



Tectonic Analysis Ltd,

Director: Dr. James Pindell,

Chestnut House, Burton Park, Duncton, West Sussex GU28 0LH, ENGLAND

Phone or Fax: 44-1798-343517 Email: info@tectonicanalysis.com Web: www.tectonicanalysis.com

Tectonic Analysis Ltd announces

THE HYDROCARBON GEOCHEMISTRY OF COLOMBIAN BASINS

This extensive and comprehensive examination and reinterpretation of Colombian geochemical data represents the state-of-the-art. Derived from our 1998 study “**The Colombian Hydrocarbon Habitat: Integrated Sedimentology, Geochemistry, Paleogeographic Evolution, Geodynamics, Petroleum Geology, and Basin Analysis**”, it covers all basins *except* Middle and Upper Magdalena (the geochemical systems of these 2 basins are quite well known and addressed in other studies). This report was produced by the careful integration, synthesis and systematisation of the majority of Ecopetrol's in-house reports and files on geochemistry. In addition we include additional introductory and summary material including outlines of proven and conjectured hydrocarbon systems.

The report comprises ca. 86,000 words of text (ca. 100 pages densely formatted) is extensively illustrated with 69 figures, including chromatograms, correlation diagrams and maps/cross-sections of key areas. All the data presented is also supplied in spreadsheet format (22 tables 1-2-3 or excel format) for integration with your own databases. The report is supplied on paper and CD-ROM (Adobe Acrobat pdf, other formats on request). Please contact us for pricing details.

CONTENTS

OVERVIEW

- 1.1. Purpose of this Report
 - 1.2. Controls on Hydrocarbon Occurrences Based on Interbasinal Paleogeographic Synthesis for Pre-Andean Times (Pre-Latest Oligocene)
 - 1.2.1. Hydrocarbon Evolution East of the CC-SM
 - 1.2.1.1. Source Facies
 - 1.2.1.2. Migration Paths East of the CC-SM
 - 1.2.2. Hydrocarbon Evolution West of the CC-SM
 - 1.2.2.1. Source Facies
 - 1.2.2.2. Migration Paths West of the CC-SM
 - 1.3. Controls on Hydrocarbon Occurrences Based on Interbasinal Paleogeographic Synthesis for Syn-Andean Times (Latest Oligocene to Holocene)
 - 1.3.1. Source Facies
 - 1.3.2. Andean Hydrocarbon Maturation and Migration
 - 1.4. Overview of Compositions of Colombian Oils
 - 1.4.1. Ranges of Compositions
 - 1.4.2. Biodegradation
 - 1.4.3. Implications for Petroleum Systems
 - 1.5. Characteristics of a Regional Paleogeographic Approach to Petroleum Geochemistry
- 2. PUTUMAYO BASIN**
- 2.1. Overview
 - 2.2. Known Occurrences of Hydrocarbons in the Putumayo Basin

- 2.3. Geochemistry of Putumayo Oils
 - 2.3.1. Three Putumayo Oil Families
 - 2.3.2. Biodegradation of Putumayo Oils
- 2.4. Putumayo Oil-to-Source Correlations
 - 2.4.1. Source of P1 Oils
 - 2.4.2. Source of P2 Oils
 - 2.4.3. Source of P3 Oils
- 2.5. Putumayo Source-Rock Quality
- 2.6. Thermal Maturity Considerations in Putumayo Basin
- 2.7. Timing of Oil Generation, Migration, and Biodegradation in Putumayo
 - 2.7.1. Inferences from Maturation Modeling of Putumayo Basin
 - 2.7.2. Implications of Carbon Dioxide in Putumayo Reservoirs
 - 2.7.3. Inferences from Biodegradation Window
- 2.8. Summary of Putumayo Petroleum Systems
- 2.9. Exploration Implications of Putumayo Geochemistry
 - 2.9.1. Exploration Risk in Oriente Basin Applied to Putumayo
 - 2.9.2. Prospect for Remigrated Oil

