their effort compared to the initial surveys acquired by Western Geophysical. Most of the data have been acquired in the deeper areas of the Faroe Shetland Channel and in the Faroe Bank Channel and the Wywille-Thomson to Ymir ridge area. Figure 1 shows the extent of the seismic coverage at present, excluding proprietary surveys carried out in connection with license commitments.

Potential Field Methods and other Methods

Many seismic surveys have also acquired gravity and magnetic data along with the seismic data. But there have in addition to these been acquired a few dedicated surveys of non-seismic character. These include the mentioned Aeromagnetic acquired by World Geoscience and another aeromagnetic dataset acquired by OilSearch and Full Tensor Gradient Data acquired by Bell Geospace.

There is now a very good coverage of potential field data in most of the Faroese area. The aeromagnetic data cover the entire platform and the Faroe Bank Channel. The marine gravity and magnetic coverage goes even further, while the FTG data cover large patches in the Faroe Shetland Channel.

Seabed Sampling

A couple of seabed sampling surveys have been performed, whose primary purpose has differed. Surface Geochemical Services (SGS) acquired 222 cores in 1996 and about half that number of cores in 1998 in Faroese Waters. The purpose of the seabed sampling programme was to establish if there was a working hydrocarbon system in the area.

Advanced Geophysical Methods

The basalt cover of varying thickness in the Faroese area has impeded imaging of the presumed prospective layers when using conventional geophysical methods. Scientists have therefore looked elsewhere for a breakthrough, and this has resulted in a number of advanced geophysical tests being done. The tests include three Ocean Bottom Seismometer surveys, one Dragged Array survey, one Vertical cable test, one Ocean Bottom Cable test and a number of very long offset seismic surveys with up to 35 km offset.

Data Acquired under License Obligations

A large number of geophysical data have been acquired in connection with the current exploration licenses in the Faroe Islands. These data include long offset 2D and 3D seismic data, conventional 2D and 3D seismic data, MMT, FTG.

