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AN EXAMPLE OF CHARGE CONTROLS ON RESERVOIR-SCALE FLUID PROPERTY VARATIONS

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Urdaneta Oeste is a Shell operated field situated on the southwestern edge of Lake Maracaibo, Venezuela. The field has been in operation for a long period, with in-place volumes of ~13 Bln bblsof oil and ~2.2 TCF of gas. The hydrocarbons are accumulated in four main reservoirs, namely: Icotea, Misoa, Cogollo and the Rio Negro. The shallowest reservoirs (Icotea Fm. & Misoa Fm.) have been subject to varying degrees of biodegradation, however, there is little evidence to suggest that the deeper reservoirs (Rio Negro Fm. & Cogollo Grp.) have been altered. Production is complicated by the high asphaltene concentrations in these deeper reservoirs. Stankiewicz et al. (2001) documented the asphaltene issues in the Cogollo reservoir., and a preliminary review of how the solids deposition related to geochemical processes.

The objective of this investigation has been to evaluate the controls on fluid property variation within the Rio Negro reservoir. An Integrated Charge Evaluation (ICE) project, comprising both a detailed geochemical study of available reservoir fluid samples, and a sub-regional basin model focused on the field as a whole, has been bought together to deconvolve the charge history of this reservoir. Reservoir communication / compartmentalization, and how that relates to the charge process has also been addressed. The approaches used are examples of techniques commonly applied at Shell in exploration and field appraisal.

The Rio Negro reservoir is a relatively thin (20 – 60´), distal alluvial fan sequence, comprising sands with thin shaly intercalations. The top seal for this reservoir are carbonaceous shales and clays of the Apon Fm., deposited under marine/lagoonal conditions. Porosities and permeabilities are variable but generally low (6 - 15% and 10 – 3000 mD respectively) resulting in relatively low rates of production. In terms of bulk fluid properties: oil gravities range from 27° to 32° with gas oil ratios (GOR) of the order of ~300 to 400. Asphaltene contents range from 7.8 to 13%. However, the variance of bulk properties is not systematically distributed across the reservoir. Due to the low GOR and relative undersaturation of the Rio Negro, gas lift is employed to assist with fluid recovery. This places some constraints on the geochemical evaluation, as the process impacts composition of the light ends (e.g. C7s) and restricts gas analysis to limited data obtained from downhole MDT samples.

The source of hydrocarbons is conventionally attributed to the La Luna Fm. Typical source rock properties for the La Luna in the Maracaibo area are listed in Table 1, and these are the values used in the basin model. In addition the Aptian/Albian age Machiques Mbr. of the Apon Fm. has also been identified as an additional potential source rock in the vicinity (Perez-Infante, 1996). This source has also been included in the model, using the properties in Table 1. A 3-D basin model was run using Shell's proprietary 'Cauldron' software.

Source Rock	**Average TOC (%)**	**Average HI**	**Thickness (m)**
La Luna	10	553	65
Machiques	7	500	12

Table 1. Average source rock properties used in the basin model

Detailed geochemical analysis has been performed on fluid samples from 12 wells across the Rio Negro reservoir. The data acquired include complete basic oil characterization, as well as detailed molecular analysis on several different hydrocarbon fractions (i.e. gasoline fraction, adamantanes, whole oil GC, mid-range aromatics, saturate and aromatic GC-MS). CSIA has also been performed on selected species.

The results of the ICE study show that fluid properties in the Rio Negro are controlled by a complex charge history, with oils of varying maturity accumulating in the reservoir via separate charge entry points. The main phase of charge has been from the Miocene and continues to the present day. Faulting within the reservoir has helped preserve the observed variability resulting from the charge history by impairing fluid homogenization, and presenting clear evidence for compartmentalization.

REFERENCES

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