3. LOWER MAGDALENA VALLEY s.s. (EAST OF THE ROMERAL FAULT)

- 3.1. Overview
- 3.2. Known Occurrences of Hydrocarbons in LMV s.s.
- 3.3. Hydrocarbon Compositions
 - 3.3.1. Plato Subbasin
 - 3.3.1.1. Plato Subbasin Oil
 - 3.3.1.2. Plato Subbasin Gas
 - 3.3.2. San Jorge Subbasin
- 3.4. LMV s.s. Oil-to-Source Correlations
- 3.5. Source-Rock Quality in LMV s.s.
- 3.6. Thermal Maturity Considerations in LMV s.s.
 - 3.6.1. Results of Maturation Modeling
 - 3.6.2. Comparison of Models to Maturity Observations in LMV s.s.
- 3.7. Timing of Hydrocarbon Generation and Migration in LMV s.s.
- 3.8. Summary of LMV s.s. Hydrocarbon Systems
- 3.9. Exploration Implications of LMV s.s. Geochemistry

4. SINU AND SAN JACINTO BELTS

- 4.1. Overview of Sinú Basin sensu lato
- 4.2. Known Occurrences of Hydrocarbons in Sinú Basin sensu lato
- 4.3. Geochemistry of Hydrocarbons in the San Jacinto and Sinú Belts
 - 4.3.1. Three Oil Families in Sinú Basin sensu lato
 - 4.3.1.1. Jc1 Family
 - 4.3.1.2. Jc2+Si1 Family
 - 4.3.1.3. Compositions of Seeps
 - 4.3.1.3.1. Jc1 Seep
 - 4.3.1.3.2. Jc2+Si1 Seeps
 - 4.3.1.3.3. LM1 Seep
 - 4.3.1.3.4. Mixed Seeps?
 - 4.3.2. Biodegradation of San Jacinto Oil
- 4.4. San Jacinto/Sinú Oil-to-Source Correlations
 - 4.4.1. Upper Cretaceous Source for Jc1 Oils
 - 4.4.2. Source of Jc2+Si1 Oils: Lowermost Tertiary?
 - 4.4.3. Source of LM1: Oligo-Miocene Pro-delta Shales
 - 4.4.4. Source Rocks in Offshore Sinú

- 4.4.4.1. Evidence of Thermogenic Hydrocarbons in Offshore Sinú
- 4.4.4.2. Possible Sources of Thermogenic Hydrocarbons in Offshore Sinú
- 4.5. Source-Rock Quality in Sinú Basin sensu lato
- 4.6. Thermal Maturity Considerations in Sinú Basin sensu lato
- 4.6.1. Geological Constraints
- 4.6.2. Maturity Observations
- 4.7. Timing of Oil Generation, Migration, and Biodegradation in Sinú Basin
- 4.8. Summary of Sinú/San Jacinto Petroleum Systems
- 4.8.1. Source Rocks, Maturation, and Migration
- 4.8.2. Reservoir Adequacy
- 4.8.3. Trap and Seal
- 4.9. Exploration Implications of Sinú/San Jacinto Petroleum Systems

5. CAUCA-PATÍA BASIN

- 5.1. Overview of Cauca-Patía Basin
- 5.2. Known Occurrences of Hydrocarbons in Cauca-Patía Basin
- 5.3. Geochemistry of a Cauca-Patía Oil Seep
- 5.4. Cauca-Patía Oil-to-Source Correlations
- 5.5. Cauca-Patía Source-Rock Quality
- 5.6. Thermal Maturity Considerations in Cauca-Patía Basin
- 5.7. Timing of Oil Generation and Migration In Cauca-Patía Basin
- 5.8. Summary of Cauca-Patía Petroleum Systems
- 5.9. Exploration Implications of Cauca-Patía Geochemistry

