Assessing Basins' Petroleum Systems rapidly with 1-D Pseudo-well Modelling

by Tiago Cunha

This technical note summarizes the main results from an article accepted for publication in the SEG-AAPG Interpretation Journal (Davison and Cunha, *in press*), where we used a relatively rapid 1-D pseudo-well modelling approach to assess the prospectivity of the Burgos Basin and Perdido Fold Belt, in the deep water Gulf of Mexico (Fig.1). The area has been successfully explored for oil, with a series of major light oil discoveries in both Mexico and the USA, and is recently being targeted by companies in the scope of the CNH-R01-L04/2015 Mexico deepwater Licensing Round.

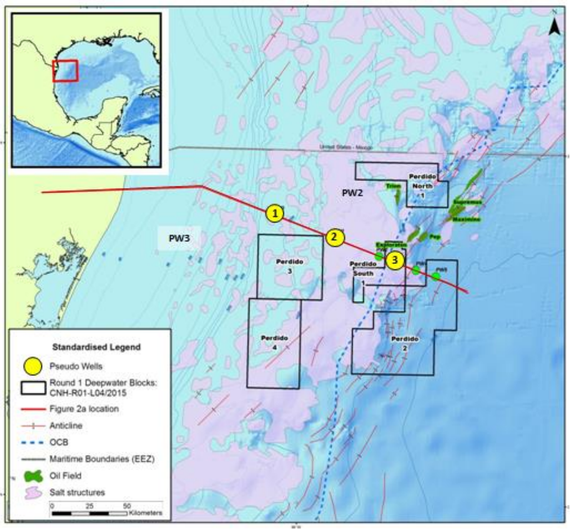

Figure 1: Map of the salt structures and discoveries in the Perdido Fold Belt and Burgos Basins and location of the cross section used for the thermal modelling (red line).

The basin formed through a sequence of rift pulses, in the Triassic and Early-Mid Jurassic, when most of the Callovian-age salt was deposited, overlain by Late Jurassic to Early Cretaceous shallow marine carbonates and thick Cenozoic detrital sequences. Tithonian source rocks (SR) are present in this northern offshore Mexican sector (Fig.2), probably with lateral kerogen facies variations between Type A and Type B (*sensu* Pepper and Corvi, 1995). Extensive salt extrusion began in mid to late Eocene times, probably triggered by the Laramide Orogeny (Alzaga-Ruiz *et al*., 2009), and continued until the Miocene through a series of pulses which can be timed from the ramps and flat geometry developed at the base of the salt. The deeper part of the Burgos Basin and Perdido FB was also intensely folded during the Oligocene-Miocene as a result of gravity gliding and toe compression. The folding has structured the widespread Eocene Wilcox sandstone reservoirs, which are imaged on the seismic data below the allochthonous salt sheets.

Despite the complex evolution of the area, the main events that control the heat flow history, and thus the maturity of the Tithonian SR, were successfully parameterized in a series of pseudo-wells (PWs) built along a seismic transect published by the Comision National de Hidrocarburos (CNH; http://www.gob.mx/cnh/). The PWs are located in the deep water Burgos Basin and Perdido FB and cover the lateral variability in the thickness of the allochthonous salt sheets and the nature of the underlying basement (continental *vs* oceanic crust; Fig.2). The main advantages of the 1-D pseudo-well modelling approach are that: (1) PW's can be built based on published seismic transects and regional knowledge of the tectonic evolution, the stratigraphy and lithologies, and the principal SR compositions; (2) 1-D modelling software is in general much cheaper than the 3-D packages, although they cannot be used to model migration and/or reservoir fluid properties; and (3) a large number of scenarios and/or model sensitivities can be tested within hours/days.