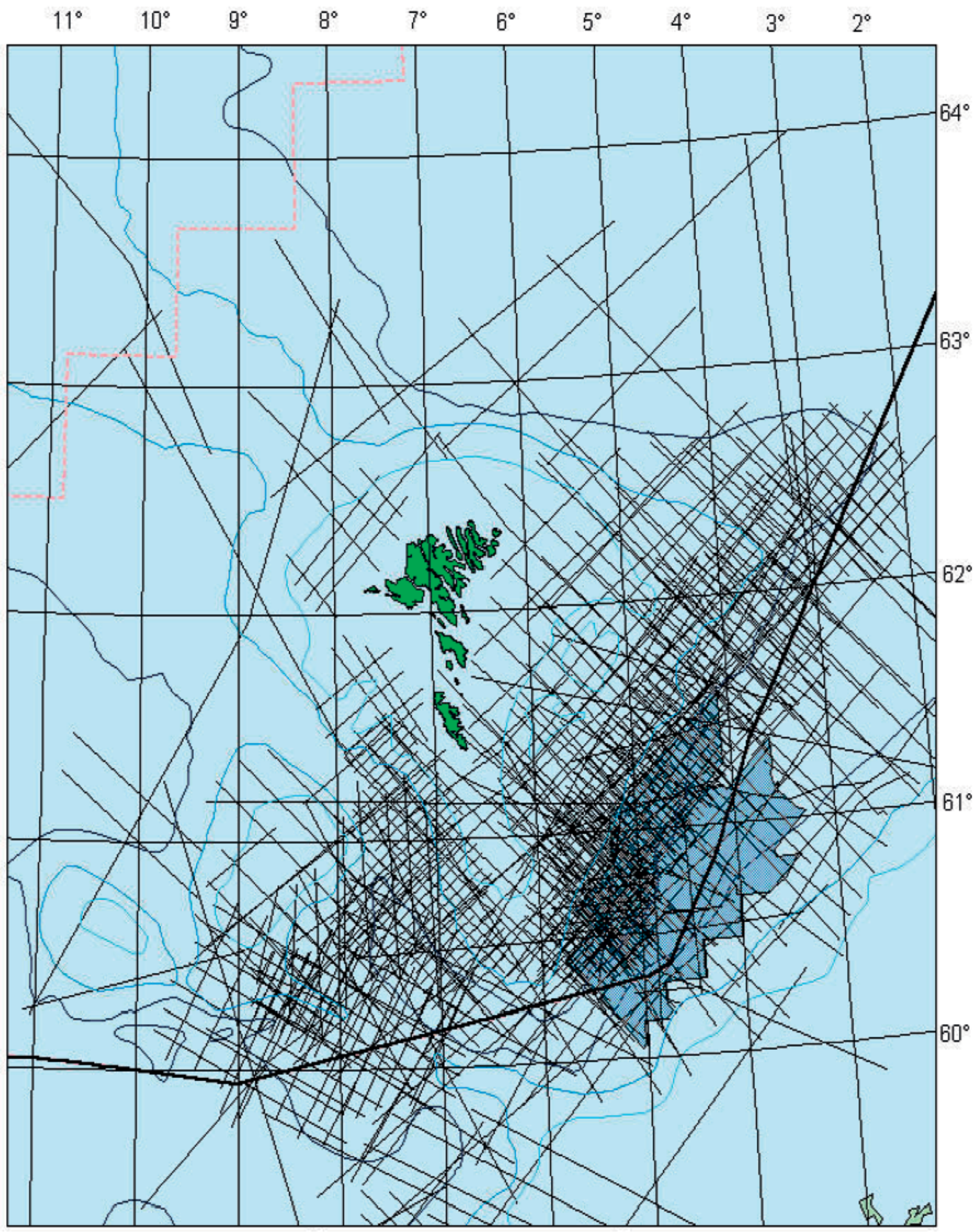


Figure 1:

Seismic data coverage. Black lines: 2D seismic. Dark blue shaded area: 3D seismic data.

10. Aspects of Sub-Basalt Imaging

The volcanic sequence described above is the primary problem for geophysical exploration in the Faroese area. The Tertiary basalt cover is extensive and varies over the region from nonexistent to thin flows to documented 3.5 km to unresolvable, with a possibility of thicknesses greater than 6 km on the basalt plateau.

This sequence is extremely heterogeneous in 3 dimensions: flows vary in thickness, geometry, and behaviour (i.e. fracturing, jointing, load structures, etc.); flow surfaces are rough and weathered; they may be interfingered with, as well as lie over or under, volcaniclastic and other types of sedimentary units. From a geophysical point of view, a very broad range of velocity-density (acoustic impedance) boundaries are present, again in 3 dimensions, and the geological sequences which correspond with these changes and boundaries may be at, or below, the limits of seismic resolution of the available wavelengths and fresnel zone capabilities. In practice, if basalt cover is present at or near the sea floor, particularly in shallow water, it has not proven possible to either discretely penetrate the basalts or coherently discriminate the recorded signals from noise, interference, and artefacts (Keser Neish and Ziska, 1996). As water depth, and sediment cover increases, the basalt thickness generally begins to decrease and it becomes possible to begin to define valid reflection energy, but this is still intermingled with spurious information and identification of valid reflected arrivals can be problematic. Therefore, this volcanic sequence presents a significant imaging barrier for both acquisition and processing applications of the seismic method; towed streamer surveys configured for conventional recording for hydrocarbon exploration purposes (e.g. 4800 m streamer, 4000 cubic inch air gun array) has had only limited success in this environment.

These interferences and artefacts may be related to the geophysical acquisition system (after Keser Neish and Ziska, 1996):

- Lack of source bandwidth, (e.g. insufficient low-frequency content)
- Poor signal to noise ratio
- Source overshooting
- Source instability
- Poor source array pattern, which may enhance multiple generation
- Insufficient source-receiver offset
- Source and/or receiver ghost effects
- Lack of signal penetration due to attenuation, scattering and wavelength considerations
- Poor control over source-receiver location (e.g. cable feather resulting in CDP smear, source position instability, etc.)

Or geologically related:

- High variability in acoustic impedance, in three dimensions
- High variability in Q, in three dimensions
- Thin beds
- Geologically induced ringing
- Complex earth-induced multiple generation
- Generation of mode conversions, both simple and complex, with associated energy loss
- Scattering of incident energy by disrupted/rough weathered surfaces
- Generation of high-amplitude events from high acoustic impedance boundaries may mask weaker events

Recent research in sub-basalt exploration has led to several promising approaches. The use of large airgun arrays specifically configured for low-frequency content can be applied to enhance sub-basalt arrivals, and bubble tuning of the airgun array can be beneficial (Avedik et al, 1996). Within the towed streamer cable system, single-sensor recording from densely spaced receivers may give improvements in spatial sampling, noise attenuation, amplitude preservation, and bandwidth and resolution (Larsen, 2002).

Long offset, or large aperture seismic data acquisition, commonly utilizing 2 in-line recording vessels, has enjoyed a resurgence of popularity for subbasalt imaging applications (White et al, 1999). The advent of long cable (10-12 km towed streamer systems) (Van der Baan et al, 2003) has placed long-offset data acquisition in the realm of an affordable, highly repeatable method. The advantages of long-offset recording for sub-basalt data acquisition are based principally upon the recording of wide-angle reflected, refracted, converted, and diving waves. Wide-angle reflections near the critical angle may be of higher amplitude than near offset reflections for the same interface, which may allow improved imaging of sub-basalt surfaces. Refracted and diving waves, recorded beyond the critical angle, provide constraints upon the velocity structure (Fliedner and White, 2001) and have proven particularly useful for depth imaging applications and can further be used to assist in confirming true reflection arrivals.