6. NORTHWEST GUAJIRA BASIN

- 6.1. Overview
- 6.2. Known Occurrences of Hydrocarbons in Northwest Guajira
- 6.3. Geochemistry of Gas in Northwest Guajira
- 6.4. Gas-to-Source Correlations in Northwest Guajira
- 6.5. Source-Rock Quality in Northwest Guajira
- 6.6. Considerations of Thermal Maturity and Biogenic-Gas Window
- 6.6.1. Amaime Terrane and its Overlap Assemblage in Northwest Guajira
- 6.6.2. Footwall below the Amaime Terrane in Northwest Guajira
- 6.7. Timing of Oil Generation and Biogenesis of Gas in NW Guajira
- 6.7.1. Oil Generation in the Amaime Terrane
- 6.7.2. Biogenesis of Gas in the Tertiary Section
- 6.8. Summary of Petroleum Systems in Northwest Guajira
- 6.8.1. Source Rocks
- 6.8.2. Traps
- 6.8.2.1. Carbonate Build-ups
- 6.8.2.2. Subtle Truncation below an Upper Middle Miocene Sequence Boundary
- 6.8.2.3. Miocene Turbidites Stratigraphic Traps
- 6.8.3. Reservoirs and Carrier Beds
- 6.9. Exploration Implications for Northwest Guajira

7. LLANOS BASIN

- 7.1. Overview of Llanos
- 7.1.1. Major Occurrences of Hydrocarbons in Llanos Basin
- 7.1.2. Tectonostratigraphic Setting
- 7.1.3. Significant Geochemically-Related Exploration Questions
- 7.1.4. Geochemical Complexity
- 7.1.4.1. Points of Agreement in Previous Studies
- 7.1.4.2. Distinction between Endmembers Oils and Families of Oils

- 7.1.4.3. Our Nomenclature of Endmember Oils, Oil Families, and Mixtures of Oils
- 7.1.4.4. Why Should a Petroleum Geologist Care about Mixed Oils?
- 7.2. Our "Octahedral View" of Llanos Oil Geochemistry
 - 7.2.1. How to View the Octahedron
 - 7.2.2. Noteworthy Characteristics of Llanos Oils
- 7.3. Synopsis of Previous Studies
 - 7.3.1. Palmer and Russell (1988)
 - 7.3.1.1. Palmer and Russell's Nonbiodegraded Oils (Families 1 and 2)
 - 7.3.1.2. Palmer and Russell's Mixed Oils (Families 3, 4, and 5)
 - 7.3.1.3. Distinguishing Palmer and Russell's Family 4 from Families 3 and 5
 - 7.3.1.4. Distinguishing Palmer and Russell's Family 3 from Family 5
 - 7.3.1.5. Our Interpretation of Endmember Oils for Palmer and Russell's Families
 - 7.3.1.6. Palmer and Russell's Migration-Dependent Compositional Changes
 - 7.3.2. Western Atlas (1992)
 - 7.3.2.1. Western Atlas' Family 1 (Caño Limón-Type in Northern Llanos)
 - 7.3.2.2. Western Atlas' Family 2 (Caño Garza-Type in North Central Llanos)
 - 7.3.2.3. Western Atlas' Family 3 (Cravo Sur-Type in Southern Central Llanos)
 - 7.3.2.4. Western Atlas' Family 4 (Southern Central and Southern Llanos)
 - 7.3.2.5. "3&4" Mixtures (Southern Central and Southern Llanos)
 - 7.3.2.6. Our Inferences about Migration Pathways
 - 7.3.2.6.1. Migration Pathways of Families 1 and 2
 - 7.3.2.6.2. Migration Pathways of Families 3, 4, and 5
 - 7.3.2.7. Western Atlas's Timing of Migration
 - 7.3.2.8. Our Interpretation of Timing of Migration
 - 7.3.3. Drozd and Piggott (1994)
 - 7.3.3.1. Overview of Drozd and Piggott's Contribution
 - 7.3.3.2. Discussion of the DMH Controversy
 - 7.3.3.3. Additional Discussion of Drozd and Piggott (1994)
 - 7.3.4. Total (1995)
 - 7.3.4.1. Overview of Total's (1995) Contribution
 - 7.3.4.2. Aspects of Total's (1995) DMH Interpretation
 - 7.3.4.3. Lower Tertiary Has Excellent Source Potential
 - 7.3.4.4. "Middle" Cretaceous One Source and Jurassic "Lutitas de Macanal"
 - 7.3.4.5. Total's (1995) Dismissal of the Paleozoic 6.137
 - 7.3.5. ESRI-ECOPETROL (1994)
 - 7.3.5.1. ESRI-ECOPETROL's (1994) Four Llanos Oil Families
 - 7.3.5.2. ESRI-ECOPETROL's (1994) DMH Interpretation and Our Additions
 - 7.3.6. BEICIP-ECOPETROL (1995)
 - 7.3.7. CENPES-ECOPETROL (1996)
 - 7.3.7.1. Summary of their Major Conclusions
 - 7.3.7.2. Our Comments on CENPES-ECOPETROL's Interpretation
 - 7.3.8. Hernández, Hernández, Luna, and Martínez (1997)
 - 7.3.8.1. Summary of their Major Geochemical Conclusions
 - 7.3.8.2. Hernández et al. on Tertiary-Sourced Oils
- 7.4. Our Synthesis of Llanos Oil Geochemistry and Implications for Exploration

