Operators of the Baffin Bay license blocks and spec companies have during the summer month of 2012 acquired a variety of exploration data offshore West Greenland as well as East Greenland.

In the Baffin Bay area, 2D seismic data have been acquired by ConocoPhillips as operator in their Baffin Bay license block called ‘Qamut’, and in addition to this, extensive 3D seismic programmes were carried out in the neighbouring ‘Napu’ and ‘Anu’ license blocks operated by Shell and also in the ‘Tooq’ license operated by Maersk.

The shallow coring consortium that has been established by all of the Baffin Bay licensees finished a stratigraphic corehole project in Baffin Bay with great success, and the forthcoming analyses of the cores will contribute to the future hydrocarbon assessment of the Baffin Bay area.

Again in 2012 TGS and ION have had operations in Greenland during which sea floor samples have been collected and 2D seismic data and airborne gravity and magnetic data have been acquired.

On the next pages you will find more information about the 2012 operations written by representatives from Cairn Energy PLC, ConocoPhillips, Maersk Oil, Shell, ION and TGS.

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Shell’s 3D seismic and shallow coring programme in Baffin Bay – summer 2012

By Hugo Le Breton, SP Manager Greenland Venture, Shell.

The sedimentary basins observed in Baffin Bay have similar dimensions to the North Sea, and multiple plays have been identified. However, with the regional subsurface evaluated on sparsely spaced 2D seismic lines from multiple vintages and no wells drilled to date, hydrocarbon prospectivity is subject to great uncertainties.

In December 2010, a joint venture (JV) comprised of Shell Greenland, GDF SUEZ, Statoil and Nunaoil was awarded two offshore blocks named ‘Anu’ (Block 5) and ‘Napu’ (Block 8). In order to gain greater understanding of the subsurface, Shell carried out a large 3D seismic survey in the blocks on behalf of the JV, in parallel with a stratigraphic coring programme on behalf of a consortium of nine Baffin Bay licensees (Cairn, ConocoPhillips, DONG, GDF SUEZ, Maersk, Nunaoil, Shell, Statoil and Tullow Oil).

The stratigraphic coring campaign

Shell contracted the scientific coring vessel, JOIDES Resolution (JR), to carry out the 62 day stratigraphic coring campaign. The JR is the world’s most renowned ice-class ocean-going coring research vessel. Thanks to its dynamic-positioning (DP) technology, its use of ice radar, satellite imagery and ice observers, and its ability to quickly withdraw the drill string from the borehole, the JR did not require support vessels.

The purpose of the coring programme was to create a “synthetic well” by drilling accessible, shallow cores close to the seabed in the relevant strata and “grafting” them together. This creates a complete and consecutive stratigraphic record that could otherwise only be obtained by coring into the deep strata in the prospect area, at much higher costs (see Figure 1).

The coring campaign is considered to have been a great success, especially given the tough environmental conditions faced, and the high densities of ice bergs encountered. The 13 cores recovered successfully generated a stratigraphic column of ~ 2000m, with information value close to 100%. Even more importantly, the work was carried out safely.

Environment, Health and Safety

The foundation of the campaign was a focus on health, safety and environment. Shell and its contractors worked together closely to apply strict standards and policies, including Shell’s mandatory “Life Saving Rules”.

Telemedicine

Because the remoteness of Baffin Bay means that Tier 3 health facilities are not available, and helicopter medevacs are difficult, it was decided to ensure that Tier 2.5 medical care should be provided on the seismic and coring vessels, by provision of a doctor and a medic on board. The key enabler was modern telecommunication allowing remote access to medical specialists via telemedicine specialists, Radio Medico.
Environment

One of the challenges of operating in Baffin Bay is to ensure that no damage is caused to the environment, which local communities are heavily reliant upon. As per the Environmental Impact Assessment, various mitigation measures were put in place, including waste management policies, an acoustic monitoring programme, Marine Mammal and Seabird Observers (MMSO's) and shut down protocols in the event of proximity to marine mammals.