One approach of substantial interest is to record converted wave arrivals to image beneath basalt (e.g. Martini et al, 2001; Barzaghi et al, 2002). Conversion occurs whenever a wave front arrives at non-normal incidence at a velocity-density contrast and is accompanied by the partitioning of wave energy into different wave types.

Analysis of converted waves is useful for a number of reasons. Firstly, converted p-waves at larger offsets have relatively larger amplitudes (Barzaghi et al, 2002) and are more continuous than first-order p-wave arrivals, making them easier to identify in the presence of multiples and noise. Secondly, depending on the geological scenario, their arrival times may occur in intervals relatively free of multiple energy. Because basalts can be of considerably higher velocity than the surrounding sediments, the critical reflection point is reached at small angles of incidence and only a relatively small amount of the incident p-wave energy may be available to penetrate the basalt layer (Van der Baan et al, 2003). Further, short offset data is subject to substantial multiple contamination arising from the high acoustic impedance contrast, and these multiples are generally of greater amplitude than the reflected p-wave energy. Processing of these arrival times and analysis of the interface which generated the wave front partitioning can help to confirm the associated p-reflection event. These converted waves can therefore be very useful in identifying true reflection events and constraining lithology, as well as giving additional information concerning unit velocity property relationships.

Ocean bottom seismometers have long been the traditional method for direct recording of deep wide angle reflected, refracted, converted and shear arrivals in deep water environments. The system is autonomous, requiring no in-water cabling systems, can be utilized using only one vessel, and reduces such system problems as weather and streamer noise and surface ghost. Developmental work on these systems should shortly allow enhanced signal replication and data retrieval, longer recording times, and improvements in system location and retrieval. When combined and integrated with towed streamer data, velocity control and complex multiple identification and removal can be enhanced, and confidence in identification of reflection interfaces improved (Flueh et al, 2002; Büttgenbach et al, 2002).

Significant advances in ocean bottom cable technology now allow acquisition of OBC data in deep waters, such as are found in much of the Faroese area. The use of this type of system within such a volcanic environment may offer many potential advantages over a towed streamer survey. Many of the acquisition-related problems may be mitigated or avoided, and problems associated with the geological system, particularly those concerning wave transmission and reception, reduced. In addition to the advantages afforded by the ability to record long offset data, the ability to accurately bottom-couple multicomponent sensors allows direct recording of shear waves, minimization of surface ghost and multiples, and enhanced recording of the lower frequencies. Issues concerning absorption, scattering, and heterogeneity can also be studied; opportunities for use of q-dependent and wave equation datuming (Martini and Bean, 2002), as well as downward continuation, can also be explored, as well as methods requiring careful velocity control.

Improvements in processing technology, particularly in pre-stack depth migration techniques (e.g. Silva et al, 2002) continue to be one of the more important avenues for improved imaging within the volcanic environment, particularly the sub-basalt units, particularly when combined with advances in seismic acquisition technology – such as those described above – which permit improved resolution of the velocity field.

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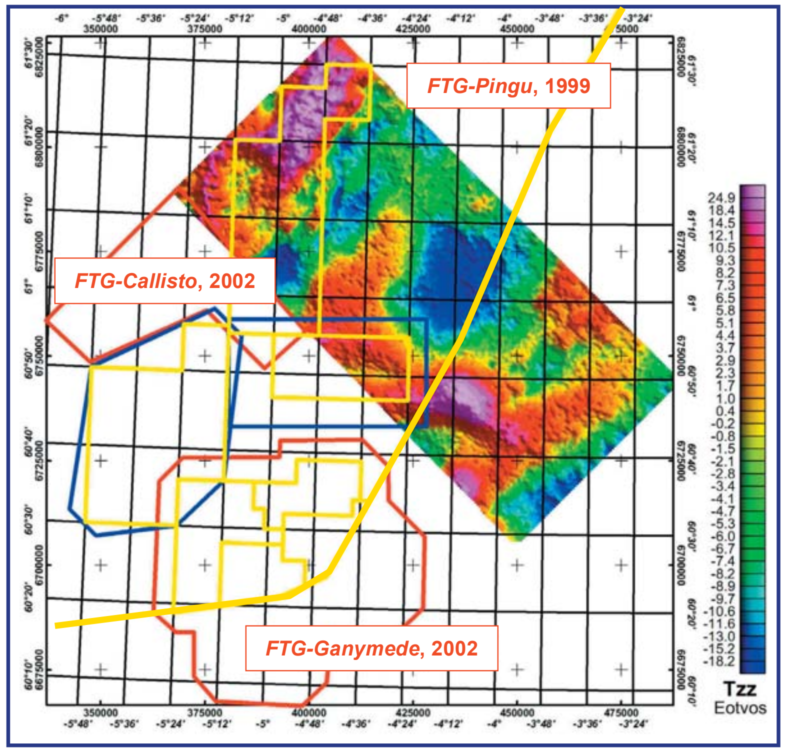
3-D Full Tensor Gradiometry

Based in Aberdeen, UK, Bell Geospace Limited develops and sells high resolution gravity based solutions to the oil and gas, minerals and government markets using its Full Tensor Gradiometer technology.