8 MATURATION AND EXPLORATION CHARACTERISTICS

- 8.1. Introduction
- 8.2. Regional Mechanisms And Timing Of Maturation
 - 8.2.1. The Early Paleogene (Middle Eocene) Maturation Map
 - 8.2.2. The Late Paleogene (Late Oligocene) Maturation Map
 - 8.2.3. The Middle Miocene Maturation Map
 - 8.2.4. The Present Maturation Map

- 8.3. Exploration Characteristics
- 8.3.1. Middle Magdalena Basin
- 8.3.2. Upper Magdalena Basin
- 8.3.3. Lower Magdalena Basin
- 8.3.4. Cesar-Rancheria Basin
- 8.3.5. Catatumbo Basin
- 8.3.6. Guajira Basin
- 8.3.8. Llanos Basin and Yavi Basin
- 8.3.8. Putumayo Basin
- 8.3.9. Paz del Río Basin
- 8.3.10. Cauca-Patia Basin
- 8.3.11. San Jacinto Belt
- 8.3.12. Sinú Belt
- 8.3.13. Pacifico Basins
- 8.3.14. Atrato (Choco Terrane)

9 SUMMARY OF MAIN CONCLUSIONS AND HYPOTHESES

- 9.1. Hydrocarbon Occurrence
- 9.2.1. Overview of Petroleum Systems of Colombia
- 9.2.2. Four Proven or Highly Likely Petroleum Systems
 - 9.2.2.1. Long-Distance Lateral Migration in Foreland Basins
 - 9.2.2.2. Vertical Migration in Tertiary Transtensional and Accretionary Settings
 - 9.2.2.3. Mixed Lateral and Vertical Migration in Thrust Belts
 - 9.2.2.4. Lateral Migration in the Caribbean Platform North of the Oca Fault
- 9.2.3. Three Conjectured Petroleum Systems
 - 9.2.3.1. Northward Lateral Migration of Solimes Basin Devonian Oils
 - 9.2.3.2. Vertical Migration within and from Paleozoic Grabens in Foreland Basins
 - 9.2.3.3. Vertical Migration From Remnants of Obducted Cretaceous Ophiolites

APPENDIX 1. A GEOCHEMICAL PRIMER

- A1.1. Overview of tools that are commonly used in geochemical studies
 - A. Analyses of source-rock facies
 - B. Indicators of source-rock maturity
 - C. Numerical modeling of oil and gas windows and of maturation/expulsion history
 - D. Study of oil and gas compositions to identify families of hydrocarbons
 - E. Correlation of oil to source-rock facies
- A1.2. Parameters commonly used for interpreting depositional environment of source rocks
 - A. Lacustrine (Type I) vs. Marine (Type II) vs. Nonmarine (nonlacustrine - Type III)
 - B. Carbonate (and/or source rocks from hypersaline environments) vs. shale
- A1.3. Tools commonly used for maturity of source rocks and hydrocarbons
 - A. The terms "oil window" and "gas window"
 - B. Visual methods
 - C. Pyrolysis
 - D. Chemical methods
 - E. Stable carbon isotopes
 - F. Biomarker maturity indices
 - G. Geologically-based numerical models and/or "rules of thumb" of maturation windows and maturation/migration history
- A1.4. Deasphalting and Evaporative Fractionation (separation-migration)
 - A. These processes cause in-reservoir changes in oil composition
 - B. Both processes require large amounts of gas and/or light hydrocarbons
- A1.5. Comments regarding biodegradation and water washing
 - A. Environmental constraints on biodegradation

