Time-Lapse Resistivity Log Responses in Horizontal Wells, Namorado Reservoir, Albacora Field, Offshore Brazil.

The Upper Albian Namorado reservoir of Albacora field, offshore Brazil, is composed of sandstone turbidites with thin (20-30 cm) zones completely cemented by calcite. These internal reservoir heterogeneities interfere with fluid flow in the reservoir, resulting in non-economical oil productivity from conventional wells. Two horizontal wells were drilled to improve oil productivity in the Namorado reservoir. In both wells, resistivity log anomalies caused by polarization horn effects, are related to the presence of calcite-cemented zones. Polarization horns are spikes of resistivity tool response that occur on the layer boundaries in highly deviated and horizontal wells.

Time-lapse measurements from a logging while drilling (LWD) 2 MHz resistivity tool in a horizontal well filled with salt-saturated mud were used to study the evolution of polarization horns and electrical anisotropy as a function of invasion. A petrophysical model of the reservoir, based on well logs and cores in a vertical well, was constructed to simulate resistivity log responses in vertical and horizontal wells. For that purpose, the Coates free fluid and Archie equations were used to calculate resistivities from mini-permeameter, porosity and rock type data. A conceptual invasion model was applied in 1D and 3D tool-response modeling programs to understand the polarization horn effect. Results show that polarization horns develop at the boundary between high resistivity cemented layers and permeable reservoir sandstones after invasion by a conductive mud filtrate.

An integrated forward modeling program was used to simulate polarization horns along two horizontal well trajectories. The purpose of this work was to match observed and simulated log traces, thereby confirming the validity of the geologic and invasion models that were developed for the Namorado reservoir.