New developments in Petroleum Systems Modeling for near field exploration

A. Kauerauf[1], A. Kleine[1], and T. Hantschel[1]

[1]Aachen Technology Center, Schlumberger, Aachen, Germany

ABSTRACT

Increasing computing capabilities and memory sizes allow for continuously increasing grid resolutions and subsequently more realistic basin and petroleum systems models. However, some computing paradigms have changed over the last years and, for example; parallelism with concurrent code execution has recently become much more important. Modeling methodologies must thus be re-adjusted to achieve optimal results. In basin and petroleum systems modeling (PSM) migration modeling is the most delaying performance bottleneck. To resolve this issue, the Darcy and invasion percolation (IP) migration methods have been combined to a new method, named Darcy+IP or combined migration method, which takes most advantage of both pure methods into account and, additionally, allows for parallel up-scaling on multiple computing cores beyond the limits what was possible before. The newly combined Darcy+IP method will be presented in detail and discussed. Case studies will be shown. An outlook for high resolution modeling in the future which allows for in reservoir modeling describing fluid gradients, which nowadays cannot be accessed with common basin modeling methods, will be given.

With increasing computing capabilities it has been found, that all these approaches do not scale well with an increasing number of cores for parallel processing. Based on this experience, the new Darcy+IP scheme has been proposed. Darcy+IP is, similar as the hybrid method, performing Darcy flow modeling in low permeable regions. When hydrocarbons reach a reservoir the flow becomes instantaneous on geological time scales. The method switches to IP, which is much simpler than the hybrid method, as it does not need a domain decomposition for the in reservoir flow. Instead, the calculation proceeds on a 3D grid. Special break through handling, allows for high resolution in geometrical complex areas without extra effort. Most of the problems of the hybrid method are mitigated significantly and the performance could be increased.

The new combined method has some interesting advantages over the classical hybrid method. It can take into account any complexity of the reservoir facies distribution in the accumulations. High permeable flow paths of tiny pathways such as permeable faults and small sand layers can also be correctly handled and the modeling of break through paths in seals and overburden layers has been improved. Flow from younger, into older sediments is also modeled correctly. In summary, the filling, spilling and break through history of a complex reservoir can be simulated on a much smaller scale more accurately and in a better resolution.

Darcy+IP allows for modeling with overall high resolution comprising high in reservoir resolution. Gradients describing compositional grading within accumulations over geological times will become processible in this resolution. Wang et al (2015) have demonstrated the value of Reservoir Fluid Geodynamics (RFG), i.e. modeling of dynamic effects on reservoir scale. Darcy+IP allows for spatial resolutions compatible with RFG and thus for more sophisticated in reservoir modeling.