Shell went above and beyond the requirements for marine mammal protection. The JR had 3 MMSO’s (including one from Greenland) aboard. Not only did the seismic vessels have MMSO’s on board, but Shell placed two MMSO’s on all five of the support vessels, as a precautionary measure (Figure 2). Shell employed 12 Greenlandic assistant MMSO’s in total during the season. We are pleased to report that no negative impacts on marine mammals have been detected to date, whether by the MMSO’s, impacts on hunting yields or anecdotal evidence from local community consultation.

Prior to drilling cores, sea bottom surveys were conducted. The survey results were evaluated by scientists on board the JR to ensure that biotic communities were avoided when drilling commenced.

The 3D seismic acquisition campaign

During a two and a half month campaign, Shell’s contractor, Polarcus, acquired in excess of 7000 km² of 3D seismic data in the ‘Anu’ and ‘Napu’ license blocks. The seismic data was collected by two state-of-the-art ICE-1A class seismic vessels (M/V Polarcus Amani and M/V Polarcus Samur, Figure 3). Each seismic vessel deployed identical airgun arrays and streamers and was supported by two chase vessels, whose primary task was ice management.

A supply vessel provided bunkering, crew change and other support services to the fleet of six vessels. Crew changes were carried out via Upernavik, for which the valued support of the community, Royal Arctic Line and Air Greenland were essential. Mobilisation and de-mobilisation were carried out by some of the vessels through St John, Newfoundland, and some via Nuuk.

The seismic operation ended safely in mid-October and is considered by all partners to have been a success.

ConocoPhillips’ ‘Qamut’ 2D seismic survey

By Niels Jørgen Ventzel, Principal Geophysicist, ConocoPhillips.

The successful ConocoPhillips ‘Qamut’ (Block 2) 2D seismic survey was the result of many different companies and people working together to successfully complete the seismic survey. The initial concept for the 2D seismic survey was developed by ConocoPhillips’ interpreters working in the Norway office. The grid of seismic lines would fill in between the existing data and with the ongoing shallow coring operation also underway, would allow more detailed, careful interpretation of the subsurface in the ‘Qamut’ block. ConocoPhillips’ co-venturers in the ‘Qamut’ license are DONG and Nunaoil.

Field operations

The actual field operations began August 17th 2012, when Artemis Angler arrived in Nuuk (Figure 4). Once the vessel arrived in the ‘Qamut’ license area, the 10km streamer and airgun
array was deployed and acquisition began. Despite towing a long streamer between icebergs, the survey progressed with an average 110km-per-day. This required extensive teamwork between the ConocoPhillips and CGGV staff on the seismic vessel. Coordination between ice observations from the chase vessels in front and information from the ice radar on the vessel had to be included in the shooting plan.

Results and conclusions

The 3298.3km project (Figure 5) was completed on August 26th 2012 when we entered Nuuk harbor again. This was a full week ahead of schedule due to careful management in the field. The data has been shipped to the processing contractor and is currently being assessed. Preliminary analysis indicates that while the multiples on the data are strong, the sampling and quality is quite good, so there are high expectations for the final results.

Maersk Oil operations in ‘Tooq’ (Block 9)

By Poul-Henrik Larsen, Area Manager, Maersk Oil.

During August and September 2012 Maersk Oil Kalaallit Nunaat A/S acquired approximately 1,850km² of 3D seismic data as operator for the License 2011/15 ‘Tooq’ in Baffin Bay (Figure 6). The acquisition window of two months was defined by the Greenlandic authorities in order to impose the least possible noise impact on local marine mammals communities. Following tests in the area prior to the survey, Maersk Oil decided to use a smaller airgun than initially planned for the imaging of the subsurface targets to further mitigate and diminish the noise impacts to the environment.

The 3D seismic survey was conducted by the vessel Polarcus Asima towing a 1km wide spread of ten streamers 6km long (Figure 7). The seismic vessel was supported by three chase vessels and one supply vessel during the whole acquisition period. The relatively large number
of vessels included in the operation was used for ice scouting to secure a safe operation without any encounters with floating glacier ice and icebergs within the survey area. The vessels were all equipped with ice radars and the operation was furthermore aided by frequent satellite images to help the overall mapping and tracking of icebergs. The ice scouting setup was very successful resulting in no ice-related incidents leading to very little operational downtime in terms of damaged equipment.

