Hild East (North Sea, Norway): How Geosciences Integration Led to the Re-Birth of an Old Discovery*

Christian H. Mathieu[1], Rune Hope[2], and Louis Bruckert[3]

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[1]TOTAL E&P UK, Aberdeen, Scotland (U.K.) (christian-henri.mathieu@total.com)
[2]TOTAL E&P Norway
[3]TOTAL SA

Abstract

Up to now, articles on Hild focused on seismic imaging. Indeed one of the most recent publication ("Hild multi azimuth seismic experiment," by K.Kravik, P.Sexton et al, EAGE 67th conference, June 2005) dealt with a so called "multi-azimuth *experiment"*! This is why it is now a pleasure to show how TOTAL E&P Norway made a giant step from "seismic experiment" to the filing of a dedicated Field Development Plan (FDP) prognosed next year through the integration of various geosciences techniques. After a brief review of the main difficulties which impacted the delay between the discovery and the decision to launch a development, the latest seismic imaging progress and their impact on the interpretation, as well as the Hild East penetrations drilled in 2009-2010 and the associated Extended Well test results, will be summarized. Synthesis of the results of these various Geosciences techniques is leading to a much better understanding of the greater Hild area and particularly the Hild East discovery. This will allow TOTAL E&P Norway to file a FDP prior to August, 2012, and, after the closing of the giant Frigg field in 2004, to operate again a major 150 to 250 Mboe field in the Norwegian waters.

The current Hild field project (TOTAL operator 49%, Statoil 21% and Petoro 30%) includes the development of the Hild East gas reservoir and the smaller overlying Frigg oil reservoir, located in 115m water depth, which are straddling blocks 30/4a and 30/7a along the borderline between UK and Norway in the Norwegian sector (Figure 1).

Nearest fields are Jura, Dunbar, and Alwyn on the UK side and Oseberg on the Norwegian side. The Hild East discovery was made in 1978 by the well 30/7-6R operated by Norsk Hydro. One year later, BP drilled well 30/4-2 3 km to the North. These 2 wells found the Middle Jurassic Brent Group to be gas-bearing.

However, there were uncertainties regarding the measured or interpreted free water levels (FWL) and 7 bars difference existed between each gas gradients. Several other Brent discoveries followed in the immediate vicinity: Hild Central drilled 3Km to the west in 1981 by Norsk Hydro (well

30/7-8R), Hild West well 29/6-1 drilled by BP in 1982, and Hild South well 29/9-1 drilled 4Km to the west-south west in 1984 by Norsk Hydro. All five wells found Brent reservoirs gas-bearing with pressure ranging between 750 and 800 bars and different gas gradients. On top of these facts, seismic imaging was a major challenge because the presence of a gas dismigration in the overlaying Cretaceous series created a large seismic obscured area (SOA over 30 km^2).

Given the poor seismic image and the apparent heterogeneity in the pressure measurements, particularly in wells 30/7-6R and 30/4-2 (Figures 2 and 3), it was admitted that the Hild East discovery was highly compartmentalized and, as a consequence, that development economics would be difficult to reach.

Current Assessment

After a significant partnership reshuffle, TOTAL E&P Norway became license operator of PL 040 and PL 043 and decided to focus on two main axes of improvement: 1) the seismic imaging improvement at Brent reservoir level and 2) the drilling feasibility, as it was anticipated that a large part of the Hild East culmination had a reservoir pressure very close to the seal frac pressure.

In spite of several 3D acquisition (1982 and 199) and numerous 3D re-processing attempts, seismic imaging remained a major challenge. After a multi-azimuth streamer survey was recorded in 2003 and brought data quality improvement outside of the SOA, it was decided to acquire an Ocean Bottom cable (OBC) survey. In 2005 a High-Density Wide Azimuth 4C OBC was acquired providing a step improvement in imaging/illumination of the objectives mainly because of a much higher Signal to Noise ratio brought by a very high fold and less noise on the seabed cable geophones--because of the azimuthal illumination and the efficient multiple suppression from PZ summation. Although the dynamical segmentation of the reservoir across the field remained a major uncertainty, the new seismic provided a more reliable structural framework.

This major step forward allowed proposing an appraisal strategy aimed at reducing this segmentation uncertainty. It consisted of:

- First, drilling a pilot hole plus a sub-horizontal well, crossing a fault and straddling two undrilled segments,
- Then, performing an Extended Well Test (EWT), consisting of producing and flaring the Brent gas for 10 days,
- Then monitoring the pressure build-up during 180 days with down-hole gauges.

