Indications for intra-Chalk seals in the F-blocks of the Dutch offshore

By integration of seismic and well data

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Abstract

A study on the Dutch Cretaceous Chalk Group is performed during a six month internship at EBN. The study area is the F-Blocks in the northern Dutch offshore. The focus of this study is to evaluate if there are indications of hydrocarbon seals present in the Chalk.
These seals act as intra-Chalk permeability barriers and can be formed by hardgrounds and tight zones.
Permeability barriers may be associated with: (1) the presence of unconformities; (2) a sudden rise in pressure within the Chalk; (3) the presence of hydrocarbon shows within the Chalk. In the study area a few indications for intra-Chalk permeability barriers have been observed.

(1) Several regional unconformities are present in the Dutch Chalk. A Late Campanian regional unconformity was seismically mapped throughout the study area. This unconformity is tied with various well logs and biostratigraphic well data.
(2) Hydrocarbon shows within the Chalk are also evaluated in order to see if the shows are located intra-Chalk as this would suggest an intra-Chalk permeability barrier. Almost all shows in the Chalk are sealed by the overlying Tertiary. Well F06-02 has a hydrocarbon column located under Top Chalk but examination suggests that the overlying Chalk is a waste zone and the column is sealed by the Tertiary.
(3) There is a sudden pressure increase in well F06-02 with hydrocarbon shows located underneath it. This sudden pressure increase coincides with the mapped Late Campanian unconformity and a well log character that suggest denser, less permeable, chalk.

This outcome of this study shows that there is weak evidence that the Late Campanian Unconformity is able to act as a permeability barrier for hydrocarbons.
Intra-Chalk structural traps have not been identified. It may be possible that an intra-Chalk permeability trap in the form of a constriction trap exists but no well tests are available.

Chapter 1 - Introduction

1.1 Introduction

The Cretaceous Chalk Formation is known to act as a hydrocarbon reservoir. Examples in the Netherlands are Hanze field and Harlingen field. In these fields the hydrocarbons are trapped and sealed at the Top Chalk. However, it is also possible to have hydrocarbons trapped and sealed intra-Chalk. This has not yet been documented in the Netherlands but there are a few examples from the UK and Denmark where this is the case. In the Fife field (UK) an oil column is trapped intra-Chalk and it is sealed by an overlying zone of 'tight' chalk (chalk with low porosity and permeability). In the Adda field (DK) an intra-Chalk oil column is suspected to be sealed by an overlying 'hardground' (calcite-cemented layer) located at a seismic unconformity. In the Halfdan field (DK) an intra-Chalk oil column is dynamically trapped and a hardground barrier prevents rapid outflow of hydrocarbons. These three fields will be discussed in greater detail in 2.3- Intra-Chalk seals and barriers.
The intra-Chalk sealing intervals are the focus of this study. Sealing intervals in the Chalk can occur in the form of hardgrounds and tight zones (e.g. Megson & Tygesen, 2005; Calvert *et al.*, 2014) and they are known to occur in the vicinity of unconformities.
In Figure 1.2 a seismic line is displayed. Even though the Top Chalk horizon and the Base Chalk horizon are relatively parallel to each other, intra-Chalk seismic reflectors display a lot of variation. One intra-Chalk reflector in particular stands out (indicated in pink squares): this is an unconformity. This study will map this unconformity in the study area and, with integration of well data, will evaluate if this unconformity may be able to acts as a seal for flowing hydrocarbons. This study is performed during a six month internship in the Technical Department of EBN.

1.2 Research Question

Are there indicators for intra-Chalk permeability barriers present in the study area? In order to answer this question a literature study will be performed in order to identify indicators of permeability barriers, the regional unconformity will be mapped in the whole study area and the seismic data will be integrated with the available well data.

1.3 Study Area

The 3D seismic information in the study area comprises the F4, F5, F6, F7, F8, F9, F10 and part of the G7 block of the Dutch offshore. It has an area of 4,320 km^2. For an overview of the study area see Figure 1.1. For well integration a number of 63 wells were used. For the location of these wells see Figure 3.1.

The remainder of this report contains information that is (temporarily) confidential.