- B. Changes to oil caused by biodegradation
- C. Water-washing
- A1.6. Secondary migration
 - A. Definition
 - B. Basic working concepts
 - C. Processes that can occur during long-distance lateral migration

APPENDIX 2. REFERENCES

LIST OF TABLES

- Table 1. Classification and distribution of oils in Putumayo basin.
- Table 2. Bulk composition and biomarkers of Putumayo oils.
- Table 3. Bulk composition and biomarkers of Putumayo source-rock extracts.
- Table 4. Bulk composition and biomarkers of all Putumayo source-rock extracts and oils having carbon-isotope measurements (extracted from Tables 2 and 3).
- Table 5. Source-rock quality and maturity factors of Caballos Formation from various wells in Putumayo basin.
- Table 6. Source-rock quality and maturity factors of Villeta Formation from various wells in Putumayo basin.
- Table 7. Vitrinite reflectance vs. depth from Putumayo basin wells Acaé-2 and Bagre W-1.
- Table 8. Bulk composition and biomarkers of Lower Magdalena Valley (*sensu lato*) oils.
- Table 9. Source-rock parameters of Ciénaga de Oro from various wells in Lower Magdalena Valley basin (from Beroiz et al., 1986).
- Table 10. Source-rock parameters of Porquero shale from various wells in Lower Magdalena Valley basin (from Beroiz et al., 1986).
- Table 11. Bulk and carbon-isotopic compositions of gases from the Lower Magdalena Valley (*sensu lato*) basin.
- Table 12. Depth gradients of vitrinite reflectance in various wells in Lower Magdalena Valley basin.
- Table 13. Summary of results of HOCOL (1993) and Martínez et al. (1994) maturation modeling (as modified in this TAI-ECP report) of the Lower Magdalena Valley (*sensu stricto*) basin.
- Table 14. Stratigraphic position of hydrocarbon shows in wells of Sinú offshore/onshore and of San Jacinto onshore (data from Alvarez and Delgado, 1993).
- Table 15. Bulk compositions and biomarkers of surface seeps of Sinú and San Jacinto belts.
- Table 16. Depth gradients of vitrinite reflectance in various wells in Sinú basin *sensu lato*.
- Table 17. Sandstone occurrences interpreted from electric logs over limited intervals in seven wells in the offshore Sinú basin.
- Table 18. Dry-hole analysis of 32 wells in Sinú basin *sensu lato*.
- Table 19. Simplified stratigraphic columns of the Patía and Cauca basins.
- Table 20. Production, tests, and shows in selected northwest Guajira exploration wells.
- Table 21. Depth gradients of vitrinite reflectance in various wells in northwest Guajira basin.
- Table 22. Past ventures analysis of selected northwest Guajira wells.

LIST OF FIGURES

- Figure 1. Compositional range of Colombian oils, on cross-plot of increasing carbonate/shale tendency vs. increasing marine/nonmarine tendency.
- Figure 2. Structure map on base of Cretaceous in Putumayo-Oriente basin with major oil fields highlighted.
- Figure 3. West-east cross-section in southern Putumayo basin.
- Figure 4. Type chromatograms/fragmentograms for TAI/ECP Putumayo oil families P1, P2, and P3.
- Figure 5. Diasterane/sterane vs. C29/C30 hopane of Putumayo oils.
- Figure 6. Diasterane/sterane vs. Ts/Tm of Putumayo oils.

