X024

Statistics on Wells in the Netherlands - What Do We Learn?

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SUMMARY

With access to virtually all E&P welldata in the Netherlands, EBN is in a unique position to extract learnings and to compile statistics on drilling performance and subsurface parameters. This presentation gives an overview of well success ratios and creaming curves. Also drilling surprises have been analysed and linked to certain types of -operational- incidents. Via the concept of the Drilling Incident Triangle a classification scheme is presented that allows capturing of drilling hazards efficiently.
Other learnings are based on the comparison of reservoir parameters that have been prognosed pre-drilling with the actual measurements post-drilling. One remarkable finding is that reservoir depth prognosis appears systematically off. Statistically the reservoir comes in deep with respect to prognosis, having a negative impact on volumes and/or productivity. A hypothesis based on selection bias that might explain these observations is presented.

Introduction

Today's E&P business in the Netherlands is considered highly mature. The present level of drilling activity is nevertheless still significant, with at least 32 exploration, appraisal and development wells being drilled each year (fig. 1). This represents an investment of around 600 million euros annually and supports the current national production level of 70 bcm/y. Gas and oil resources are situated both onshore and offshore and are being developed by a variety of operators. Targets range in depth from some 600 m to 5 km whilst the reservoir stratigraphy ranges from Tertiary to Carboniferous.
EBN, the Dutch state owned E&P company, is partner in more than 90% of these assets and participates actively in the developments. EBN is therefore in a unique position to compile lessons learned from the Dutch subsurface. The large well numbers allow the derivation of statistically meaningful conclusions in various disciplines. Whilst the majority of the wells are successful, a significant proportion fail to meet their objective. Reasons for failure can be divided into two categories:

1) Operational failure in reaching the reservoir level. Drilling Hazards do play an important role here and a good understanding of the mechanisms and occurrences will help in de-risking new wells.

2) Disappointing reservoir properties. This study gives an overview of the reservoir related failure causes, including dry well, tight rock and depletion. Their relative importance and frequency of occurrence are discussed.

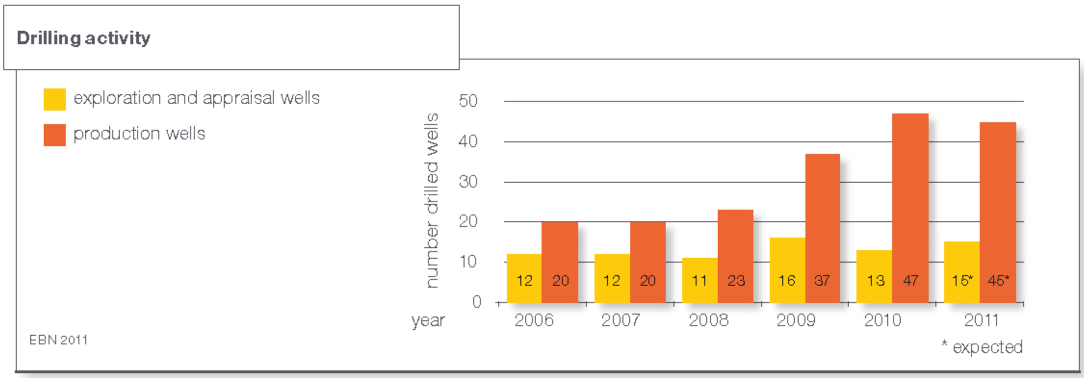

***Figure 1**:Drilling activity in the Netherlands. The increase of production wells in the last 3 years is partly the result of a recent large oil development.*

Background: drilling hazards

Around 30% of the wells do encounter operational problems causing significant delays and cost increase. In 6% of the cases the well does not reach the reservoir level at all. Drilling incidents can be classified according to the *Drilling Incidents Triangle* (fig. 2).
Incidents are typically the result of a human factor, equipment failure (engineering) or a geological cause. Often a combination of these factors play a role in a major drilling incident (e.g. high geo-pressures, MWD tool failure and inexperienced crew).

