Full Integration of Biodegradation Processes in Petroleum System Modeling*

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Abstract

Pre-drill prediction of oil quality is a major issue as petroleum exploration extends towards costlier areas. Biodegradation is the most important oil alteration process at a world scale and is responsible for the major part of bituminous and heavy oil reservoirs in the world (Roadifer, 1987). Several studies have already been performed to determine qualitative biodegradation scales (Moldowan, 1992; Peters, 2005) or quantitative levels of biodegradation in reservoirs through basin and petroleum system modeling (Larter, 2003; Walters, 2009).

Introduction

Until now, different approaches have been proposed in the literature and in petroleum system simulators to model biodegradation processes and quantify their impact on trapped hydrocarbon quality. However, all the existing approaches use a post-processing calculation, which is not fully satisfactory due to the complexity of processes occurring in the history of a petroleum system. For instance, mixing of biodegraded and fresh oil, as well as the impact of viscosity changes on migration, are poorly taken into account. Moreover, the character and evolution through time of the oil water contact, which is known to play a key role in the biodegradation scenario of a reservoir, are usually over-simplified.

Discussion

In our work, we integrate the biodegradation processes within a basin and petroleum system forward simulation. Based on a Darcy's migration simulator, we simulate the evolution through time of the hydrocarbon quantity, composition and viscosity (Figure 1). An innovative way to determine the intensity of microbial activity and the evolution of the oil water contact where biodegradation is confined has been used. Controlling factors of biodegradation processes integrated in the model are temperature, available space for microorganisms' activity, oil saturation and relative biodegradability of hydrocarbons compounds. The approach has been developed for compositional as well as black oil simulations.

Summary

This new approach has been applied on a real case and it appears that besides the residence time in the biodegradation temperature window, rate of reservoir infill and migration paths are key controlling factors of the biodegradation. Our results fit well the observed data and, compared to the usual post processing calculations, highlight the improvements brought by our fully coupled approach to the determination of oil quantity, viscosity and migration timing.

Selected References

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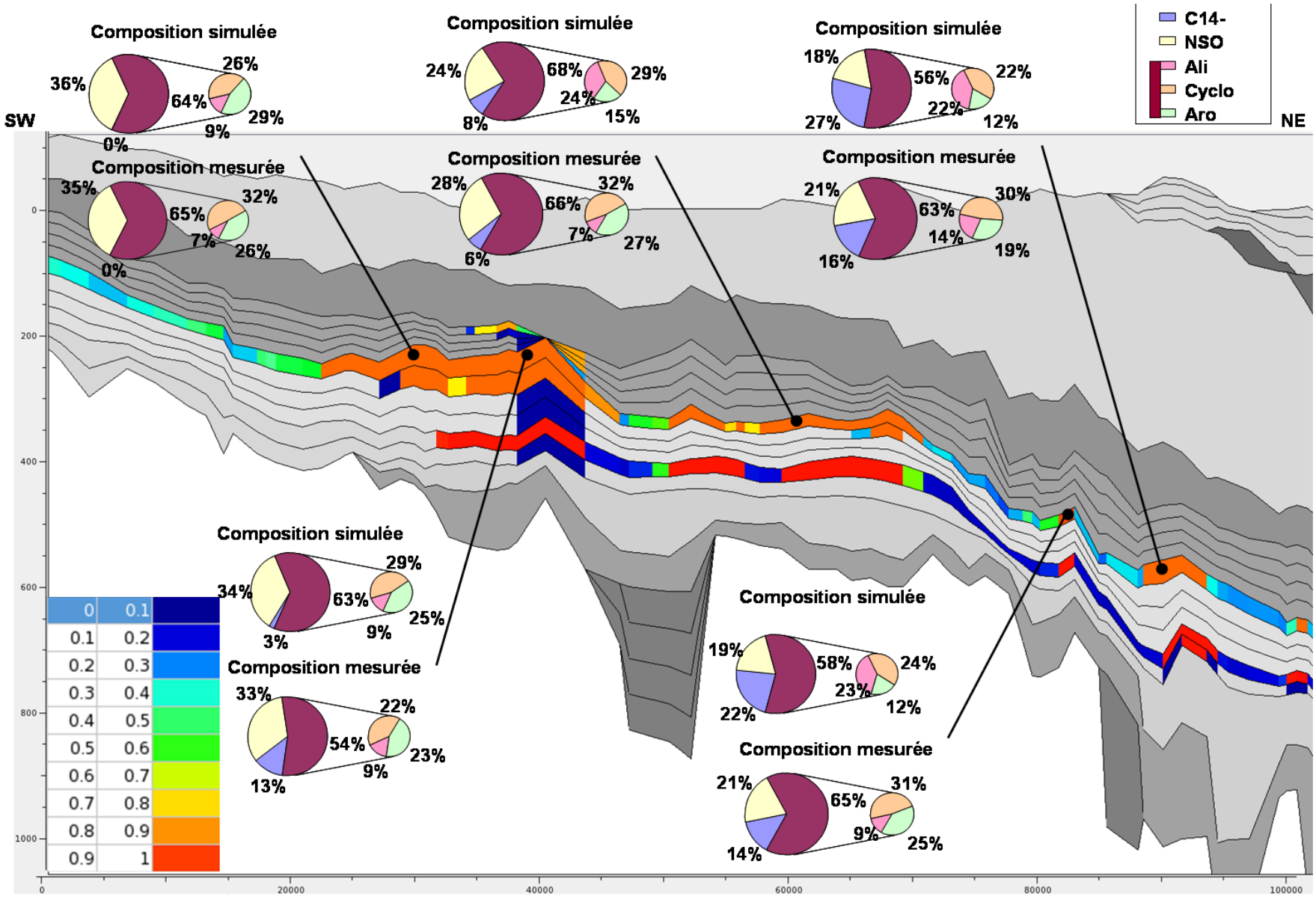

Figure 1. Hydrocarbon saturation and composition of biodegraded fields with comparison between measured and simulated compositions.