- Figure 7. Ts/Tm vs. C35/C34 homohopane of Putumayo oils.
- Figure 8. C29/C30 hopane vs. C35/C34 extended hopane of Putumayo oils.
- Figure 9. C29/C30 hopane vs. phytane/C18 of Putumayo oils.
- Figure 10. Ts/Tm vs. pristane/phytane of Putumayo oils.
- Figure 11. DMH/C30 hopane vs. phytane/nC18 of Putumayo oils.
- Figure 12. DMH/C30 hopane vs. Ts/Tm of Putumayo oils.
- Figure 13. DMH/C30 hopane vs. C35/C34 extended hopane of Putumayo oils.
- Figure 14. Depth distribution of DMH/C30 hopane in Putumayo oils.
- Figure 15. Phytane/nC18 vs. pristane/nC17 in Putumayo oils.
- Figure 16. Depth distribution of pristane/nC17 in Putumayo oils.
- Figure 17. Depth distribution of phytane/nC18 in Putumayo oils.
- Figure 18. Type chromatogram/fragmentograms for source-rock extracts from Caballos, Villeta "T", Villeta "B" limestone, Villeta Lower "U", Villeta "A" limestone, and Villeta "N" shale.
- Figure 19. Diasterane/sterane vs. C29/C30 hopane of Putumayo extracts.
- Figure 20. Diasterane/sterane vs. Ts/Tm of Putumayo source-rock extracts.
- Figure 21. Ts/Tm vs. C35/C34 homohopane of Putumayo source-rock extracts.
- Figure 22. C29/C30 hopane vs. C35/C34 extended hopane of Putumayo source-rock extracts.
- Figure 23. C29/C30 hopane vs. phytane/C18 of Putumayo source-rock extracts.
- Figure 24. Ts/Tm vs. pristane/phytane of Putumayo source-rock extracts.
- Figure 25. DMH/C30 hopane vs. phytane/nC18 of Putumayo source-rock extracts.
- Figure 26. DMH/C30 hopane vs. Ts/Tm of Putumayo source-rock extracts.
- Figure 27. DMH/C30 hopane vs. C35/C34 extended hopane of Putumayo extracts.
- Figure 28. Stable carbon isotopes of Putumayo oils and source-rock extracts.
- Figure 29. Canonical variable vs. pristane/phytane of Putumayo oils and source-rock extracts.
- Figure 30. Gammacerane/C30 hopane vs. C35/C34 homohopane of Putumayo oils and source-rock extracts.
- Figure 31. Vitrinite reflectance vs. depth for Putumayo wells Acaé-2 and Bagre W-1.
- Figure 32. Structure map of Lower Magdalena Valley basin on top of basement.
- Figure 33. South-north cross-section of Lower Magdalena Valley basin from Puerta Negra-1 to Balsamo-2.
- Figure 34. Northwest-southeast cross-section of Plato subbasin from Balsamo-2 to El Dificil-1.
- Figure 35. Northwest-southeast cross-section of San Jorge subbasin from San Jorge-1 to Rincón-1.
- Figure 36. Stable carbon isotopes ($\delta^{13}C$ -aromatics vs. $\delta^{13}C$ -saturates) of Lower Magdalena Valley oils.
- Figure 37. Canonical variable vs. pristane/phytane of Lower Magdalena Valley oils.
- Figure 38. Diasterane/sterane vs. Ts/Tm of Lower Magdalena Valley oils.
- Figure 39. C29/C30 hopane vs. phytane/n-C18 alkane of Lower Magdalena Valley oils.
- Figure 40. C30-sterane/(C29+C30)-sterane vs. oleanane/C30-hopane of Lower Magdalena Valley oils.
- Figure 41. DMH/C30-hopane vs. phytane/n-C18 alkane of Lower Magdalena Valley oils.
- Figure 42. Phytane/n-C18 alkane vs. pristane/n-C17 alkane of Lower Magdalena Valley oils.
- Figure 43. Diasterane/sterane vs. C29/C30 hopane of Lower Magdalena Valley oils.
- Figure 44. Ts/Tm vs. pristane/phytane of Lower Magdalena Valley oils.
- Figure 45. DMH/C30 hopane vs. Ts/Tm of Lower Magdalena Valley oils.
- Figure 46. C29/C30 hopane vs. Ts/Tm of Lower Magdalena Valley oils.
- Figure 47. API gravity vs. sterane-based Ro-equivalent of Lower Magdalena Valley oils.
- Figure 48. API gravity vs. DMH/C30-hopane of Lower Magdalena Valley oils.
- Figure 49. API gravity depth-profile of Lower Magdalena Valley oils.
- Figure 50. DMH/C30 hopane vs. C29/C30 hopane of Lower Magdalena Valley oils.
- Figure 51. Gas "wetness" vs. $\delta^{13}C$ methane of Lower Magdalena Valley (s.l.) gases.
- Figure 52. Carbon isotopes of propane vs. ethane of Lower Magdalena Valley (s.l.) gases.
- Figure 53. Ethane/propane vs. "dryness" of Lower Magdalena Valley (s.l.) gases.
- Figure 54. Map of San Jacinto and Sinú belts. The structural map in the southern onshore area is from HOCOL's (1993) "near base Late Miocene" map; contour values are seismic two-way time (ms). The structural map in the offshore area is from Thrasher's (1994) Figure 2.7; the mapping horizon is not identified, but by cross-reference to Alvarez and Delgado's (1993, Anexo 2) cross-section, we infer that the contours are depth (in feet) to the top of their "syntectonic megasequence".