In this study a drilling hazard is defined as a *peril that potentially impacts drilling*. Certain types of drilling hazards have a significant geological component and are referred to as *geo-drilling hazards*. The latter can eventually lead to *geo-drilling incidents*. These incidents require geoscientists for proper understanding and can often be avoided by doing the geological homework meticulously. Good access to learnings from wells drilled earlier is crucial.

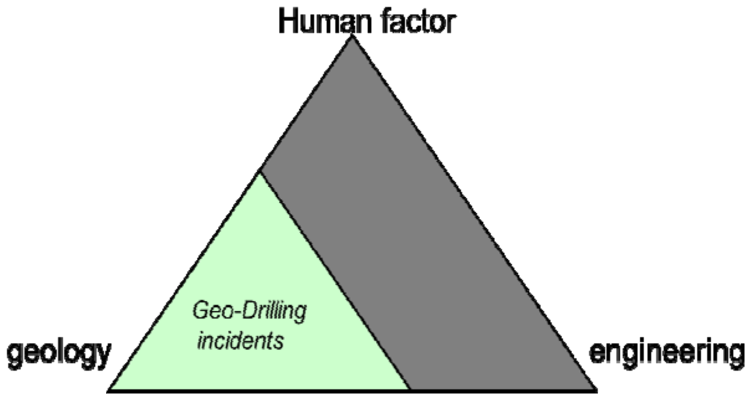

Figure 2 *Drilling Incident Triangle*

Geo-drilling hazards encountered regularly in the Netherlands include anomalous geopressures, which could lead to a well control incident. Differentially sticking, mobile formation and faulted zones can, for example, result in a stuck drill-string and may eventually require sidetracking (fig. 3). These events have in common that they jeopardize safety and incur additional operational costs. Improved knowledge of the possible geodrilling hazards in a particular location can reduce the associated risks.

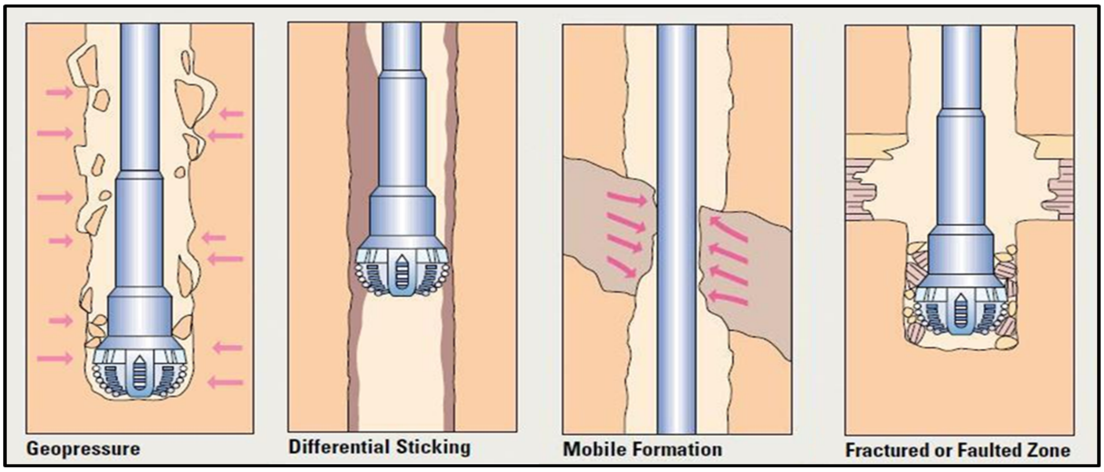

Figure 3 *Typical geo-drilling hazard in the Dutch subsuraces*

Background: reservoir findings

Whilst the exploration well success-ratio with 70% is still very high, there are wells that do not deliver hydrocarbons (economically) from the reservoir. Among the reasons for disappointing reservoir findings are: 1) water-bearing reservoir, 2) reservoir volumes small, 3) tight reservoir, 4) depleted reservoir.
Whilst reasons 1-3 are more applicable to exploration wells, appraisal and development wells can be negatively impacted by any of these reasons. Good insight in the statistics behind these reasons can help to avoid disappointments in the coming wells.
A special case is when the reservoir is encountered deeper than the prognosis. In particular for appraisal and development wells this tends to have a negative impact on the volumes and produceability of the hydrocarbons (fig 4).

