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PETROLEUM SYSTEM EVALUATION OF NORTHEASTERN MARACAIBO BASIN: INCOMES FROM 2D BASIN MODELING AND RISK ANALYSIS

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Located in northeastern Maracaibo Basin, the area known as Eastern Zulia illustrates the result of the collision of the Caribbean Plate and the South American Plate. Such interaction generates a transpression zone characterized by the presence of the Tigre – Pueblo Viejo and the Burro Negro – Mene Grande strike fault systems affecting the sedimentary pile during Cenozoic times. The major tectonic deformation revealed by the new interpretation of the region evidences the existence of thrusts and listric faults associated to a decollement level within the Upper Cretaceous, which seems to be affected by shale diapirs.

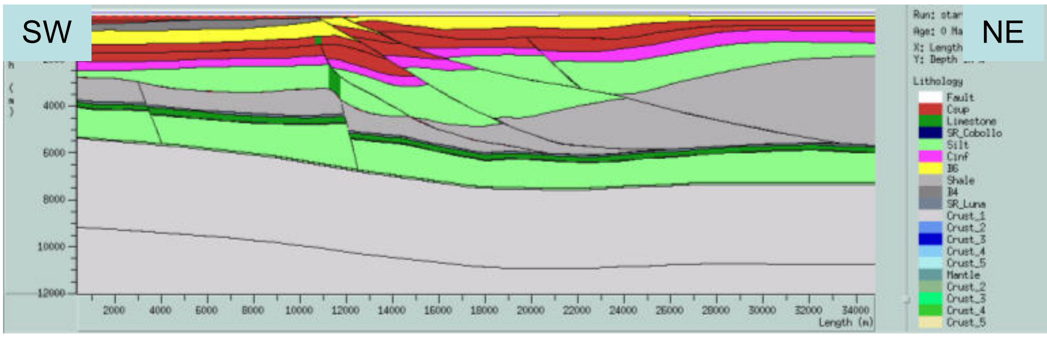

Figure 1: First modeled section. Within the structural framework, basement normal faults and thrust are deforming the Cretaceous – Pleistocene sedimentary pile.

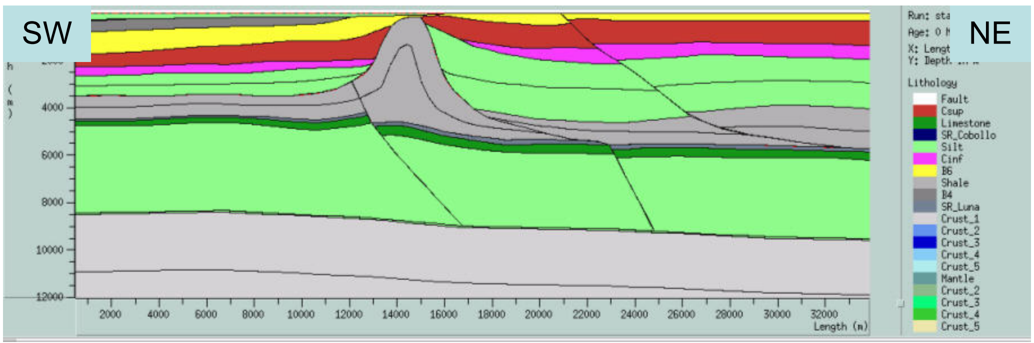

Figure 2: Second modeled section. Within the structural framework, shale diapir and listric faults are affecting the Tertiary sedimentary pile.

To analyse the petroleum system under the interpreted deformation state, two profiles are selected and restored determining the input data for the forward simulations (Figs. 1 and 2). The methodology for basin modeling in complex area is described in Schneider et al., 2002; Schneider 2003). Once the restoration and calibration processes is terminated, the modeling shows a progressive increment of the kerogen transformation ratio for the Cretaceous oil-prone source rock from east to west of the study area starting during the Paleocene and filling main Cretaceous and Tertiary reservoirs during the Paleogene period (Figs. 3 and 4).

Three phenomena are highlighted in the simulations: (1) the influence of basement normal faults, which facilitates the entrapment and migration of the hydrocarbons, (2) the presence of mud diapir phenomena linked to accumulation, erosion and biodegradation that are affecting the hydrocarbons during the diapir growth and (3) the influence of faults and seal permeability on the migration paths and on the pressure regime.