In addition, the proposed 3D trajectory of the pilot hole should have allowed crossing the edge of the Frigg sands accumulation in a location where oil should be found and sampled.

Finally the 30/4-D-1H pilot hole was spudded September 19, 2009. It reached TD at 4128m MD February 7, 2010, after successful coring and wireline logging of both objectives, the Frigg and Brent sandstones. Pressure data gathered during this pilot hole allowed us to go for a simpler side-track trajectory targeting a limited compartment. The 30/4-D-1 AH-C5 penetration reached TD at 4500m MD March 23, 2010. The wells were drilled by the new built semi-submersible drilling facility West Phoenix without any HSE incident.

As a result, the Brent formation was successfully appraised and extensive data gathering was achieved, including 76 meters of cores. 30/4-D-1-AH

(Figure 2) was completed as a pre-production well, with a successful extended well test performed. Maximum production rate was 1,600,000 Stm^3 per day through a 40/64-inch nozzle. The production rate was kept for approximately 10 days before reservoir pressure build-up monitoring started. Through an innovative design with wireless pressure gauges in the reservoir section and data transmittal via a surface buoy with satellite communication to shore, the reservoir pressure build-up has been continuously monitored for up to 180 days after the drilling rig left location. This gave very valuable information about the perceived key risk of reservoir segmentation and connected gas volumes. Indeed, although the Hild East structure is complex and faulted and the seismic image is still not crystal clear (Figure 3), the Extended Well Test results are extremely encouraging, confirming the reservoir communication across fault blocks between substantially connected volumes. These results allow us to simplify the initial Field Development Plan with a significantly reduced number of development wells designed with more simple trajectories - slanted wells instead of horizontal drains.

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The presence of an oil accumulation with gas cap in the Frigg Formation was also confirmed. An oil column of 21 meters was encountered in good-quality sands. Extensive data gathering was carried out, including 40 meters of cores. A significant oil volume was sampled by wireline formation testing, giving valuable input for process and valorization studies and allowing the saving of a dedicated well and associated DST.

TOTAL E&P Norway, operator, is currently further evaluating the results, updating the resource estimate and continuing field development studies of both Brent and Frigg formations (Figure 4). A FDP application either filed recently or expected to be filed soon will allow TOTAL E&P Norway to operate a new major 150 to 250 Mboe field in the Norwegian waters.

Reference

Kravik, K., P. Sexton, L. Lemaistre, V. Aubin, A. Riou, and F. Bertini, 2005, Hild multi-azimuth seismic experiment: EAGE 67th conference, Madrid, Spain, June, 2005.