In addition to the 3D seismic acquisition, Maersk Oil conducted a hydrographic survey within the 3D area utilising the McGregor vessel Strait Hunter. This survey was launched in early July and lasted until late August. In August, it was run simultaneously with the 3D seismic survey. A very detailed image of the seabed was established using the multibeam echo sounding technique. In addition, some 50 samples of the seabed were acquired for further technical and geochemical study.

All data is currently being processed and analysed, and will subsequently be included in the overall hydrocarbon assessment of the block.

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**Cairn Energy PLC’s operations in Greenland 2012**

*By Ian Watt, Director of Assets (Greenland), Cairn Energy PLC.*

Cairn has been operational in Greenland since 2007 and the country remains one of Cairn’s geographical areas of focus. Cairn in the first phase of its exploration programme in the region has drilled eight of the 14 wells that have now been drilled in Greenland (Figure 8).

The second phase of Cairn’s exploration programme in Greenland is focused on one of its exploration blocks called ‘Pitu’. The ‘Pitu’ block is located in the Melville Basin, off the North-West coast of Greenland, an area which has attracted significant industry interest. Cairn is currently in the process of interpreting 3D seismic data which it acquired over parts of ‘Pitu’ in 2011. Depending on the outcome of this process, which is well advanced and includes mapping and technical evaluation, Cairn is currently targeting exploration drilling in ‘Pitu’ in 2014. The Norwegian national oil company Statoil will now partner and work alongside Cairn...
on the ‘Pitu’ license having acquired a 30.625% interest earlier this year. Any possible exploration drilling undertaken on the block will be focused on safety and subject to receiving approval from the Government of Greenland.

During 2012, Cairn has also been active in South Greenland. A seabed geochemical sampling survey has been completed in the area and the results are currently en route to a laboratory where they will be analysed. In 2011 Cairn acquired a 3D seismic survey over the area which it is now in the process of being interpreted and next year Cairn will work to find a farm-in partner before considering further significant activity in the area.

**TGS’ operations offshore East and West Greenland**

*By Gulnara Hickman, Project Development Greenland, TGS.*

During the 2012 acquisition season, TGS has continued building a geological and geophysical database in several regions offshore Greenland.

TGS started acquiring data in Greenland in 1999. To date, the geophysical database comprises of about 118,000km of 2D seismic data; 40,000km of reprocessed 2D seismic data; 95,000km of shipborne gravity; 206,000km of aerogravity; 315,000km of aeromagnetic data. In addition, 5 sea floor sampling projects have been carried out on both West and East Greenland.

**Acquisition of the NEG12 2D seismic dataset**

In Northeast Greenland TGS, in partnership with Fugro, has completed acquisition of the NEG12 2D seismic dataset by collecting over 3,400km of new data and achieving higher production than TGS’ previous NEG surveys with the majority of the data collected over the licensing round blocks (*Figure 9*).

In addition to the seismic data TGS, in partnership with Volcanic Basin Petroleum Research (VBPR) and Nunaoil, have collected sea floor samples for analyses for geochemical evidence of hydrocarbon seepage and for seismic tie to Mesozoic and Tertiary sequences. EGS12 results will be highly relevant for understanding hydrocarbon potential and for increased confidence for 2012/2013 licensing round applications.
2D data acquisition and sea floor sampling offshore Southeast Greenland

In Southeast Greenland, TGS is continuing to build a database in the new frontier area by acquiring 2D regional seismic data and collecting sea floor samples (in partnership VBPR). The aim of the ABS12 sea floor sampling project is to identify the hydrocarbon potential of this area.

Sea floor sampling offshore Southwest Greenland

In Southwest Greenland new sea floor samples have been acquired in the Fylla area. The objectives of the SWGS12 survey is to provide new information about petroleum system and stratigraphy by collecting hydrocarbon seep samples and stratigraphic samples using gravity cores and dredges. TGS partners with VBPR and Nunaol for this project.

Reprocessing of 2D vintage data using the new Clari-fi technique

In West Greenland TGS’ latest broadband processing technology Clari-fi is being applied to vintage seismic data, located in offshore areas between Disko Island and Nuuk. The first three test lines demonstrated significant uplift in data quality and around 23,000km of additional 2D data will add to an increased geological confidence of the region.