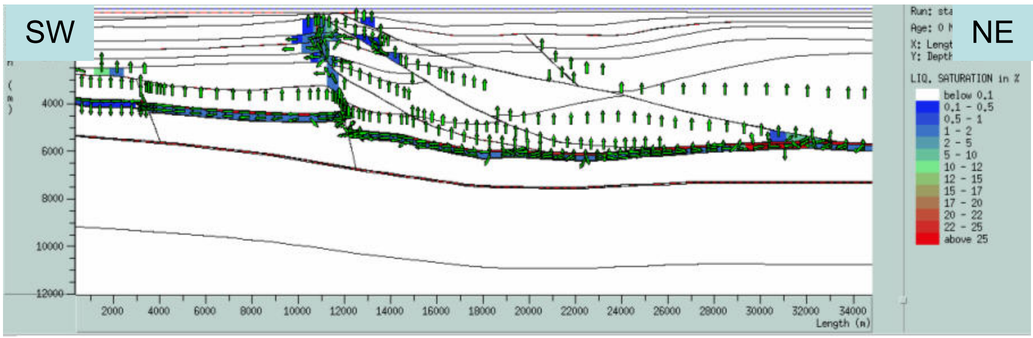

Figure 3: Final state for the first modeled section. Accumulations in the Tertiary reservoirs are associated to the presence of basement normal faults beneath them.

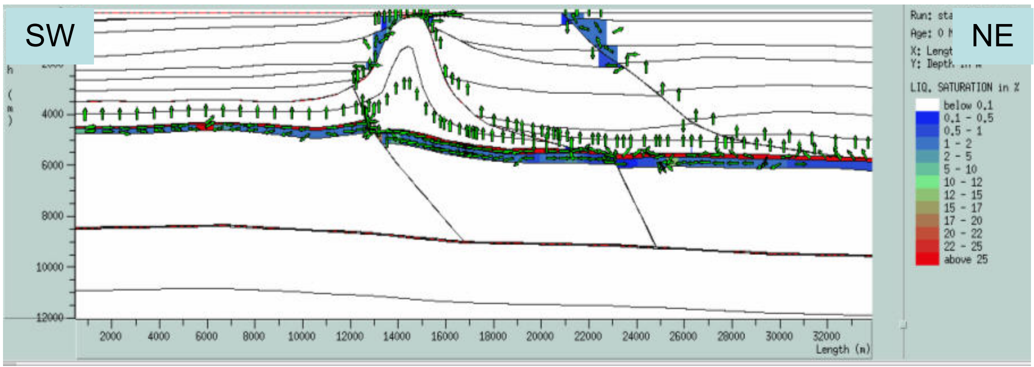

Figure 4: Final state for the second modeled section. Accumulations in the Tertiary reservoirs are associated to the development of shale intrusions. In this case the erosion and biodegradation may affect the more important accumulations superposed over the diapir.

Combining experimental design and response surface modeling techniques it is possible to quantify the major impact parameters according to their influence on the results (Wendebourg, 2003). The sensitivity analysis allows identifying that the permeability of the faults and the Total Organic Carbon (TOC) of the Cretaceous source rock are the parameters that mostly affect the existence and quality of the accumulations (Fig. 5). Furthermore, the risk analysis performed during this study allows evaluating that the range of probability is still wide.

And, even if the modeling allows estimates a favorable timing between maturation and accumulation, the sensitivity studies point out the necessity to clarify and characterize through geophysical and geochemistry techniques the input parameters in order to reduce the uncertainties on the results.