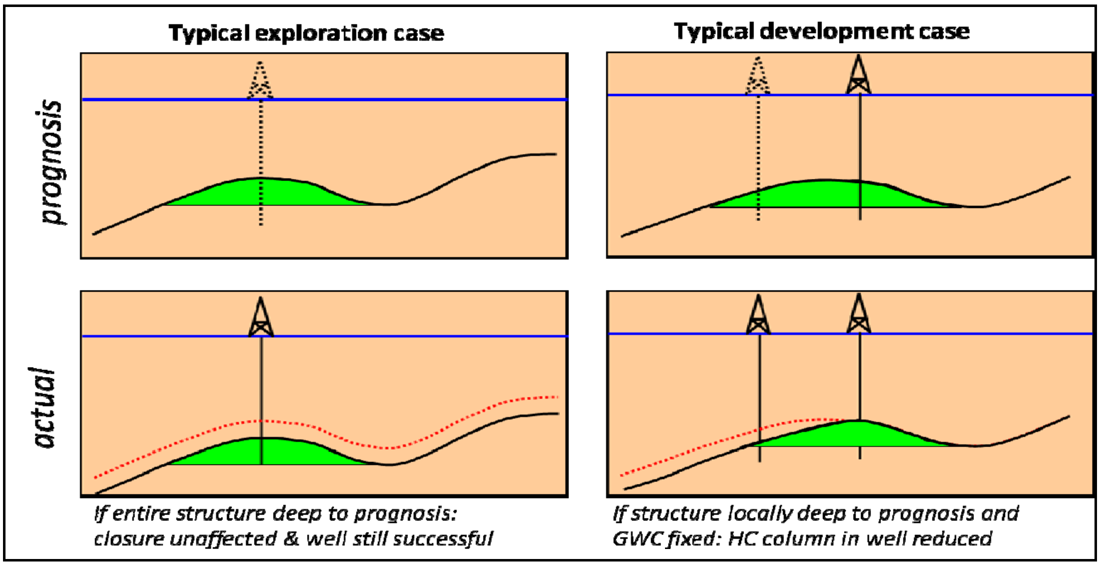

Figure 4*The impact of depth prediction errors can lead to failed wells, depending on the situation.*

Analyses: drilling hazards

EBN has access to a large well database allowing to analyse well results extensively. Statistics are available that show what drilling mishaps are actually occurring. The analysis of the drilling incidents has led to a *drilling hazard classification scheme*. This scheme will serve as the basis for a drilling hazard database whose setup is planned as a Joint Industry Project together with TNO. Easy access to known *geo-drilling incidents* in the Netherlands can help to de-risk future wells. Improved understanding of drilling hazards should lead to safer and cheaper wells.

Analyses: reservoir findings

The *exploration well success ratio* (fig. 5) and the *creaming curve* are key statistics in judging the exploration maturity for a certain area. Additional statistics are provided to gain insight in the reasons for failure – or success – of wells drilled in the Netherlands as mentioned above.

