

FIRST HGS/EAGE CONFERENCE ON LATIN AMERICA



The Petroleum Geology of Offshore Honduras

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EAGE

ASSOCIATION OF GEOSCIENTISTS 8



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- Eocene Jamaica-Honduras
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- Onshore & offshore Mosquitia
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- Application to the Patuca basin



Disclaimer Some or all of what I am about to say may be true



Exploration History





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Eastern Honduras-general stratigraphy & basins





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The geology



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Strike-slip extensional tectonics



Adapted from Mann, Sanchez & Emmet 2015



Source and product oils of the Upper Nicaraguan Rise

We know that oil has been generated in north-eastern Honduras as it has reached the surface in:

Main Cape #1 ~100bbls+ to the surface – two pulses

La Pure oil seep onshore, lake Cococaratasca

Mosquitia #1 & Lempira #1 oil shows

Oil shows in several offshore wells (traces of bitumen which can be identified under florescent light) in the Cretaceous sections of several wells, ie not the younger Eocene derived oil

Suitable source rocks have also been encountered: ~ 770m of very rich source rock in the nearby Coca Marina #1 of Eocene age. This organic rich interval is encountered in many wells in adjacent Nicaragua and as far away as Jamaica – where it is called the Chapleton-Litchfield formation, ie it is regionally significant and robust

Cretaceous source rock e.g. the Guare fish beds, onshore NE Honduras. The shales have bituminous odour and are laminated

Elevated TOC & WLL responses at Upper Cretaceous levels in some wells

There are at least two regional Cretaceous source system due to periods of global anoxia

The Turonian is the source (Upper Cretaceous) for the oil in Maracaibo and southern Petén basin and elsewhere.

& Apto-Albian age Lower Cretaceous, northern Petén and elsewhere in the region

There are references to older source rocks, these references and occurrences have yet to be examined, but are not thought relevant to the Patuca and Mosquitia basins

The Patuca basin has not been drilled – The analysis and comparison of the recent satellite and seabed coring data, acquired by BG demonstrate that two oil families are present – the following set of slides & notes attempt to do the same



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Eocene: Punta Gorda, Coco Marina #1 well, Mosquitia basin

Rock Eval plot - removed

Punta Gorda. Honduras 5-10+%TOC, marly limestone

~770m of super rich source

Ref SERNAM data base, original Brown & Ruth, (now GeoMark Research), presented by JGI in Houston 2008 AAPG



Akna, Patuca basin, 5bbln STOOIP. One of several Miocene carbonate structures within the Patuca basin



Ref JGI 2008, SERNAM, CaribX Caribbean review/data base

- 770m of enhanced TOC, S2, HI, minor sulphur
- A prolific source seen in multiple wells in offshore Honduras and Nicaragua with a time equivalent in Jamaica 650m of Eocene source (Litchfield-Chapleton member)
- Whilst the Eocene appears to be less well developed on the flanks of the Patuca basin,
- based on CaribX seismic interpretation there are several hundred metres of presumed Tertiary section above the Cretaceous unconformity and below the Miocene reservoir interval that possesses a similar seismic character to the Eocene source section in the Mosquitia basin (also a Cretaceous source)



Jamaica to East coast Honduras



Rock Eval plot - removed

Punta Gorda. Honduras 5-10+%TOC, marly limestone

~770m of super rich source

Ref SERNAM data base, original Brown & Ruth, (now GeoMark Research), presented by JGI in Houston 2008 AAPG



Eocene oil, Main Cape #1, discovery, UNCOCAL 1974. Unequivocally linked to the Eocene, Punta Gorda (oil family 1)





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Eocene: Punta Gorda source rock – Mosquitia basin



Ref CaribX Caribbean review / data base 2009-2015

The Punta Gorda source rock appears to be best displayed within the Coco Marina #1 well, Mosquitia basin, there are several other significant penetrations in the Mosquitia basin and adjacent basins to the south



Cretaceous source rocks/oils – onshore NE Honduras



- Guare fish beds, bituminous odour
- Onshore oil seeps noted by BG in Cretaceous geology
- Buena Vista Oil Company: spent Cretaceous source rocks
- Oils shows in offshore Cretaceous well sections
- Cretaceous source rocks onshore Jamaica
- Cretaceous oils onshore/offshore Jamaica
- Possible Cretaceous derived hydrocarbons in Paraiso #1
- High TOC values in Venezuelan DSPD core holes