- Figure 55. Schematic cross-section of the Sinú and San Jacinto belts (from Alvarez and Delgado, 1993, their Anexo 2).
- Figure 56. Diasterane/sterane vs. C35/C34-hopane of Sinú and San Jacinto oil seeps.
- Figure 57. Diasterane/sterane vs. oleanane/C30-hopane of Sinú and San Jacinto oil seeps.
- Figure 58. Oleanane/C30-hopane vs. C35/C34-hopane of Sinú and San Jacinto oil seeps.
- Figure 59. Oleanane/C30-hopane vs. C27/C29-sterane of Sinú and San Jacinto oil seeps.
- Figure 60. Diasterane/sterane vs. C23-tricyclic terpane/C30-hopane of Sinú and San Jacinto oil seeps.
- Figure 61. C25/C34hopane vs. C23-tricyclic terpane/C30-hopane of Sinú and San Jacinto oil seeps.
- Figure 62. Oleanane/C30-hopane vs. C23-tricyclic terpane/C30-hopane of Sinú and San Jacinto oil seeps.
- Figure 63. C29-sterane maturities: 20S/(20S+20R) vs. $\beta\beta/(\beta\beta+)$ of Sinú and San Jacinto oil seeps.
- Figure 64. MBP (3-methyl biphenol/2-methyl biphenol) vs. $\beta\beta/(\beta\beta+)$ of Sinú and San Jacinto oil seeps.
- Figure 65. MBP (3-methyl biphenol/2-methyl biphenol) vs. C29 20S/(20S+20R) sterane of Sinú and San Jacinto oil seeps.
- Figure 66. MBP (3-methyl biphenol/2-methyl biphenol) vs. MDR (4-methyl dibenzothiophane/1-methyl dibenzothiophane) of Sinú and San Jacinto oil seeps.
- Figure 67. Phenanthrene maturities of Sinú and San Jacinto oil seeps: "M2"=[(3ME+2ME)/(9ME+1ME)] vs. "MP1"=[1.5 x (3ME+2ME)/(Phenanthrene+9ME+1ME)]
- Figure 68. Histograms of net sandstone thickness in seven wells of offshore Sinú basin. The data were picked from the electric logs that are reproduced by Wendt (1992 and analyzed in our Table 17). The crossplots are of total thickness of net sandstone logged vs. total thickness of sedimentary column logged for each of seven wells and for the combined results of the seven wells. Net sandstones are defined as those intervals with greater than 50% sandstone on Wendt's petrophysically-calculated lithologic logs. The green line in the composite crossplot is the calculated best-fitting linear regression (least squares) through the seven data points.
- Figure 69. Map of major tectonic elements in Guajira peninsula.