AAPG International Conference
Barcelona, Spain
September 21-24, 2003

Mokhles Mezghani[1], Valerie Langlais[1], Mickaele Le Ravalec-Dupin[1], Frederic Roggero[1] (1) Institut Francais du Petrole, Rueil-Malmaison Cedex, France

Integration of Production and 4D Seismic Data for Improved Reservoir Characterization

This paper describes an integrated methodology, based on a non-linear optimization loop, for estimating three-dimensional reservoir parameters (porosity, permeability…) from both production data (bottom hole pressure, water cut, gas-oil ratio…) and pre-interpreted 4D seismic data (saturation cubes, impedance cubes…). This data should provide an improved reservoir characterization: production data are sensitive to porosity and permeability in the drainage area only, while 4D seismic data provide a good lateral characterization of fluid distribution. The proposed inversion methodology effectively integrates different data types into a consistent geological model that can be used for obtaining reliable production forecast and assessing risk management.

The main difficulty is to account for different scales in the proposed methodology: the geological scale (fine scale), the fluid flow simulation scale (coarse scale) and the seismic scale (intermediate scale). Several key issues are integrated within this methodology and will be presented in this paper, amongst them geostatistical modeling, up-scaling/down-scaling algorithms, fluid flow modeling (black-oil model), rock physics modeling (Gassmann model) and optimization algorithms.

Production and the 4D seismic data are computed from a multi-phase fluid flow simulation. A Gassmann rock physics model is used link the flow and the elastic properties. The reliability of the geological model is improved through the minimization of a weighted least-squares objective function, which includes both production and 4D seismic data. The gradual deformation parameterization, applied at the geological scale, is used to update the reservoir petrophysical properties. The fluid flow simulation, performed at the fluid flow simulation scale (geological model up-scaling), provides the simulated production results. The rock physics simulation, performed at the seismic scale, requires the down-scaling of the simulated saturation cubes.