

## CAMBRIDGE CARBONATES LTD MEXICO EXPERTISE

### INTRODUCTION

**Cambridge Carbonates Ltd** have considerable experience of working in Mexico and on Mexican subsurface data, having studied the area since the early 1990's. Our experience is primarily in the SE of Mexico (offshore and onshore) and Tampico-Misantla areas, looking at both Mesozoic and Cenozoic carbonate plays. We have presented at international conferences, and also published in the AAPG (Tectonic Sequence Stratigraphy of the Western Margin of the Gulf of Mexico in the Late Mesozoic and Cenozoic: Less Passive Than Previously Imagined', AAPG Memoir 79, 2003).

Our regional expertise enables us to offer bespoke services to clients, including reviews of existing plays, development of new play concepts, aiding seismic interpretation, core logging, petrographic and diagenetic services. For further information, please contact Andrew Horbury: [andy@cambridgecarbonates.co.uk](mailto:andy@cambridgecarbonates.co.uk)

### SURESTE REGION

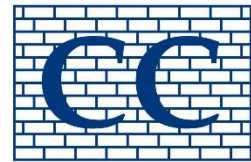
#### **Exploration/Regional Studies:**

**Marbella Sureste Regional:** Examination and logging of cores from key regional wells across SE Mexico, as input into a regional exploration project.

**Transform Zone:** Examination and logging of cores and logs from key regional wells along the transform fault zone (Cerro Nanchital-Malpasos trend), as input into a regional exploration project.

**Artesa-Mundo Nuevo Platform study:** Palaeogeographic mapping of the platform during the Cretaceous incorporating data from well logs, seismic and seismic facies, plus core logging

**Sureste Onshore Jurassic:** Definition of sequence stratigraphy and mapping of log facies by sequence through the Jurassic from key regional wells in the Sureste Basin (onshore). Calibrated by examination and logging of cores.



**Litoral de Tabasco Jurassic:** Definition of sequence stratigraphy and mapping of log facies by sequence through the Jurassic from key regional wells in the shallow offshore Litoral de Tabasco area, including the Sinan and Ayin discoveries. Calibrated by examination and logging of cores.

**Core logging, offshore: Cantarell area:** A selection of core from exploration wells, including Ek, Ixim, Nix, Sam, Takin-101 and Utan were described and their depositional environments interpreted.

### **Reservoir/Appraisal Studies:**

**Gaicho Study:** Development of reservoir model. Involved core logging, petrography, cathodoluminescence, fluid inclusion data, log facies analysis, seismic/seismic facies interpretation.

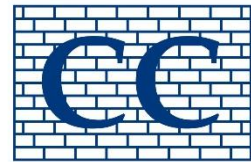
**Muspac Study:** Development of reservoir model. Involved core logging, log facies analysis.

**Saramako-1:** Well post-mortem to understand why Mesozoic objective failed. Involved core logging, well log analysis, and study of neighbouring wells, some seismic data.

**Jujo-Tecominoacan Jurassic:** Development of new field layering model based on sequence stratigraphic principles. Well log-based project calibrated by core control. Incorporated dynamic data from well tests and annual production information. Presented at the Geological Society of London 2000.

**Jacinto, Paredon, Tepeyil and Fenix Jurassic:** Development of field layering model based on sequence stratigraphic principles (follow-on from J-T project). Well log-based project calibrated by some core control.

**Juliva Project:** Primarily this was a study of the fractured Cretaceous carbonates of the Sen and Luna fields, and adjacent satellite structures. It involved identification of sequences and well correlation, some study of core, and development of fracture models that could be tied to production.



**Pokoch-Ichalkil Jurassic:** Development of reservoir model to assist in appraisal programme. Involved core logging, petrography, cathodoluminescence, fluid inclusion data, log facies analysis, seismic/seismic facies interpretation.

**Cantarell:** Evaluation of Cretaceous carbonate reservoirs of the Cantarell field. This involved sedimentological description of core, microfacies analysis and log-based sequence stratigraphic layering. Presented at Paris AAPG 2005.

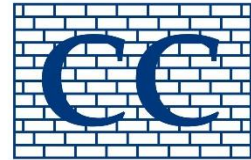
**Coban Evaporite Play:** Regional project covering Nazareth field in Chiapas and Guatemalen fields (Rubelsanto, Chinaja, Tierra Blanca) as part of an economic appraisal to reactivate the Guatemalan fields.

**Xux-May-Tsimin:** Sub-regional exploration/appraisal study of Jurassic dolomitised oolitic and Cretaceous basinal and resedimented carbonates using sedimentological, stratigraphic, diagenetic, petrophysical and seismic stratigraphic study. This involved core logging, microfacies analysis of thin sections and detailed sedimentological interpretation of FMI logs. The petrographical data was also used to condition petrophysical models. The results of this study were a high-resolution sequence stratigraphic correlation of the Kimmeridgian dolomite with the recognition of unconformity-bounded groups of sequences and combined seismic and petrophysical attributes to map distribution of ooid shoals. Also recognition of salt-associated structural development controlling of Cretaceous facies and stratigraphy.