3D FTG measures all independent components of the gradient tensor describing the Total Gravity Field. This yields a resolution an order of magnitude greater than that of conventional gravity.

3 speculative FTG surveys (*Pingu*, *Callisto* & *Ganymede*, outline in red and Tzz data image shown right) were acquired in 1999 and 2002. Causative signal from above and beneath the basalt layer is extracted by applying standard potential field interpretation techniques (frequency filtering), such as that shown below from the *Pingu* Tzz data. Additional information relating to sub-basalt and basement structure is also resolved.



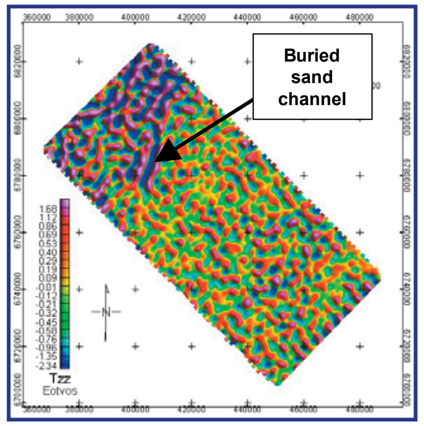
Frequency Filtering of FTG Tzz component resolves sub-surface complex geology:

Shallow gas-sand channels above basalt;

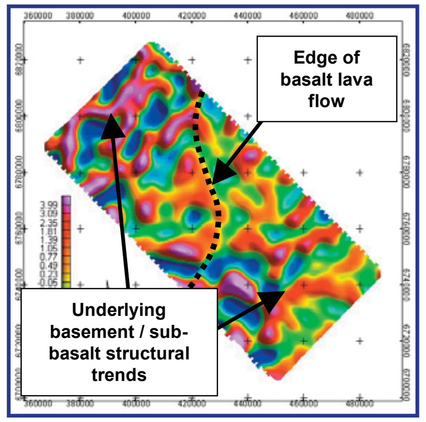
Basalt complexity in terms of isopach and structuring;

Sub-basalt sedimentary targets and basement structure

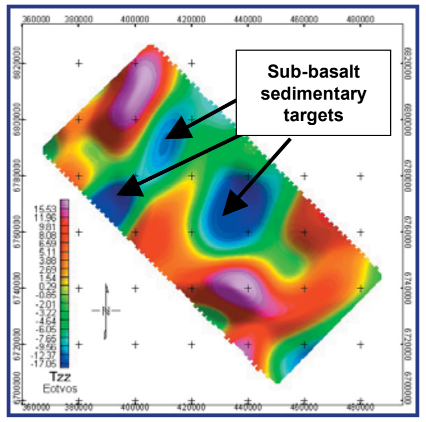
FTG Tzz signal 'above' basalt



FTG Tzz signal from 'basalt layer'



FTG Tzz signal sub-basalt



For more information on 3D-FTG and Bell Geospace and how we may be of help with your exploration requirements, please feel free to contact either:

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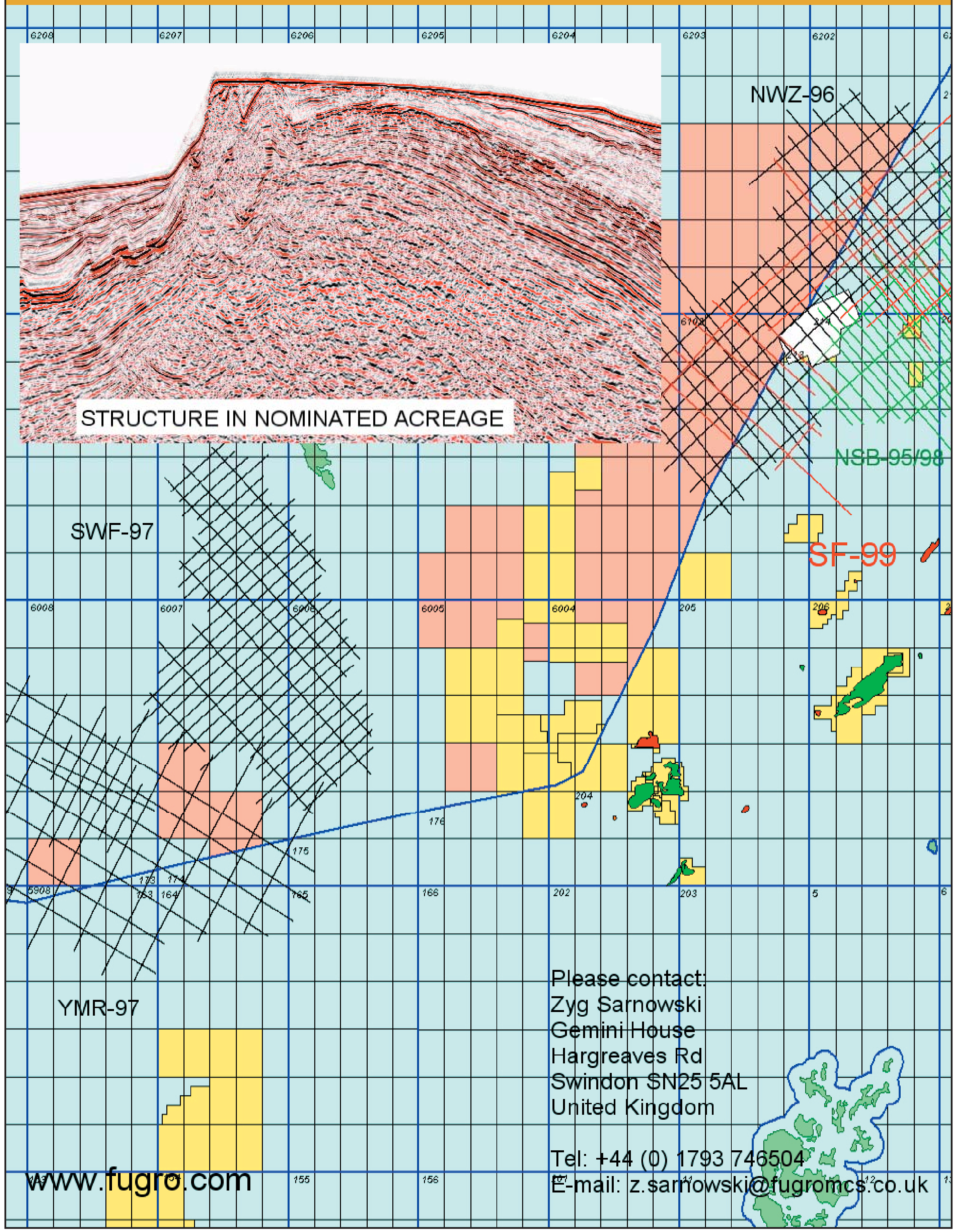
Non Exclusive Seismic Data

FAROES LICENSING ROUND



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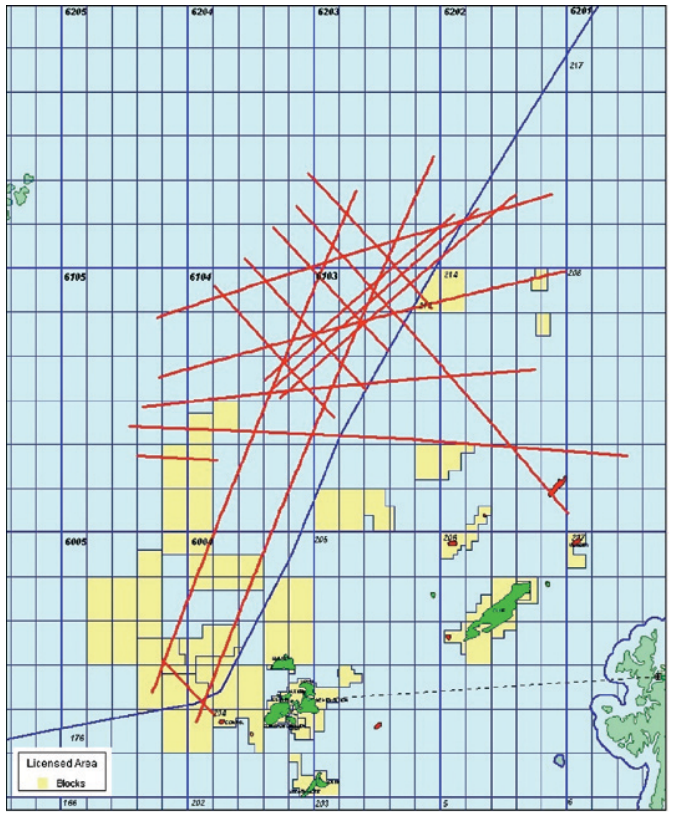
Faroe Islands - Shetland Tie 2001/2002 (IS-FST-01/02) 2,145 km

Survey name: Faroe Islands - Shetland Tie 2001/2002
Survey type: Non-exclusive 2D seismic survey
Survey size: 2,145 km FF
Data available: February 2003



Geological summary

The survey is designed to tie geological provinces and a number of wells, including the three recent wells in Faeroese waters of which one was a gas/oil discovery. The Jurassic basin west of Shetland and the progressively younger basins further west are tied. Focus has been given to depicting the extent and seismic facies of Lower Tertiary sands both in British and Faeroese waters.