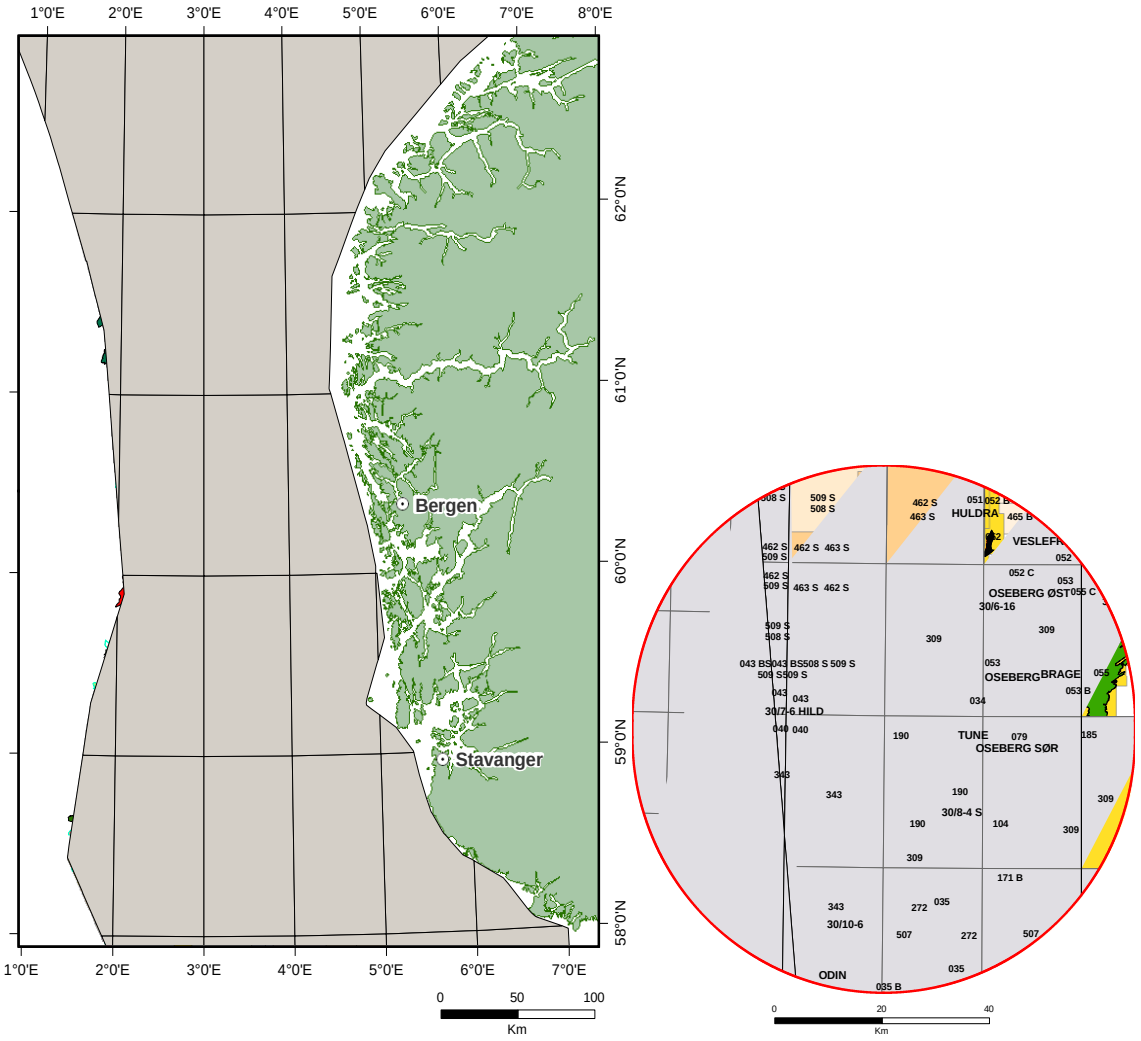

Figure 1. Norwegian Continental Shelf: Central & Northern North Sea. Hild location and Zoom

