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Title **Integrated Study of a Fractured Middle East Reservoir with Stratiform Super-K Intervals - Part 2: Upscaling and Dual Media Simulation**
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Abstract

The paper describes the upscaling and reservoir simulation of a giant Middle East oilfield, whose geological modeling is described in a companion paper (1). The main objective of the study was the simulation of the irregular water advance observed in some parts of the field, as a consequence of peripheral water injection.

Three scales of heterogeneity were identified in the characterization phase, namely the matrix, the stratiform Super-K intervals and the fractures. To accommodate the different hydraulic properties of each heterogeneity system, a dual-media approach (dual porosity and dual permeability) was used.

The assignment of the effective properties to the simulation grids (matrix and fracture grids) was performed independently for the three heterogeneity systems. In particular, the geostatistical facies model was upscaled using algebraic methods, while the stratiform Super-K layers and fractures properties were explicitly reproduced at the simulation gridblock scale, through an original upscaling procedure.

The history match was achieved in a short time, by a small variation of the fractal dimension of the fracture distribution and without resorting to any local modification.

Simulation results showed that the fracture system was the controlling factor in terms of water advance and breakthrough, while the impact of the stratiform Super-K layers proved to be of second order.

In a later stage, the model was utilized to run production forecasts under different exploitation scenarios.

Conclusions of this study indicate that for such porous and fractured reservoirs with stratiform Super-K occurrences, a detailed characterization of all the heterogeneity systems, coupled with a dual-media formulation, are necessary requisites for accurate reservoir simulation and effective reservoir management.

Introduction

Heterogeneities are always present, to some degree, in natural petroleum reservoirs (2). Their impact can be very important in the overall dynamic behavior of the reservoirs, especially when secondary recovery project are active, e.g., water or gas injection.

In the Middle East area, many oil reservoirs are currently experiencing unexpected production performance, especially early water breakthrough, which started usually soon after the implementation of waterflooding projects. In most studies, such unexpected behavior is generically related to the presence of reservoir heterogeneity, in the form of some high permeability conduits which link the injector and the producer wells. Note that, while such simplified understanding can be sufficient for a history matching exercise, a much better description of the reservoir heterogeneity is required, in terms of type and distribution, when the simulation model is used in forecasting mode.

This project concentrated on the geological description, upscaling and numerical simulation of a giant Middle East carbonate reservoir, which experienced early water breakthrough in some parts of the field. Since it was felt that reservoir heterogeneity was the driving factor behind this unexpected behavior, most of the effort was devoted to the description and simulation of such heterogeneity.