The structural relationship of the intrabasinal highs, crucial from an oil generation and trapping point of view, will be well illustrated. Specific attention has been given to the trapping potential of the northerly part of the East Faeroe High.

Acquisition parameters

Acquisition Contractor
Multiwave Geophysical Company AS (MGC)

Vessel
R/V Polar Princess

Streamer Definition

Streamer type:	Sercel Seal
Type:	Digital 24 bit
Number of streamers:	1
Streamer length:	10 050 m
Streamer diameter:	50 mm
Streamer depth:	8.0 m +/-1.0 m
Number of groups:	804
Group interval:	12.5 m
Group length:	12.5 m

Data Recording

System:	Sercel Seal
Recording length:	10 sec
Sample rate:	2 ms
Low-cut filter:	Out
Hi-cut filter (dB/Oct):	200 Hz/370
Recording format:	SEG-D Rev 2
Tape format:	IBM 3590

Energy Source

Airgun source type:	Bolt Long Life
Air pressure:	2,000 psi
Volume:	4,240 cu. inch
Peak to Peak (128Hz/18dB):	138 bar m.
Number of sources:	1
Source depth:	6 m
Shot interval:	25 m

Processing sequence & deliverables

Processing contractor
Ensign Geophysics A/S, Stavanger
Processing sequence
A comprehensive processing sequence is applied

Available deliverables
Shot point location maps in available scales, UKOOA format navigation tapes, final filtered stacked and migrated data on video 8 cartridges in SEG-Y format, Velocity information on tape in ESSO V2 format.

Contacts and address

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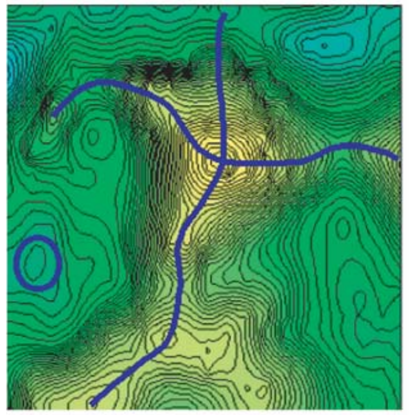
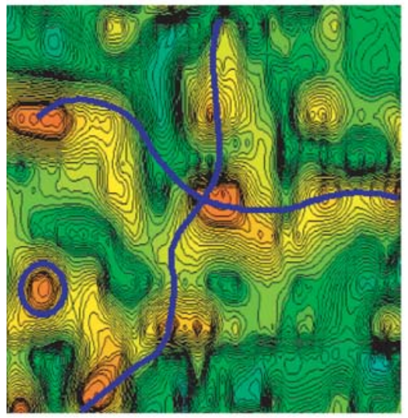
High resolution seep and aeromagnetic data proves



Aeromagnetic data



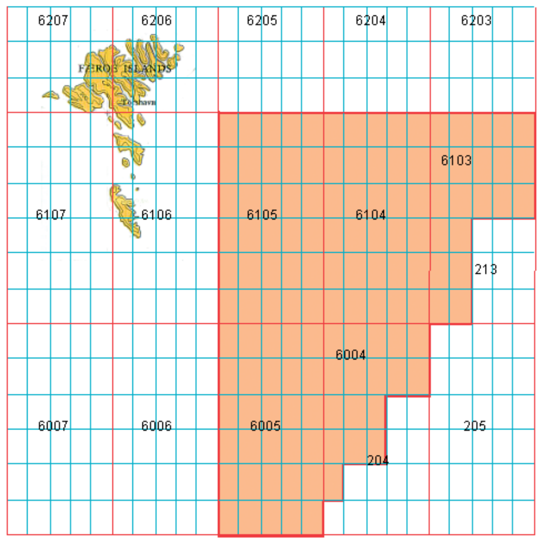
Composite seep data

Even with the best 3D seismic, clear identification of a possible trap and a viable seal, if there is no direct evidence of oil presence on a migration pathway leading from a proven source, drilling a well could be an expensive failure.

High resolution aeromagnetic data can assist with the identification of faults and migration pathways, increasing confidence in seismic interpretation. With noise levels as low as 7pT rms, Oilsearch aeromag can reduce exploration risk.