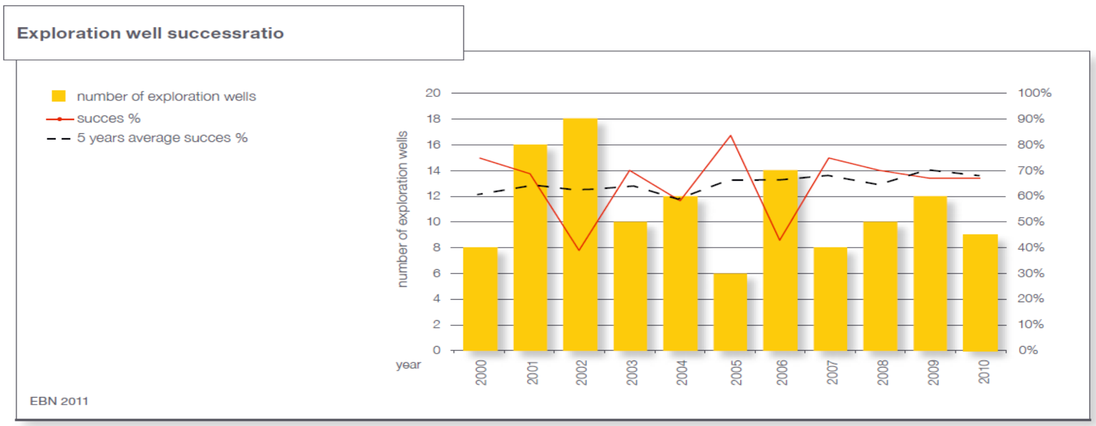

Figure 5 *Exploration well success ratio in NL*

Interesting conclusions can be drawn by comparing prognosed with actual reservoir parameters. These parameters include reservoir thickness, porosity, net-to-gross and statistics can be generated for different plays or for different operators.
One puzzling finding is a clear bias in depth errors (fig. 6): the difference between the prognosed reservoir depth and the depth as found by the bit. A new hypothesis (based on *selection bias*) is suggested to explain these observations.

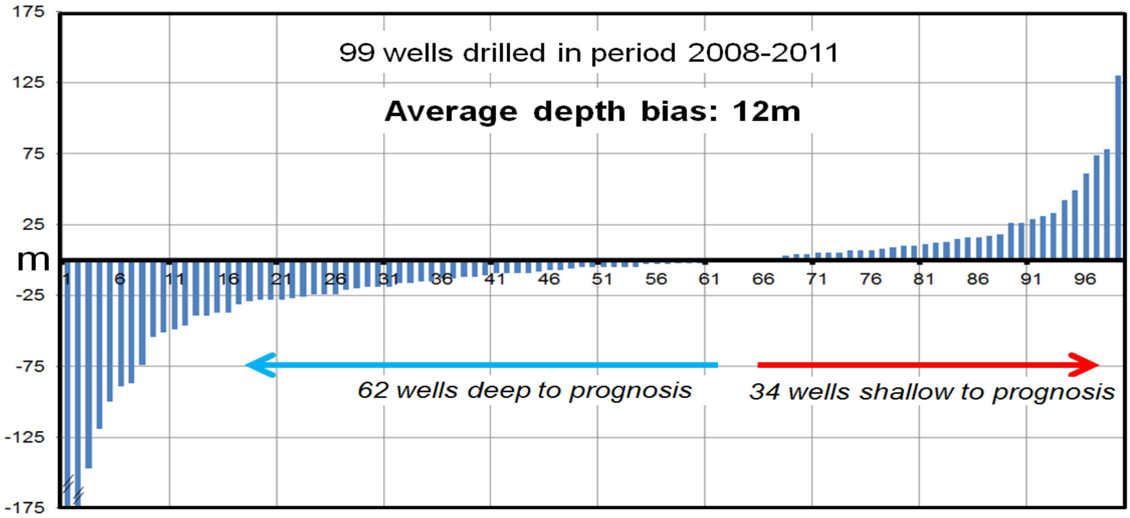

Figure 6 *depth prognosis error*

Conclusions

The analysis of well results using EBN's large well-database allows the compilation of useful and representative statistics. Success ratios, creaming curves and typical drilling surprises are presented. Despite the maturity of the Southern North Sea basin, drilling incidents due to geohazards still do occur frequently and are sometimes very costly.
A good overview of the historic well findings in combination with a thorough subsurface evaluation and an open-minded uncertainty analysis is paramount for successful drilling projects.

References:

Focus on Dutch Gas. 2011 EBN publication www.ebn.nl/files
Hoetz, Guido et al. 2011. Salt Induced Stress Anomalies: an explanation for variations in seismic velocity and reservoir quality. Petroleum Geoscience Vol.17 2011