

# Exploration Framework Atlas Series:

**Tectonic  
Analysis**

## Volume 4: Mexico and Gulf of Mexico (4<sup>th</sup> Edition)

by

**James Pindell  
Lorcan Kennan**

**Tectonic Analysis, Ltd**

**See also**

**Volume 1: Colombia**

**Volume 2: Venezuela-Trinidad**

**Volume 3: Central Andes**

**Volume 5: Trinidad since 12 Ma**

**<http://www.tectonicanalysis.com>**

**incorporating:**

**Gulf Coast of USA**

**East and South Mexico**

**Central America**

**Cuba and N. Caribbean**

**COPYRIGHT ©, 2006, Tectonic Analysis, Ltd.**



**CONTENTS:****PART A**

- A1 Preface, background to the project and contact details
- A2 Contents of this Atlas
- A3 Summary of principal conclusions

**PART B Context and Supporting Material**

- B1 Bathymetry of the northern and central Gulf, protraction areas, key wells and prospects, key geologic and tectonic features.
- B2 "NAMAD" magnetic map of North America showing approximate area of oceanic crust.
- B3 Smith and Sandwell 1-minute free-air gravity anomaly map.
- B4 DNAG Bouguer gravity anomaly map, key geologic and tectonic features.
- B5 Smoothed, shaded depth to basement map (various sources).
- B6 Total sediment thickness map.
- B7 Beta or crustal stretching factor map (assumes zero flexural strength).
- B8 Mexican basins and structures map based on the published maps of Mexico, showing key geologic, tectonic features derived from our model.
- B9 Timescale used for this project (compares 1996, 2004 absolute ages).
- B10 Timescale and seismic picks for Gulf seismic, showing revised reflector ages compared to published schemes, and showing sources of the data.
- B11 Stratigraphic chart for Texas and Mexico, NE Gulf of Mexico, showing revised ages, timescale, and key tectonic and stratigraphic events.
- B12 Legend for the paleotectonic maps.
- B13 Legend for the paleogeographic maps.
- B14 Notes on revised and new maps and figures.

**PART C Methodology and Major Themes**

- C1 Introduction and Outline of methodology;
  - 1) Restoring crustal blocks to their original shapes.
- C2 2) Equatorial Atlantic gravity and ocean crust age; reconstructions for 83 Ma and 110 Ma.
- C3 Equatorial Atlantic Reconstruction for 120 Ma (closure); Estimated rates of ocean crust formation; Implications of the model for early heatflow.
- C4 3) Reconstruction of Western Pangea; Permo-Triassic collapse of the Ouachita Orogen; Onset of intercontinental extension.
- C5 Two state model for Gulf of Mexico evolution. Stage 1: Late Triassic to Oxfordian rifting.
  - 1) Asymmetric rifting model and basin modelling; Model for geometry of rifting on the Florida Margin.
- C6 Setting up a forward model for asymmetric rifting. Features of the Yucatan margin, Mexico.
- C7 2) Discussion of Concept of "Continent-Ocean Boundary Zone"; Seismic example of "Continent-Ocean Boundary Zone"; "Salt-chasm" geometry as oceanic crust breaks through;
- C8 Outline of key Stage 1 rifting and sedimentation processes. Crustal type map, and relationships to salt;
- C9 Cretaceous stratigraphy supports the asymmetric rift model. Heatflow map, comparison with model predictions.
  - 3) Stage 1 rifting and sedimentation
- C10 4) Salt basin formation and cessation of salt-deposition Relationship to asymmetric rift model
  - 5) Maximum thickness of salt in the Gulf;
- C11 6) Relationship of salt to basement at its feather edge. "Forward backstrip model" and implications for basement depth.
  - 7) Basement fault styles around the margins of the deep Gulf.
- C12 Observed and theoretical structure of the Eastern Mexican margin.
  - 8) Stratigraphic cross-sections support other proposed Stage 1 structures.

- C13 Stage 2: Oxford.-Valang. Oceanic Spreading; Passive Margin Evolution;
  - 1) "Supra-salt plateau" concept, Oxfordian "salt chasm". Red Sea analogue for the Oxfordian Gulf of Mexico;
- C14 Extent of early salt-cored shelf and slope.
  - 2) History of collapse of the supra-salt plateau. Comparison with superficially-similar, but non-viable, published models.
- C15 Salt flow towards the deep Gulf and relation to Woodbine setting; Prediction of Baha, Jack Paleogene clastics and the Wilcox breakaway.
- C16 3) The problem of thick salt and crust type under the Sigsbee Canopy.
- C17 4) Implications of the salt collapse model for source rock distribution.
  - 5) New "elevator" model for maturation of perched Jurassic source rocks.
- C18 6) Predicted Late Jurassic-Cretaceous stratigraphic succession and deformations within the supra-salt plateau.
- C19 7) Six-stage cross-section model for the creation of the Gulf of Mexico rifted margin: Processes, Definitions, Perspectives, and Clarifications. Seaward dipping reflectors and detachment faulting offshore Florida.
- C20 Cross-section models for Gulf evolution prior to oceanic crust formation.
- C21 Cross-section models of oceanic crust emplacement, formation and subsequent collapse of the "salt-chasm".
  - Summary of Stage 1 and Stage 2 plate motions and structures. Map of Stage 1 migration of Yucatán and proposed flow lines.
- C22 Map of Stage 2 migration of Yucatán and proposed flow lines. Map and perspective views of ridge-transform fabric in the Gulf.
- C23 Heatflow models: implications of the asymmetric rifting model; Predictions of heatflow at end of Stage 1 rifting. Heatflow through time in areas of oceanic crust. Estimated heatflow at time of Tithonian source rock deposition.
- C24 Prediction heatflow history variations near and away from oceanic crust. Age and origin of the Challenger Reflector in the deep Gulf; The Chicxulub impact and circum-Gulf marginal collapse. Ties to seismic under the Sigsbee salt and through the Baha well.
- C25 Challenger tie line showing some age constraints and regional extent, and relationships of seismic reflectors in the deep Gulf of Mexico.

