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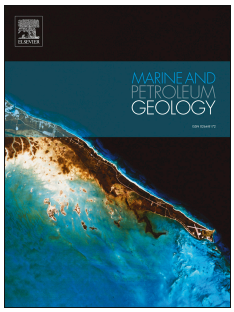

Some practical guidance for petroleum migration modeling

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Some Practical Guidance for Petroleum Migration Modeling

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Abstract

Petroleum migration modeling is widely used to assess petroleum charge and fluid phase risk in exploration and appraisal. There are three principal migration methods: Darcy flow, invasion percolation, and flowpath (or ray tracing). Each method relies on different assumptions and yields different outcomes. This paper analyzes the strengths and weaknesses of these methods as they are implemented in PetroMod®, providing a practical guide as to how and when to apply each migration method. Flowpath is the most simplistic and computationally fastest method and should only be applied when a quick screening is required. Invasion percolation delivers satisfactory results for most geological settings, from structurally and stratigraphically simple to complex, but does not consider expulsion from the source rock properly. Darcy flow is the preferred method for unconventional resource assessments and supports maximum downward migration. A traditional modeling approach is to use two methods, applying Darcy flow to tight rocks and flowpath to highly permeable rocks. Another combined method can be used in such a way that Darcy flow is applied to the source rock and invasion percolation to the carrier and reservoir beds. The latter seems to deliver best results in most geological settings, while also providing more realistic results of secondary migration losses.

Key word: Petroleum Geology; Petroleum; Basin Modeling; Migration; Darcy; Flowpath; Invasion Percolation

1 Introduction

Analyzing petroleum migration within the subsurface and through geological time is important for exploration and appraisal to understand petroleum charge availability, fluid phase and quality, and possible fluid changes across field compartments (**Peters et al., 2012**).

Different ways of analyzing petroleum migration can be applied to quantify the hydrocarbon charge and fluid risk. In simplest terms, a conceptual approach without modeling migration pathways can be applied, or a modeling based approach simulating migration pathways, or a mix of both. The conceptual approach may be able to deliver volumes and assess risk, but normally focuses on source rock maturity and timing of generation and expulsion relative to trap and seal development and may use standardized assumptions for expulsion efficiencies and migration losses. When performing migration modeling through time and space and when multiple geologic scenarios are assessed, the numerical migration method may needlessly skew results and interpretations. However, different migration methods usually lead to different results. Often the selection on the method is based on which matches best the observed present day petroleum accumulation data and this method is figured out iteratively. A significant limitation of our ability to model migration derives from our general inability to directly observe it in nature. For example, the density of occurrence of individual migration stringers at a basin