Introduction

Regional mapping of key petroleum system elements is an important step in the exploration workflow. Understanding the tectonic and sedimentation history across a basin is a vital element to identifying and high-grading prospects. Large areas of the Mexican Gulf of Mexico (MGoM) still remain undrilled. This combined with the vast structural variability across the offshore region, makes extrapolating a regional geological model from sparse calibration points and picking an appropriate analogue for a prospect difficult.

A regionally consistent sequence stratigraphic framework for the entire MGoM is critical to constraining fairways and de-risking prospects in each basin. It is now possible, for the first time, to complete such a study, through the provision of a consistent basin-wide modern seismic survey and access to a vast well database. Supplementing regional facies mapping and prospect delineation with key petroleum system parameters from analogues at the well level are important to understand the potential characteristics and performance of a prospect.

In this study focus will be given to demonstrating the variability between Cenozoic clastic depositional systems and associated reservoir parameters, that makes predicting and benchmarking reservoir characteristics difficult. Selected examples shown highlight the importance of integrating past-exploration results, both locally and regionally, together with a robust sequence stratigraphic framework to understand the key risks, evolution and variation of a reservoir system.

Method

The Cenozoic sequence stratigraphic framework presented forms part of a wider study from the Middle Jurassic to the present day across the MGoM. The analysis of 200 wells are integrated with 186,435 km of TGS’ 2D Gigante seismic data to provide a regionally consistent basin framework across each of the offshore basins (Figure 1).

Detailed interpretation of wireline, core and biostratigraphy, together with regional seismic interpretation has allowed the development of a sequence stratigraphic model. This includes detailed well-based lithological, gross depositional environment (GDE) and associated facies interpretations. Seismic data is used to correlate and extend the GDE maps away from the well control. The result is a reliable sequence stratigraphic framework and fairway maps across the entire MGoM.

Depositional environment and related facies distributions are a key control on reservoir quality and mapping provides a predictive method in exploration. For this paper the regional stratigraphic analysis is supplemented with results from TGS’ extensive post-drill analysis study, containing over 450 exploration and development wells drilled in MGoM. This study provides key petroleum system parameters including those to evaluate reservoirs (i.e. lithology and thickness, average porosity and permeability, net-to-gross, temperature, pressure, production test rates and hydrocarbon shows). These analogues are combined with the regional GDE mapping to identify, characterise and benchmark several reservoir targets across the offshore region.

Examples

Selected examples showing depositional and reservoir variability throughout the Cenozoic will be shown from Perdido, Mexican Ridges, Catemaco Fold Belt, Campeche and Salina Del Istmo regions of the MGoM.

Regional analysis of seismic and well data details the four known major stratigraphic depositional intervals in the Cenozoic:

1. The Paleocene-Middle Eocene is noted by a forced regression, resulting in several large submarine lowstand fan systems depositing the Wilcox and Whopper formations in US and Mexican Perdido Fold Belt.

2. The Oligocene in the Perdido region is characterised by sinuous submarine channel sandstones interbedded with claystones. The Oligocene is also targeted in the Catemaco Fold Belt, where
a northward-trending slope channel sandstone fairway is observed adjacent to the westward edge of the Campeche salt basin.

3. The Miocene in the Salina Del Istmo and Comalcalco area is dominated by fluctuations in relative sea level. In the Early Miocene, lowstand basin floor and slope-fan sandstones and claystones are dominant. By the Middle-Late Miocene, shoreface and channel sandstones are deposited in an active salt-influenced basin.

4. The Pliocene in the Salina Del Istmo region is characterised by the withdrawal of allochthonous salt canopies and large extensional counter-regional faults, forming a mini-basin architecture. Shoreface and channel sands are dominant.

![Figure 1 Map of MGoM showing seismic and wells used to generate sequence stratigraphic framework for the offshore region.](image)

From the evaluation of well data, it has also been observed that local variations in the composition of depositional facies could have an influence on net-to-gross assessment and overlooked reservoir potential in some areas. In the Catemaco Fold Belt, sandstones in some wells have a high gamma-ray response, compared to coeval reservoirs in nearby basins, due to the presence of feldspathic material.
and are confirmed by additional petrophysical analysis (Figure 2). This results in a higher reservoir net-to-gross calculation when compared to the original operator interpretation.

![Figure 2 Well log example from Catemaco Fold Belt showing original reservoir interpretation post-drill (Operator lithology interpretation - Track 2) and additional reservoir identified (Track 10) by integrating recent analysis undertaken using a petrophysical CPI.](image)

Through the integration of well and seismic analysis, the variation of deposition facies, which provide one of the primary controls on porosity in clastic reservoirs, have been identified across the MGoM. When reviewed together with reservoir data from analogues, the range of possible characteristics for a reservoir are critically assessed. This study will also present the variability in key reservoir parameters across major stratigraphic depositional intervals (Figure 3).
**Conclusions**

The variability of Cenozoic clastic depositional systems in the MGOM makes predicting and benchmarking reservoir characteristics difficult. A sequence stratigraphic approach is important to delineate reservoir fairways in order to high-grade prospects for further investigation. The use of a single analogue carries inherent risk and is insufficient to fully evaluate the range of possible outcomes when de-risking a prospect. Supplementing detailing mapping of key source, reservoir and seal fairways with past exploration results from post-drill analysis studies are important to fully understand a prospect and help to minimize risk in regional geological models.