**PART D Descriptions of paleotectonic and paleogeographic maps**

- D1 1) Initiation of Stage 1 rifting, "COB" reconstruction 180 Ma;
  - 2) Early Stage 1 rifting, "Blake-Spur" reconstruction, 167 Ma.
- D2 3) Late Stage 1 rifting, Early salt basin, 161-162 Ma; Key issues relating to the salt basin.
- D3 More on salt, and its relationships.
- D4 4) "Salt fit" reconstruction, Middle Oxfordian, ca. 158 Ma. "Buried hills" concept; Oceanic ridge, transform structure;
  - 5) M25 Earliest Kimmeridgian, Early Stage 2 spreading, 154 Ma.
- D5 6) M21, Earliest Tithonian, 148 Ma, key source rock time;
- D6 7) M16, Late Berriasian, Ridge reorganizes in Gulf, 141 Ma.
- D7 8) M12, Late Valanginian, Ocean crust formation ends, 138 Ma;
- D7 9) M10, Mid-Hauterivian, Early passive margin; Reef trends, 133.5 Ma;
- D7 10) M0, Early Aptian, onset of Caribbean-related tectonism, 124 Ma.
- D8 11) Late Albian, Woodbine Event; Early salt tongues, 102 Ma;
- D8 12) A34, Earliest Campanian, Onset of Mexican orogeny, 83.5 Ma.
- D8 13) A31, Late Maastrichtian, Chicxulub impact & effects, 71 Ma;
- D9 Southern Mexico at 75 Ma; Migration of Chortis Block.
- D9 14) A25, Latest Paleocene, Central Mexican "Laramide" orogeny;
- D10 How the salt cored shelf-slope feeds deep water Wilcox sands. Southern Mexico at 55 Ma
- D10 15) A21, Middle Eocene, Peak S. Mexican "Laramide" orogenesis;
- D11 Southern Mexico at 42 Ma
- D11 16) A13, Earliest Oligocene, linked extension-compression, 33 Ma; Southern Mexico at 25 Ma;

- 17) A6, Early Miocene, Central Mexican extension, volcanism; Onset "Chiapanecan" orogenesis, 19 Ma.
- D12 Southern Mexico at 15 Ma
  - A5, Earliest Late Miocene, Younger salt tectonics, 10 Ma
  - Southern Mexico at 10 Ma
  - Southern Mexico at 2-5 Ma

**PART E Basin Genesis and events in the Mexican Basins**

- E1 1) Huayacocotla and Huizachal Basins;
  - 2) Sabinas and Parras Basins;
  - 3) Tampico-Misantla Basin.
- E2 4) Tuxpan Platform "Basin";
  - 5) Burgos Basin and Chiapas Foldbelt Basin.
- E3 6) Campeche and Salinas Basins.
- E4 7) Macuspana Basin and the Akal-Reforma "horst".
- E5 8) Comalcalco Basin;
- E5 9) Offshore Tuxpan Platform Basin.
- E6 8) Veracruz Basin.
- E7 9) Greater Yucatan Platform.

**PART F Regional scale paleotectonic maps**

Palinspastic paleotectonic maps showing structural, basin evolution:

- F1 Toarcian (180 Ma);
- F2 Earliest Bathonian (167 Ma);
- F3 Latest Callovian (ca. 161-162 Ma);
- F4 Middle Oxfordian (158 Ma);
- F5 Anomaly M25, Latest Oxfordian (154 Ma);
- F6 Anomaly M21, Latest Kimmeridgian (148 Ma);
- F7 Anomaly M16, Late Berriasian, (141 Ma);
- F8 Anomaly M12, Late Valanginian (138 Ma);
- F9 Anomaly M10, Mid-Hauterivian(133.5 Ma);
- F10 Anomaly M0, Early Aptian (124 Ma);
- F11 Late Albian (102 Ma);
- F12 Anomaly A34, Earliest Campanian (84 Ma);
- F13 Anomaly A32, Latest Campanian (71 Ma);
- F14 Anomaly A25, Latest Paleocene (57 Ma);
- F15 Anomaly A21, Middle Eocene (45 Ma);
- F16 Anomaly A13, Earliest Oligocene (33 Ma);
- F17 Anomaly A6, Early Miocene (19 Ma);
- F18 Anomaly A5, Late Miocene (10 Ma).

**PART G Regional scale paleogeographic maps**

In addition to the 18 tectonic maps, we provide 10 paleogeographic maps:

- G4 Earliest Oxfordian facies (158 Ma basemap);
- G5 Anomaly M25, Late Oxfordian facies (154 Ma basemap);
- G6 Anomaly M21, Kimmeridgian facies (148 Ma basemap);
- G7 Anomaly M16, Tithonian facies (141 Ma basemap);
- G8 Anomaly M12, Valanginian (pre-Hosston) facies (134 Ma basemap);
- G10 Anomaly M0, Aptian facies (124 Ma basemap);
- G11 Albian facies (102 Ma basemap);
- G12 Anomaly A34, Santonian facies (84 Ma basemap);
- G13 Anomaly A32, Campanian-Maastrichtian facies (71 Ma basemap);
- G14 Anomaly A25, Paleocene facies (57 Ma basemap).

**PART H Gulf-focus paleotectonic maps (18 Maps as in Part F)****PART I Gulf-focus paleogeographic maps (10 Maps as in Part G)****PART J Bibliography**

ALSO OPTIONAL GIS PACKAGE v.1.0.