**Complejo Bermudez:** Re-evaluation of conventional reservoir model of Jurassic dolomitised ooids and Cretaceous resedimented carbonates. Facies analysis carried out by core logging, microfacies and log correlation. Recognition of the interaction of carbonate sedimentation and salt movement. Identification of carbonate platforms formed over structural highs over transient salt structures. Salt movement is also responsible for uplift and karstification and brecciation of carbonate platforms in basinal areas. The results of this study were a new conceptual model for the interaction of salt movement and carbonate sedimentation and carbonate platform evolution.

# Cambridge Carbonates Ltd

*Expertise in carbonate and evaporite systems*



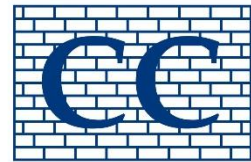
**Puerto Ceiba field:** Major re-evaluation of the conventional reservoir model of Jurassic and Cretaceous carbonates. This was based on examination and description of core, log correlation and sedimentological interpretation of FMI logs. This showed that conventional stratigraphic succession had been severely disrupted by the syn- and post-depositional effects of salt movement and with drawl. One of the results of this study was a recognition of the importance of the role of salt withdrawal as a major control on the stratigraphy and reservoir layering in basinal carbonates. New lithofacies were recognised including sheared mudrocks interpreted as salt withdrawal residues and detrital conglomerates comprising Kimmeridgian and Tithonian clasts interpreted as reworked insoluble residues emplaced on the sea floor by emergent salt bodies.

**Costero:** Evaluation of Jurassic and Cretaceous carbonate reservoirs involving existing core sedimentology, microfacies and log-based sequence stratigraphic layering. This involved log correlation and facies and isopach mapping using Petrel. The results of this study were a new sequence stratigraphic understanding of the layering of Kimmeridgian dolomitised oolitic reservoir and a refined understanding of the depositional model and layering of Cretaceous basinal and resedimented carbonates.

**Caliza Macuspana Coti/Tepetitan field:** Appraisal of gas field incorporating sedimentological and sequence stratigraphic information from newly cored wells. Review of existing core sedimentology, microfacies, log and seismic stratigraphic information to produce new reservoir layering of field.

**Sihil/Cantarell:** Evaluation of Jurassic and Cretaceous carbonate reservoirs of the Sihil block of the Cantarell field. This involved sedimentological description of core, microfacies analysis and log-based sequence stratigraphic layering. FMI logs were used to evaluation the late Cretaceous breccias.

**Giraldas/Iris field study:** Sedimentological study of core integrated with and seismic stratigraphy. This demonstrated the development of tower karst in Cretaceous platform carbonates onlapped by shallow water Cretaceous carbonates. Diagenetic study of platform carbonates based on fluid inclusions and cathodoluminescence allowed recognition of karstic diagenesis in crest of field.



## **Outcrop Studies:**

**Caliza Macuspana:** Sub-regional project to map sequences within the CM and develop facies models. Published.

## **TAMPICO-MISANTLA REGION**

### **Exploration/Regional Studies:**

**Offshore Tampico Regional Jurassic Study:** Study of regional exploration potential from well (log, core description and petrography) and seismic data, in the offshore area, from the Bejuco-La Laja canyon area up to Burgos, down to the 200m water depth contour. Also incorporated some coastal onshore data.

**Offshore Tampico Regional Cretaceous Study:** This comprises chalk-type plays with Tamaulipas Inferior reservoir, in both structural traps internally sealed within the Cretaceous, and stratigraphic buried hill-type plays beneath the Cretaceous-Miocene unconformity.

**Eastern Tuxpan Platform:** Reservoir characterisation evaluation of the Cretaceous and Jurassic carbonates in two major fields and adjacent wells.

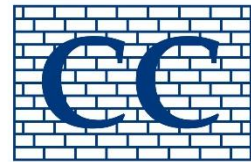
**Ebano-Pánuco Study:** Ongoing preparation of multiclient report on the origin and reservoir characteristics of these fractured basinal carbonate reservoirs.

**Middle Jurassic rift infill:** Study of the Tepexic and Huehetepec fms, and Early Jurassic synrift clastics of the El Tajin, Huyacocotla and Huizachil fms in the Poza Rica-Alamo area of the Tampico-Misantla basin.

**Kimmeridgian Oolite Bank Study:** Evaluation of Jurassic oolitic reservoir in the SW Tampico Misantla basin, to the west of the Tuxpan Platform. Identification and mapping of possible bank system in the San Andres Formation. Mostly seismic-well log based study incorporating some core logging.

**Tuxpan Platform Interior study:** Examination of deep wells (core, logs) within the onshore part of the Tuxpan Platform, with the objective of understanding its internal architecture and the possibility of developing new exploration plays.





**Marine Golden Lane study:** Sub-regional project involving examination of the 3D seismic expression of the eastern margin of the Tuxpan Platform. Calibration with deep-well stratigraphic data.