Combined with high resolution, multi-channel seep data, potential migration pathways can be identified and shown to be active. Oilsearch seep detection delivers an indication of the oil characteristic, and can read oil films on the sea surface down to 50ppm.

Oilsearch has performed a high resolution seep and aeromagnetic survey in Faroese quads 6105, 6104 and 6005 and "White Zone"/UKCS quads 6103/213 and 6004/204, covering 133 blocks with a total of 16,000 km of survey data. The results show excellent correlation with known adjacent oil systems (Clair, Foinaven/Schiehallion) and provide a comprehensive picture of the oil systems over the entire region. With this data, you can improve the probability of exploration success. Without it, you can always guess where the oil is.



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For data sales and pricing information, contact

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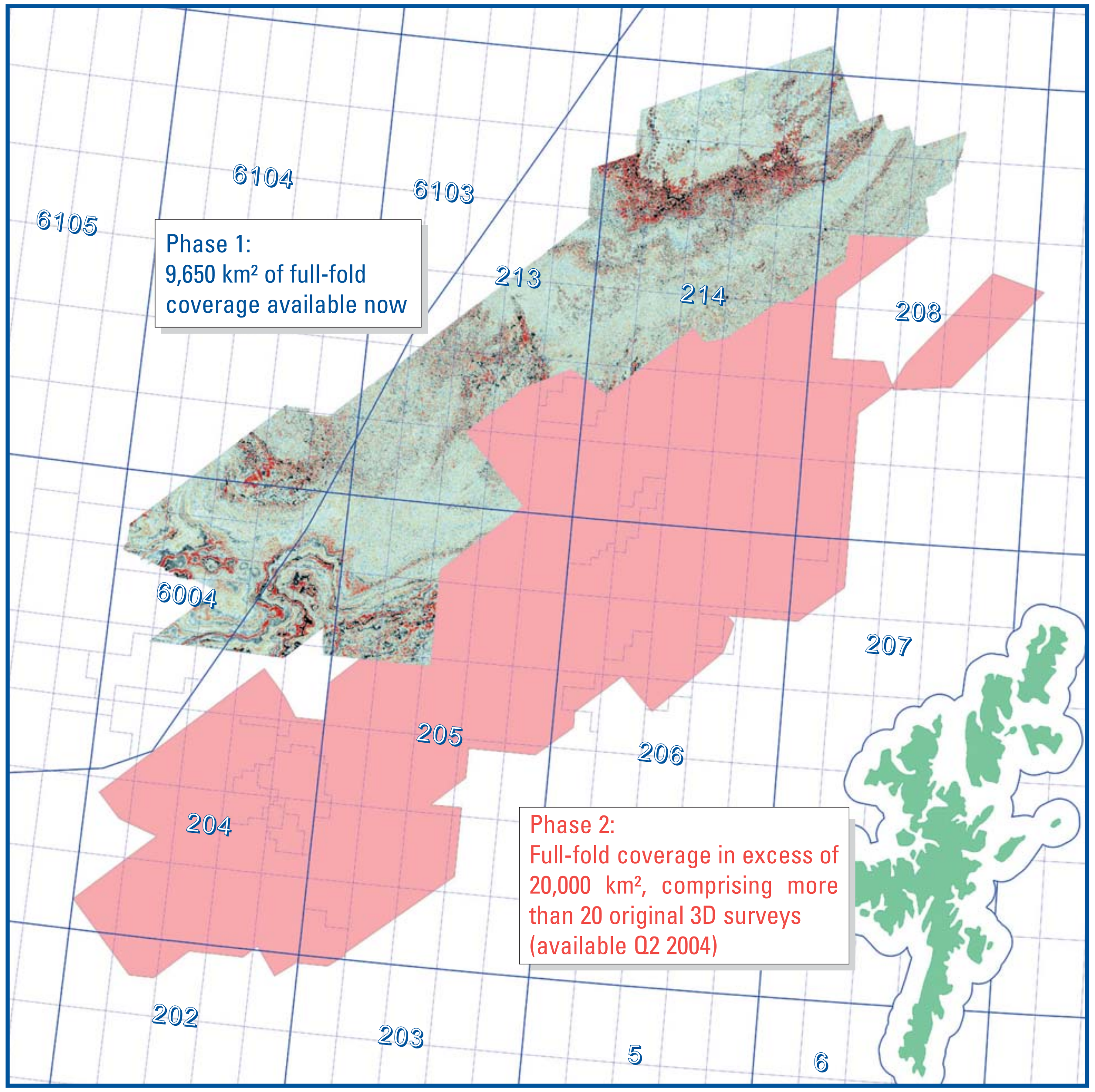
PGS Faroe Shetland Basin Mega Survey



