

THE WISTING DISCOVERY: AN UNUSUAL USUAL SHALLOW BIODEGRADED OIL IN THE BARENTS SEA?

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Introduction

The present study reports on shallow reservoired, unusual biodegraded oil, discovered in well 7324/8-1 Wisting Central. The wellbore is located on the north-western Bjarmeland Platform between the Hoop Fault Complex and the Maud Basin, Norwegian Barents Sea. The Bjarmeland platform experienced uplift in the range of 1500-2000m during the last 60Ma. The shallow reservoir depths of 662mMD (237m below seafloor), characterizes this reservoir as a prime example of an exhumed petroleum system in offshore Arctic waters. The Wisting oil leg has been discovered in sand- and siltstones of the Middle Jurassic Stø and Upper Triassic Fruholmen formations, with and oil-water-contact at 708m MD in the Fruholmen Formation (Norwegian Petroleum Directorate (NPD), 2016). A gas cap was not proven, but may exist up-flank. Despite the shallow reservoir depth and low reservoir temperature of about 16°C, the degree of biodegradation is exceptionally low. Therefore, the present study tries to shed light on the reasons behind the geochemical signatures and asks if the Wisting oil is a geological exception or can be regarded as an unusual usual discovery. Geochemical analysis included routinely applied GC-FID and GC-MS measurements.

Results

The API and the GOR of the oil sample are 38° and 50sm³/sm³, respectively (NPD, 2016). As shown in Figure 1, the Wisting oil represents some degree of microbial alteration as indicated by reduced or absent *n*-alkane peaks mainly in the C₁₀₊ range, while the light hydrocarbon fraction seems to be affected to a lesser extent, although the volatile *n*-alkanes are degraded compared to aromatic and branched compounds. However, no unresolved complex mixture can be observed and the pristane/*n*-C₁₇ and phytane/*n*-C₁₈ values are 5.98 and 5.61 respectively, which characterize the oil as slightly biodegraded. Such low degree of biodegradation came as a surprise given the reservoir temperature and the burial depth. Based on palaeo temperature modelling, it could be shown that the reservoir has been exposed to temperatures ranging between 80 and 100°C, favouring the process of palaeo pasteurization (Wilhelms et al., 2001). Hence, it should not be possible to observe any signs of microbial alteration, unless the reservoir has been exposed to renewed microbial intrusion and/or paleo pasteurization was not complete and some (hypothermophile?) microbes may have survived.

Based on these observations, different microbial alteration processes have to be taken into account: (1) anaerobe microbes survived the pasteurization and became active during exhumation of the reservoir due to re-entering temperature conditions that encourage microbial activity. This biodegradation type has been termed as “retrograde biodegradation”; (2) specific anaerobe microbial strains that preferentially consume C₁₀₊ hydrocarbons are present in the reservoir and are responsible for this biodegradation signature. Yet, the question remains if these bacterial strains would be active in a rather cold environment; (3) aerobic hydrocarbon degraders are present in the reservoir that have been inactive due to the

absence of free available oxygen. However, during several glacial and interglacial events, fresh meteoric water that carries great amounts of oxygen could have been brought into the basin by the process of glacial pumping.

In order to understand which of the above mentioned process is responsible for the biodegradation, it is important to recognize when reservoir charging occurred. If the Wisting reservoir has been charged at maximum burial, paleo pasteurization should have sterilized the reservoir against microbial activity. This in turn would mean that the petroleum accumulation has been exhumed together with reservoir. Yet it also can be considered that migration into the reservoir occurred after exhumation due to reactivation of faults. Such a scenario however would assume a deeper petroleum pool for late migration or expulsion and migration after the last uplift stages.

A comparable biodegradation trend has also been observed for petroleum from well 7220/6-1 Obelix, that is located ca.145km SE of the Wisting discovery on the Loppa High. The 7220/6-1 well has been defined as dry with shows. Hence, the rather unusual biodegradation pattern found in the Wisting oil is considered as more usual than previously thought.

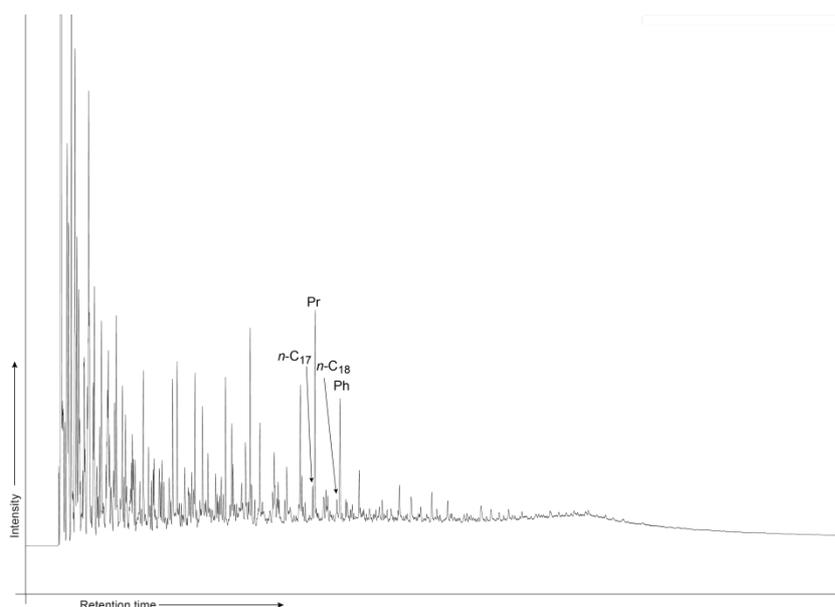


Figure 1: GC-FID whole oil chromatogram of the 7324/8-1 Wisting Central oil.

References

- Norwegian Petroleum Directorate (NPD), 2016. www.factpages.npd.no (accessed December 2016).
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