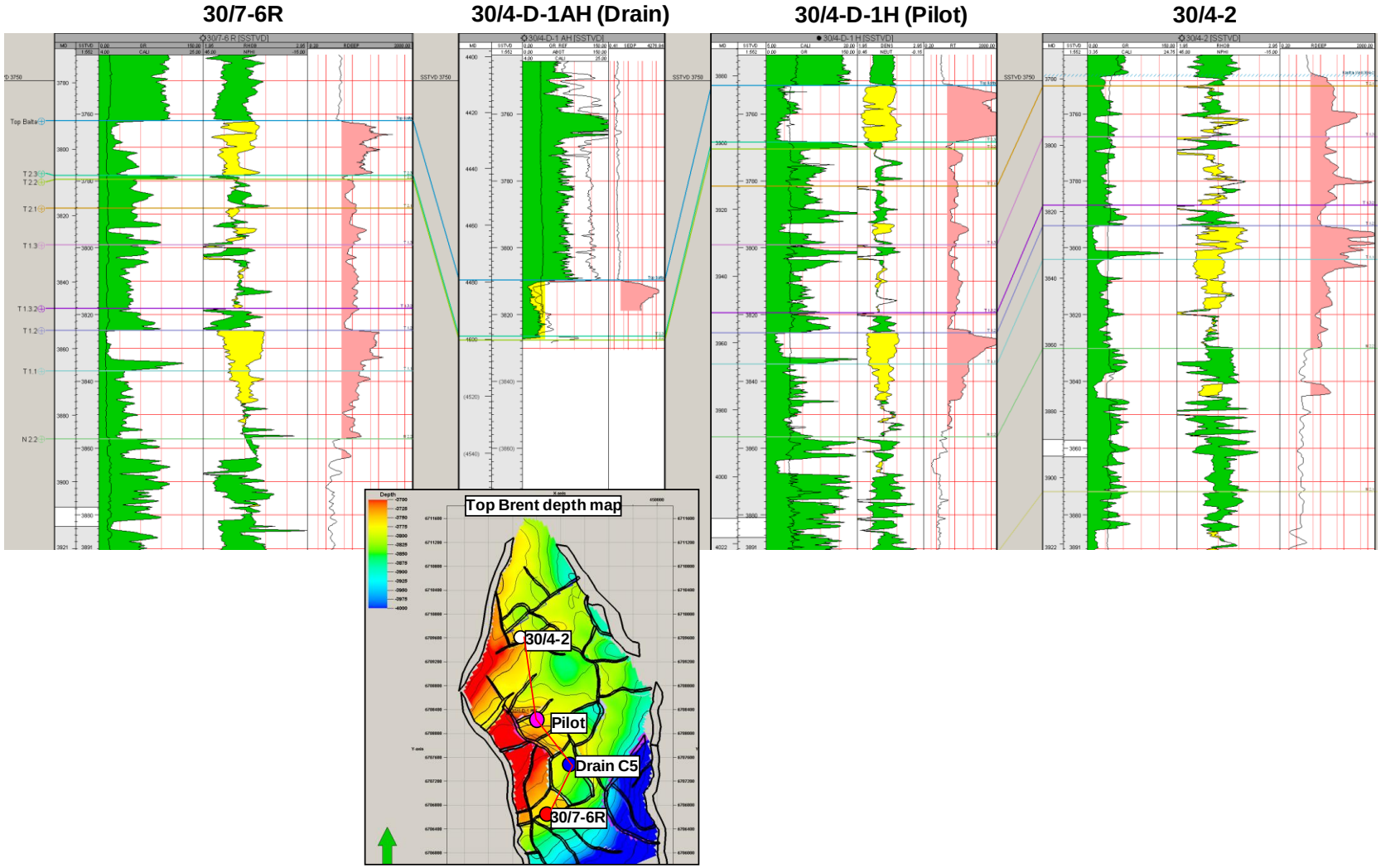

Figure 2. South- North wells correlation across Hild East.

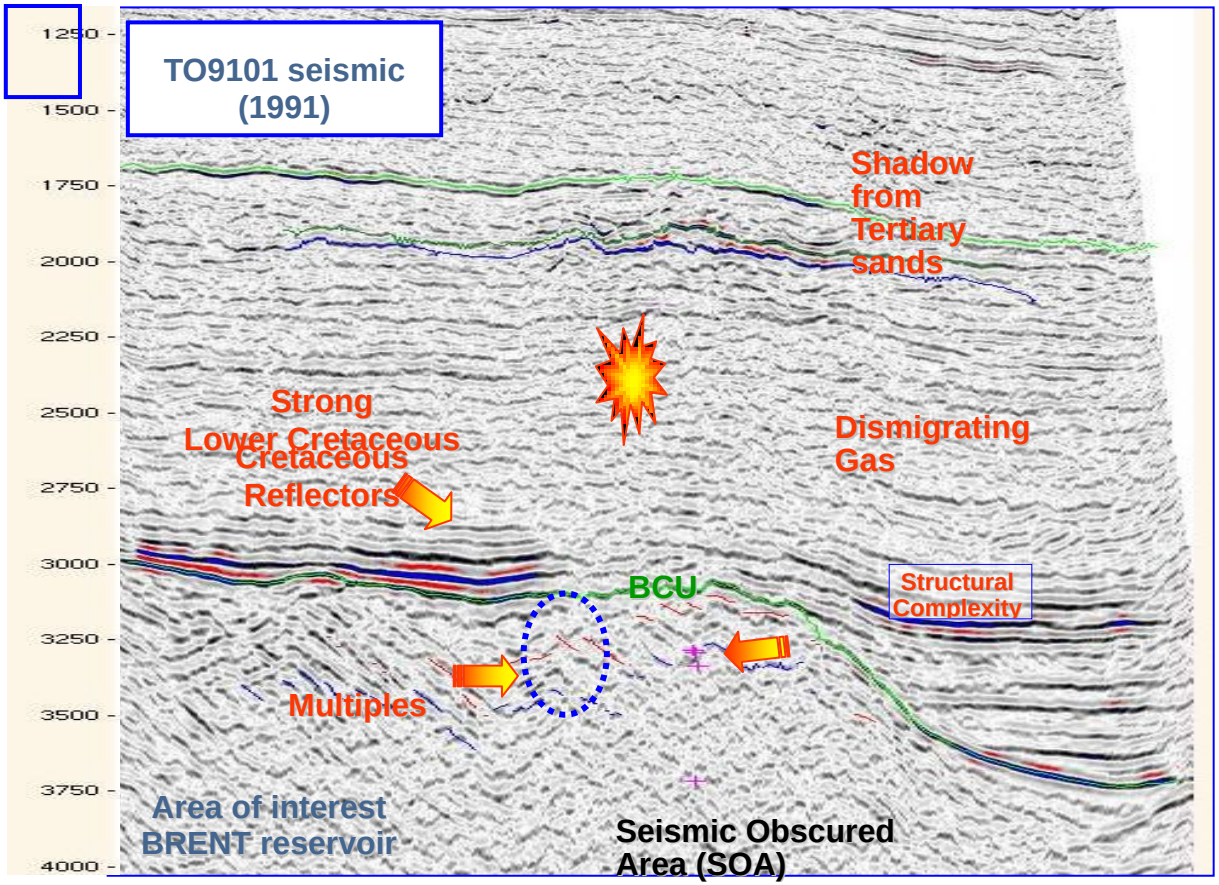

Figure 3. Hild seismic obscured area.