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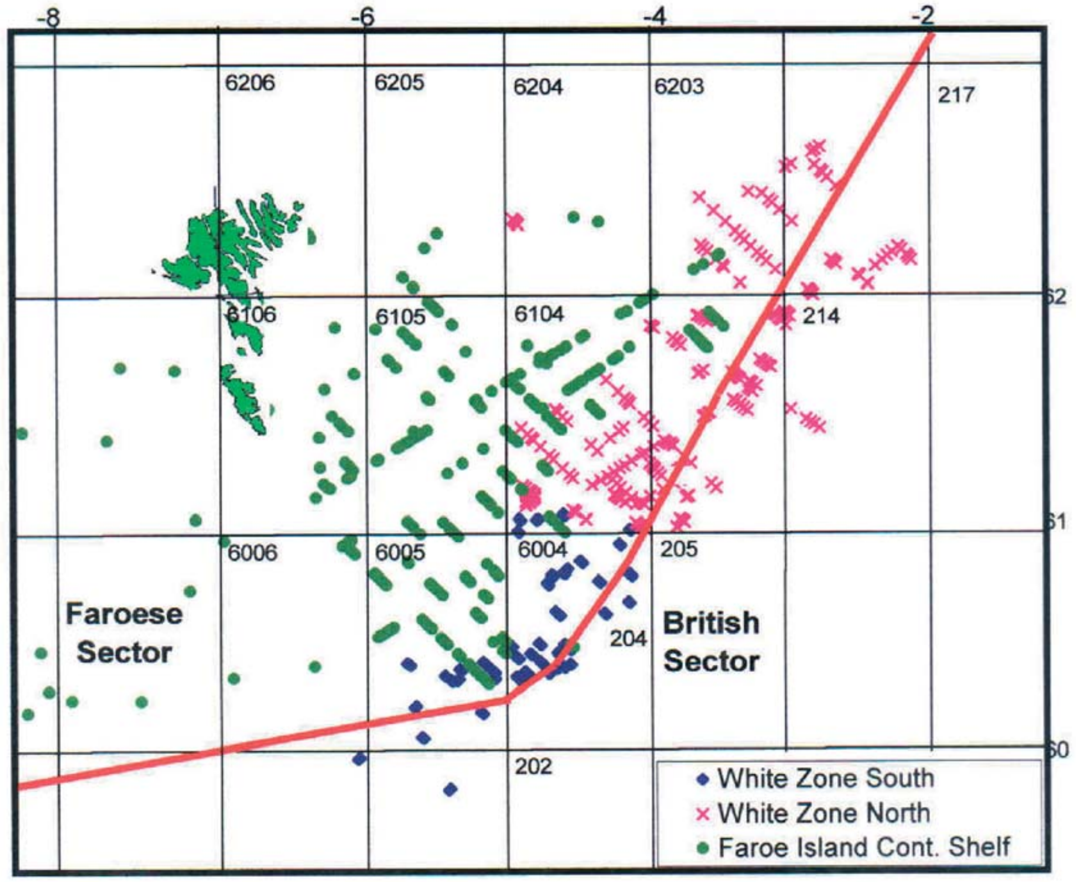
Faeroes Continental Shelf, White Zone South and White Zone North, Surface Geochemistry, 1996, 1997 and 1998

Area	No. Samples	Original Price	Present Price
Faeroes Continental Shelf	280	US$ 130 000.-	US$ 40 000.-
White Zone South	200	US$ 110 000.-	US$ 35 000.-
White Zone North	255	US$ 120 000.-	US$ 38 000.-



The geochemical report contains both screening and detailed geochemical data of both gaseous and liquid hydrocarbons from shallow cores at locations selected from commerscial 2D seismic. The geochemical analyses follow certified procedures in a standardised analytical program. The analytical program includes the following analytical techniques; headspace gas, occluded gas, adsorbed gas, carbon isotope composition of selected gases, TC/TOC, solvent extraction, quantitative GC analysis of extract, TSF and high resolution GC-MS. All gas chromatograms, GC-MS fragmentograms and TSF spectra are produced in the report.

Surface geochemical Services (SGS) and the parent organization Geolab Nor are recognized leaders in surface geochemical studies, while Omegalink is a recognized leader in heat flow measurements, especially when undertaking the heat flow simultaneously with the geochemical coring. Since 1986, SGS/Geolab Nor have collected more than 12 000 cores for geochemistry and together with Omegalink have undertaken since 2001 more than 500 heat flow measurements simultaneously with the geochemical sampling. Our customers are all the major oil companies plus a number of medium sized and smaller companies. We have worked in areas like the Barents Sea, Norwegian Sea, North Sea, North Atlantic Margin, Baltic Sea, Caspian Sea, Mediterranean, Offshore West Africa, Offshore East Africa, South China Sea. See our web sites (www.surface-geochemical.com or www.geolabnor.no) for more information

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