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Identifying and Predicting Mobile Water, Cerro Negro Block, Orinoco Heavy Oil Belt, Eastern Venezuela

Excessive water production is anticipated to be a production problem in the Orinoco heavy oil belt. Recognizing this, Operadora Cerro Negro has made efforts to understand, predict and avoid mobile water whilst developing the Cerro Negro block. A clear understanding of this issue is now emerging based on downhole data from vertical boreholes, special core analysis, and early production data.

Three sources of producible water are recognized: (1) a down-dip aquifer; (2) in-field perched water in structural lows in high-quality sands and (3) thin lower-quality water-productive oil-bearing sands. The lower-quality sands are dispersed throughout the block and can occur partially saturated with mobile water. Water sources 1 and 2 are readily identified in logs and maps. Identifying type 3, now referred to intuitively as "soggy rock," has required more detailed investigation.

In light oil reservoirs, mobile water is usually located in a transition zone, and can be modeled using capillary pressure and relative permeability functions. This approach is not appropriate in Cerro Negro because the original oil density has been altered, and the primary water saturation may have been overprinted, possibly by water charge from the surface and from consolidating shales. In Cerro Negro, the actual and immobile water saturation must be accounted for explicitly in the petrophysical interpretation. Actual saturation is calculated using conventional methods, whilst the immobile water saturation is determined using a correlation to bulk volume shale and fluid flow tests on core. Mobile water can then be calculated, subtracting immobile from actual water saturation.