**Triton-Calipso study:** Study of the age and origin of the 'Tamabra' breccias to the east of the Tuxpan Platform. Core and cuttings study, with significant petrographic and some cathodoluminescence and fluid inclusion support. Published as an extended abstract in 2011.

**Puskon-1:** Seismic and seismic facies study pre-drill to link in with the Triton-Calipso study. Post-drill post-mortem study of cuttings petrography from the bottom-hole stratigraphy.

**Frente de Sierra Gas Project:** Study of fractured basinal carbonates (mostly Tamaulipas Formation) in the Sierra Madre Oriental to the west of the Tuxpan Platform. Mostly evaluation of old well data.

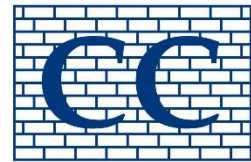
**Veracruz:** Brief overview of carbonate reservoirs in the thrust parts of the Cordoba Platform. Well data.

## **Reservoir/Appraisal Studies:**

**Tamaulipas-Constituciones field study:** Evaluation of the sequence architecture of Jurassic oolitic reservoir. The study involved development of high-resolution log-based sequence stratigraphic layering calibrated by core sedimentology.

**San Andres – Remolino-Hallazgo field study:** Evaluation of Jurassic oolitic reservoir to re-assess the potential for water injection after shut-in of field. Study involved development of high-resolution log-based sequence stratigraphic layering calibrated by core sedimentology.

**Paso Real Field study:** Compilation of data from original well reports (1920's), production data, a couple of modern wells with good log suites, and modern 3D seismic cube to define areas of possible step-out production.



**Atún Field study:** Compilation of petrophysical and production data from all wells to understand the reservoir properties of the karstic reservoir system. Attention was also given to the possibility of deeper reservoirs/traps existing.

**Poza Rica field study:** Examination of seismic and well data including core, of the western limits of the Poza Rica Field, with the objective of drilling further step-out production wells towards the SW. Presented in 2004 accompanied by an extended abstract.

**Arenque field study:** Full core study (1500m of core logged) of the field and adjacent regional control points. Petrographic study including cathodoluminescence project, fluid inclusion calibration. Later involvement with step-out production wells based on 3D seismic facies interpretation. Results of initial work published in 1996.

**San Andres field:** Evaluation of Jurassic oolitic reservoir to re-assess the potential for water injection after shut-in of field. Study involved development of high resolution log-based sequence stratigraphic layering calibrated by core sedimentology

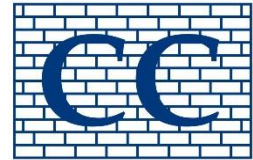
## **NORTE REGION**

### **Exploration/Regional Studies:**

**Aquila/Lamprea:** Study of very deepwater Mesozoic seismic facies to the east of Tampico and the Tuxpan Platform, with the objective of understanding how far to the east could Mesozoic carbonate plays be extended, over areas of stretched continental crust.

**Burgos Basin:** Review of published data for incorporation into IHS reports and 2003 AAPG publication.

**Perdido:** Study of younger Mesozoic seismic facies and tie-in to the Baha-1 well in the US, with the objective of understanding the possible extent of Upper Cretaceous clastic reservoir facies.



## **Reservoir/Appraisal Studies:**

**Lerma-Talisman:** Study of Kimmeridgian age gas fields particularly with respect to the impact of diagenesis (via cathodoluminescence) on reservoir geology, and problems of high H<sub>2</sub>S contents.

## **Single Well Studies: core logging and petrography**

**Higuera-1, Sabalo-1 and Corvina-1**

## **Outcrop Studies:**

**Sierra Madre Oriental Fieldwork:** Three-week reconnaissance fieldwork over the area of the Valles carbonate platform, its margins, and satellite mini-platform (Actopan), in the Huasteca area situated between the Sierra de El Abra and San Luís Potosi.

## **REGIONAL**

**Carbonate Database Project:** Data scouting and building an interactive database and intranet on a wide range of Mexican carbonate and clastic reservoirs, over a period of 1 to 1.5 years/person. Covering reservoir geology and petroleum engineering data.

**Carbonate Seismic Atlas Project:** Data scouting and building an interactive database and intranet on the seismic expression of Mexican carbonate and clastic reservoirs, over a period of 1 to 2 years/person. Covering reservoir geology and petroleum engineering data.

**Carbonate Reservoir Review:** Various compilations at different times for different clients summarizing country-wide characteristics of the principle reservoir types (or different play types based on reservoirs) including data derived from Pemex production figures and knowledge of reservoir types and their distribution. These have yielded data on productivities per well, productivity richness per sq km, by reservoir type, and allow a ranking of likely reservoir opportunities.

**Workshops:** Thematic workshops introducing the Petroleum Geology of Mexico, run for various clients, both in their offices and at the offices of Cambridge Carbonates Ltd. Clients include Statoil, Premier Oil, Ophir. Usually the introductory course runs for two days, one day for each of North and South Mexico.