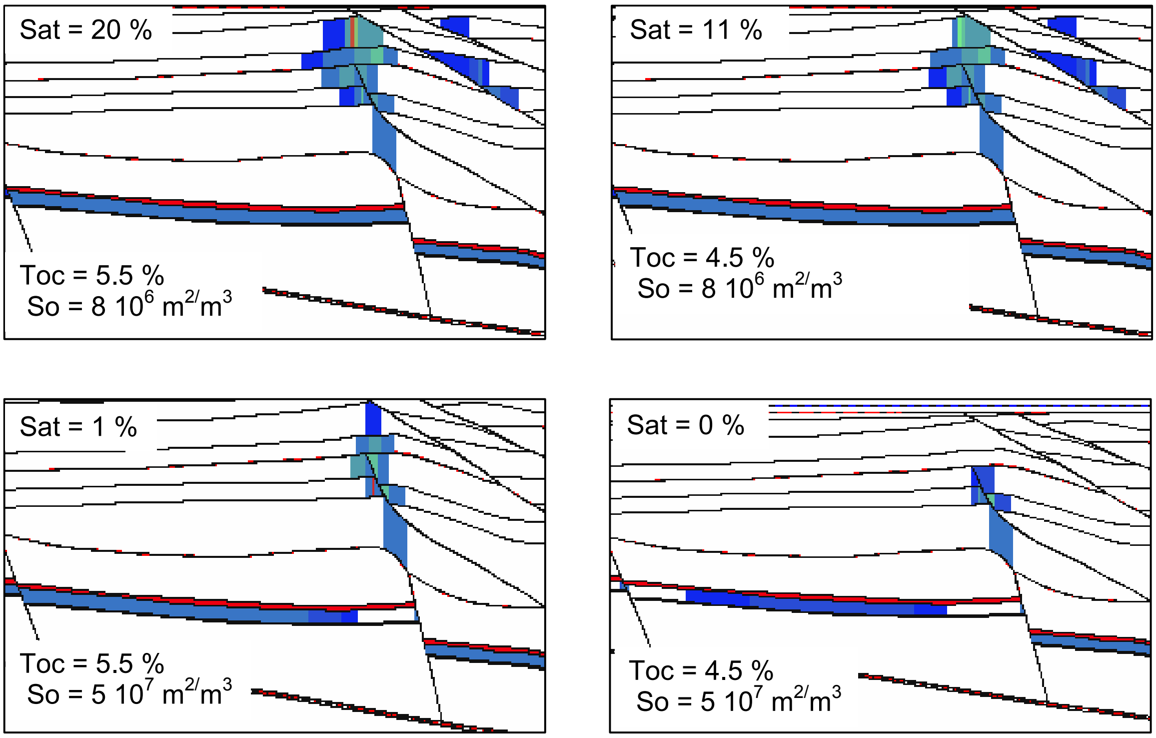

Figure 5: Influence in the saturation observed through the fault permeability and T.O.C variations.

References

Escalona, A., Mann, P., 2003. Three- dimensional architecture and evolution of the Eocene pull–apart basin, central Maracaibo basin, Venezuela. Marine and Petroleum Geology, Vol.20, pp.141 –161.

Gallango, O., Chien-a-Lien., Talukdar, S., Taheri, M., 1984. Estudio Geoquímico Regional de la Cuenca de Maracaibo. INT-00907,84. INTEVEP, S.A., Los Teques.

Gallango, O., Cassani, F., 1992. Biological marker maturity parameters of marine crude oils and rock estracts from Maracaibo basin, Venezuela. Organic Geochemistry. V 18. Nº 2, p. 215 - 224.

Lugo, J., Mann, P., 1995. Jurassic – Eocene Tectonic evolution of Maracaibo Basin, Venezuela. AAPG memoir 62, p. 699 – 725.

Parnaud, F., Gou, Y., Pascual, J.C., Capello, M.A., Truskowski, I., Passalacqua, H., 1995. Stratigraphic syntesis of western Venezuela. AAPG memoir 62, p. 681 – 698.

Schneider, F. 2003. Basin Modeling in Complex Area : Examples from Eastern Venezuelan and Canadian Foothills. Oil & Gas Science and Technology –Rev, IFP, Vol 58, N°2 p. 313 – 324.

Schneider, F., Devoitine, H., Faille, I., Flauraud, E., 2002. CERES 2D : A Numerical Prototype for HC Potencial Evaluation in Complex Area. Oil & Gas Science and Technology –Rev, IFP, Vol 57, N°6 p. 607 – 619.

Wendebourg, J., 2003. Uncertainty of Petroleum Generation Using Methods of Experimental Design and Response Surface Modeling: Application to the Gippsland Basin, Australia. Multidimentional Basin Modeling, AAPG/ Datapages Discovery Series, N° 7, p. 295 – 307.