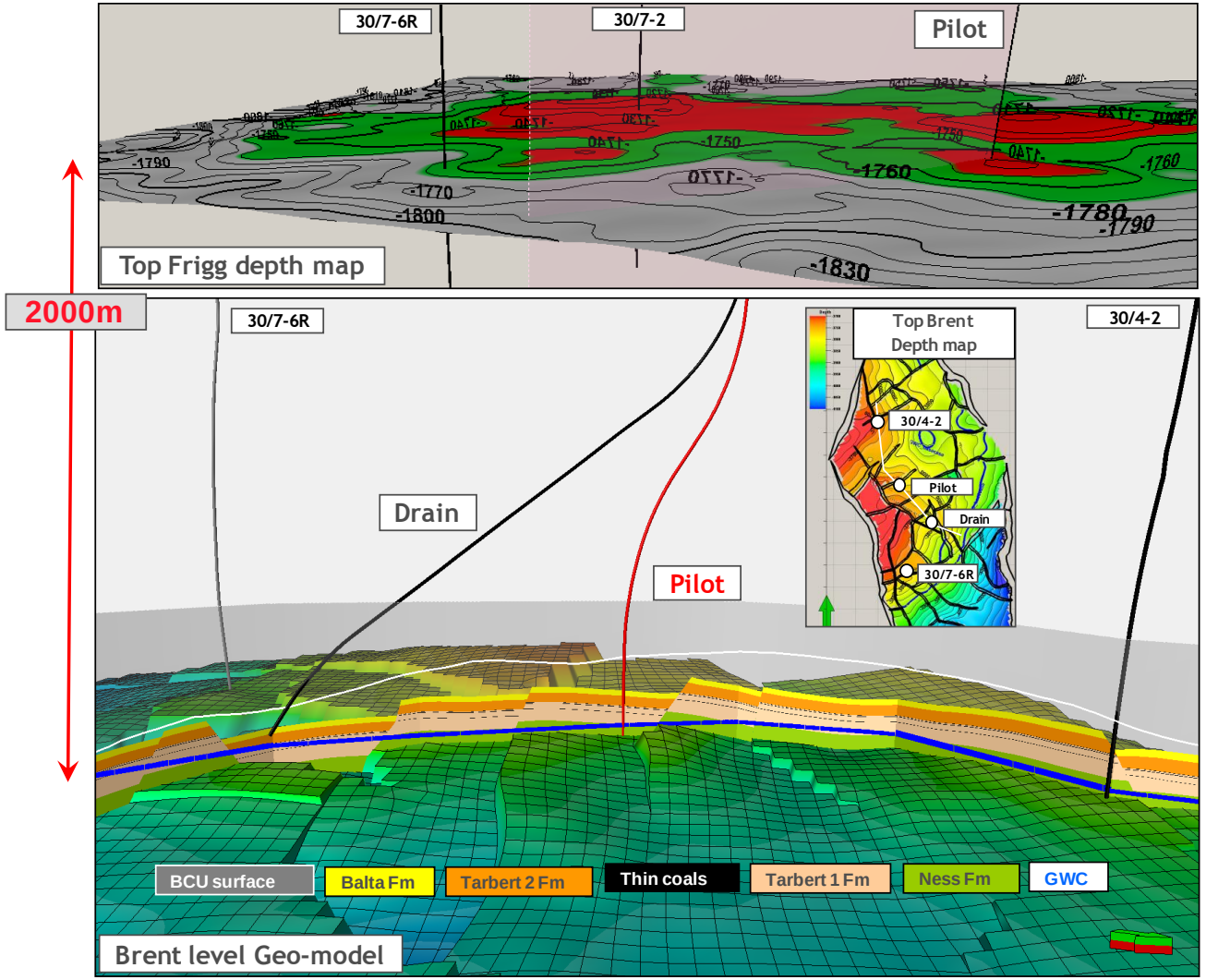

Figure 4. Hild 3D view illustrating Frigg and Brent Formations appraised by wells 30/4-D-1H and -1AH-C5.