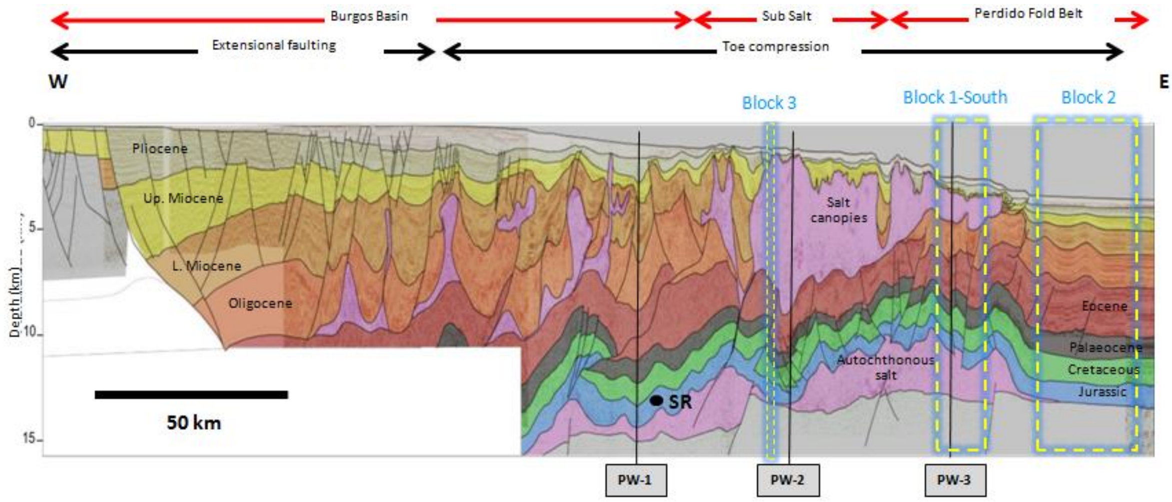

Figure 2: Cross section of the Perdido FB and Burgos basins with the location of the pseudo-wells and simplified stratigraphy. The yellow dashed lines delimit the blocks from the CNH Deepwater 2016 Round. The OCB is the approximate location of the ocean-continent boundary.

The PW modelling results show clearly how the massive salt extrusion cools the underlying basin and significantly prolongs the period of Tithonian source rock maturity, despite being buried to depths of ca.10 km sub-sea (Fig.3). In places several peaks of oil generation are predicted between the Paleocene and Present (e.g. PW-3), associated with the rapid emplacement of thick allochthonous sheets and subsequent thermal recovery. This has significant implications for the prospectivity of the basin, since most of the oil discoveries in the region are located in the frontal folds, which formed during the Oligocene-Miocene compression.

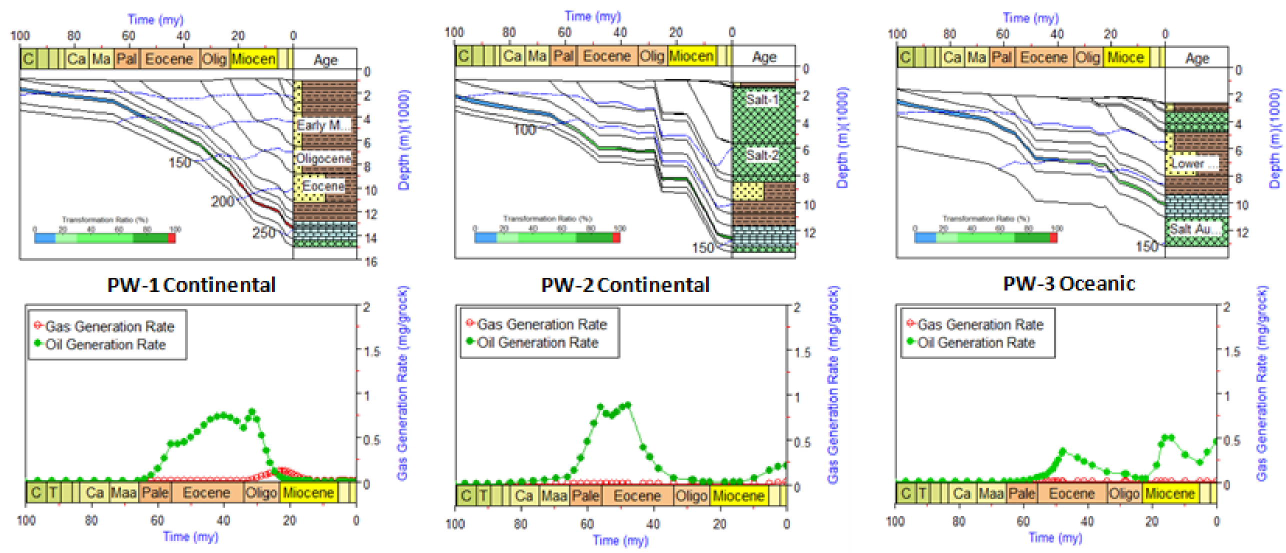

Figure 3: Summary of the 1-D modelling results for 3 pseudo-wells, showing: Top - Burial history with the transformation ratio of the Tithonian SR; Bottom – Oil and gas generation rates through time

Alzaga-Ruiz, H., M. Lopez, F. Roure, and M. Seranne, 2009. Interactions between the Laramide Foreland and the passive margin of the Gulf of Mexico: Tectonics and sedimentation in the Golden Lane area, Veracruz State, Mexico: Marine and Petroleum Geology, **26**, 951-973, doi: 10.1016/j.marpetgeo.2008.03.009.

Davison I. and T.A. Cunha (*in Press*). Allochthonous salt sheet growth: thermal implications for source rock maturation, deepwater Burgos Basin and Perdido Fold Belt, Mexico. SEG/AAPG Interpretation Journal.

Pepper, A. S. and P. J. Corvi, 1995. Simple kinetic models of petroleum formation. Part I: oil and gas generation from kerogen: Marine and Petroleum Geology, **12**, 291-319, doi: 10.1016/0264-8172(95)98381-E.