ION’s airborne program in NE Greenland

By Joe Gagliardi, VP Marine, ION.

In 2006, ION began acquiring modern seismic data in the Arctic, operating near the ice using traditional open water methods. Over the next three seasons, ION furthered its capabilities by developing technologies and techniques to gather seismic data in and under the ice. Highly prospective areas of the Arctic had been bypassed due to the risks of operating in this environment. Harsh weather conditions and vast polar ice provide a very short seasonal window to complete seismic surveys. In addition, this extreme climate poses risks to personnel, equipment and data quality. Until 2009, seismic exploration was designed to get as close to the ice as possible. ION recognized that acquiring data in the Arctic's challenging environment would require revisiting and redefining many aspects of the seismic acquisition workflow. ION assembled a team of experts to develop specialized procedures, tools and technologies to safely and efficiently collect commercial grade seismic data.

This specialized project team included marine seismic operations experts, geophysicists, vessel captains, ice pilots and engineers with experience operating vessels in ice. Mechanical, electrical and systems engineers, navigation and positioning experts, project managers and others were brought in to customize the technology and optimize all aspects of the workflow. Equipment was carefully selected, including vessel type and class; in-water data acquisition equipment (considering durability, capability and tolerances to temperature extremes) and including modifications to the acquisition vessel’s hull; integrated navigation and positioning systems; ice measurement,
prediction and management tools; and methods were developed to properly deploy and maintain the in-water equipment to avoid loss and damage from the ice. The result of the team’s efforts was a unique, in-ice marine towed streamer survey, deployed in 2009 off the coast of Northeast Greenland (Figure 10).

Since its initial deployment in Greenland in 2009, ION has conducted a number of under-ice Arctic projects in the Beaufort and Chukchi Seas, as well as the High Arctic offshore Russia. In 2011, the company successfully completed a third survey off the coast of NE Greenland which has now resulted in a regional grid providing significant structural control as well as in-depth understanding of the regional geology. The Arctic programs are acquired in accordance with ION’s famous BasinSPAN concept (18 seconds record length and 10km cable) providing ultra-deep imaging and unique insights in the basin’s tectonic history and petroleum system.

To further improve the geological understanding of the NE Greenland region, during 2012, in partnership with ARKeX, ION conducted an airborne full Tensor Gravity Gradiometry survey covering all of the 2012 & 2013 BMP license round blocks (Figure 11). After integrating the Gravity Gradiometry data with the 2D seismic, an improved 3D model is now available to the oil industry to further de-risk exploration activities.

Utilizing ION’s unique Arctic technology and methodology, ION has recorded to date in excess of 30,000km of seismic data under the ice, expending more than one million man hours with a total recordable incidence rate (TRIR) of 0.62, well below industry accepted thresholds. Furthermore, all of these projects have been completed without incident to the environment, a critical factor for E&P activities in the Arctic.
Licensing rounds in the Greenland Sea

Two successive licensing rounds will take place in area offshore Northeast Greenland (i.e. the Greenland Sea); a pre-licensing round, which is reserved for members of the KANUMAS Group (StatoilHydro, BP, ExxonMobil, ChevronTexaco, Shell, Japan Oil, Gas and Metals National Corporation and Nunaoil A/S) and an ordinary licensing round.

The total area on offer constitutes 49,948km$^2$ divided into 19 blocks. In the pre-round license area 11 of these blocks are offered, totaling an area of 29,867km$^2$. The deadline for license applications in the pre-round is on 15th December 2012. On 15th March 2013 the Greenland Government shall determine whether any licenses shall be awarded in the pre-round.

After completion of the pre-round those parts of the total area of 49,948km$^2$ which are not covered by licenses shall be offered in the subsequent ordinary round. This ordinary licensing round is open to all interested parties and will be formally opened on 15th June 2013 by the Greenland Government.

Deadline for submission of non-obligating pre-qualification application is on 1st July 2013.

On 15th August 2013 a decision on the pre-qualification can be expected from the Greenland authorities.

Deadline for license applications is on 15th October 2013 for companies or groups of companies.

On 15th January 2014, the Greenland Government shall determine whether any licenses shall be awarded in the ordinary round.

For more information on the application procedure please visit the BMP website.

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