# Water Weakening of Chalk – Insight from Lab Experiments and Numerical Modelling

In most cases, when fluids are produced from a reservoir the pore pressure decreases. A decrease in the pore pressure means that the reservoir rock itself needs to carry a heavier load, and as a result of this the rock usually compacts. There are at least two practical aspects of compaction, on one hand, compaction is an important drive for oil expulsion, but on the other hand it affects infrastructure such as well casings and could also lead to serious seabed subsidence and sinking platforms. For the Ekofisk field the seabed subsidence was so significant that the platforms needed to be jacked up by six meters in 1987. After seawater injection started in 1985 it took approximately 4 years before the reservoir pressure increased and as a consequence of that the compaction rate was reduced by approximately 1/3, but not completely eliminated. Field observations also revealed that there was a significant reservoir compaction taking place close to the water front. This phenomenon is usually termed "the water weakening effect".

The underlying mechanisms of the water weakening effect are not completely understood. In this talk I will review some of the most relevant lab work that we have performed to investigate the water weakening phenomenon, and the numerical models we have developed to interpret the lab experiments. Cores have been flooded with brines at reservoir temperature and in-situ effective stresses and some series of cores have even been tested at actual values of overburden stress, and pore pressure. The compaction of the cores has been logged as a function of time, chemical composition of the brine, and effective stress. Some of the cores have been flooded with seawater-like brines for close to three years at reservoir conditions. The data has been interpreted with geochemical models coupled with multiphase flow models, on pore and Darcy scale. Produced water from a well at the Ekofisk field have been compared with the core data. One of the main conclusions from this work is that the water weakening effect is most likely related to chemical interactions between the rock and the injected water, and that the chemical signature from the cores are similar as from the Ekofisk well. We have observed mineralogical alterations in the cores, which can explain part of the water weakening effect. Another important contribution is the effect of changes in surface charge and potential. Ions from the brine can adsorb onto the rock surface, change the surface charge and thereby affect the strength of the cores.

This talk is based on a several publications together with Prof. M. V. Madland (University of Stavanger), researchers from IRIS and University of Stavanger.

Bio:
Aksel Hiorth is Chief research scientist within enhanced oil recovery (EOR) at IRIS and Professor within reservoir technology at the University of Stavanger. Currently he is research director at The National IOR Centre of Norway. He has a PhD within theoretical physics from University of Oslo, and has been principal investigator within several large research projects supported by the industry and the research council of Norway. In the last decade he has mainly worked with

developing simulation models that can describe the physical and chemical processes taking place during multiphase flow in porous rocks.