FROM HOMOGENEOUS TO HETEROGENEOUS ROCKS- UNDERSTANDING FUNDAMENTAL CONTROLS OF HYDROCARBON SATURATION: PERCHING EFFECTS

Abstract:

Building realistic and reliable subsurface models requires detailed knowledge of both the rock and fluids involved. While the hydrocarbon volume estimation has a profound impact on the viability of a development, next to the permeability, saturation height models, free fluid levels and the hydraulic communication have a significant role in determining the recoverable reserves.

When in different parts of the same field different free fluid levels (leading to different fluid contacts for the same rock quality) are identified, the lateral hydraulic communication at the field level can be challenged. In this presentation, we propose a new strategy in studying one process leading to different free water levels (FWL) known as “perched” water contacts. Perched water contacts are the result of water entrapment (behind barriers for lateral flow) during hydrocarbon migration in the reservoir. The fundamental controls that lead to the perched contacts formation are studied and shown to be the rock quality and relative permeability. Counterintuitively, the perching effect is not going to feature in poor quality rocks (sub-milli Darcy permeability) – the effects would be visible only for a considerable barrier height. Regarding transition zones, the results show no significant difference is expected above the perched zone when compared to the unconstrained parts of the field. Field observations and dynamic simulations are used to identify the perching controls. A clear distinction is shown between capillary pressure and buoyancy. The fundamental assumption that the capillary pressure can be calculated by using the height above free water level is shown to be deficient when water becomes immobile.

Concerning the process of building a Saturation Height Model from core measurements, we use a recent methodology that aims at ensuring consistency between permeability and Saturation height. The MICP or Saturation height model carries an intrinsic permeability that can be compared to the permeability model. The results show a significant inconsistency can occur between the porosity -permeability data (a reliable, well controlled and measurable property under stress) on one hand and the MICP/SHM inferred permeability on the other. The conclusion is that the most robust dataset for preparing the SHM is under the conditions the MICPs/PCs have been acquired. When the MICPs/PCs have been acquired under ambient conditions and the resulting model has as inputs stressed porosity and permeability, the SHM will predict the correct stressed entry pressures. The findings are validated against a dataset where the capillary pressures acquired under both ambient and stress conditions.

Bio:

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