High TOC %, WLL data & seismic indications for source on the Turonian – Turquesa & Gracias a Dios wells



NW American plate & Cretaceous source rocks/oils – proto Honduras





Upper Cretaceous, Turquesa #1 TOC's up to 8.55% & barely in the oil window



as for Maracalbo? (see insert) Gracias a Dios in fact TD'ing the Turonian? NB BG have Gracias Dios TD'ing in Up Cret. Carbonates Punta Patuca-1 Resistivity & GR -Source? Mixed claystone, hard limestone, dense Dolomite, Upper Cretaceous – near TD No source rock data



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Shows and flows, on & offshore, Honduras

Mosquitia #1	Several sub-economic oil and gas shows drilled in 1963)						
Lempira #1	flowed oil to the surface (anecdotal, drilled in 1956)						
Main Cape #1	Oil to the surface and shows of oil and gas: DST #1 2808-2810 85bbls						
	DST #2 2753-2757, 2761 16bbls						
	DST #3 2711-2716 60bbls 38 API oil						
Berta #1	Calculated moveable hydrocarbons at 1391-1398 (log note)						
	Calculated moveable hydrocarbons at 1995-2010 (log note)						
Caribe #1	Bitumen coatings in lower Cretaceous Limestones (log note)						
Castilla #1	1160-1240m Ethane (log note)						
	3535-3560m dull yellow fluorescence, good streaming cut (log note). 11400ft to						
	11,700ft Dull fluorescence throughout						
Castana #1	8850ft fluorescence						
Coca Marina #1	1970-2025m Yellow-white fluorescence and cut (log note)						
	2400-2520m C4, straw yellow cut, flash cut (log note). High trip gas 2480-2860m						
Diamante #1	1510m & 1650-1690m pale straw yellow cut (log note)						
	4950ft Pale straw yellow cut						
	5400ft Straw yellow cut						
	1985-2025m C3 (log note)						
Banca Gorda #1	1050-1130m C4 and traces of dead oil (log note)						
	1370m increased mud fluorescence (log note)						
ODP1000	1322-1447m Enrichment of volatile hydrocarbons – believed						
	to be migratory rather than in situ (log note)						
Gorda Bank	3550m oil fluorescence, dead oil						
82 83	1 Illing illing and the						



Juego de muestras de Main Cape 1

Three DSTs, two oil types

Onshore

Omoa #1, gas shows Ceibela #1 oil & gas shows Ceibela #2 & 3 oil shows







Satellite data, multi-beam sonar, seabed cores and seismic caribx indicators of hydrocarbons, Patuca basin





- 198 stations, 201 piston cores 3440 samples, 36 "quality" heat flow measurements, 1127 head space, 214 Gore/AGI analysis, GC & GCMS analysis
- H₂S odour, gas expansion in 26 cores
- Both AGI (Gore) & CGG-Robertson-Geolabnor independently identified migrant/thermogenic hydrocarbons within and along the flanks of the Patuca basin
- Seep fauna/chemosynthetic communities recognised
- Butane present
- Oil, gas, condensate indicated in headspace gas data
- GC and GCMS data indicate oil



First class III AVO responses Near & Fars comparisons indicate hydrocarbons DHI

Satellite slicks

Multi-beam imagery – pock marks & gas plumes





Onshore NE Honduras – two oils



Offshore North East Honduras oils (2)



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PALAEOZOIC

SEVONAN PERCIS

0400-

CEMINIA

-

MESOZOIC CENOZOI

Main Cape-1 oil

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Main Cape & Maracaibo compared





Ref The biomarker guide



Caribbean petroleum systems, Sofer plot







Caribbean Petroleum Systems terpane plots



Based on average values for global petroleum systems built tough the analysis of terpane biomarkers from several thousand oils, GEOMARK'S OILS database (<u>www.RFDbase.com</u>) predictions regarding source rock lithology and depositional environment regardless of geologic age can be made. Oils collected from the region by CaribX have been analysed for the same biomarkers and data plotted against the global occurrences as described by GeoMark Research in various publications and data published by GeoMark for some of the classic oils / source rock end members in the region, namely the Upper Jurassic Smackover, Lower Cretaceous Sunniland and the Turonian La Luna and Eagleford oils.



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Summary 1, NE Honduras – Two source rocks

Correlation between optical and hydrocarbon maturity indicators



Evidence for two source rocks units: Upper Cretaceous and Eocene

Eocene, high terrestrial organic matter input marine-lacustrine

Cretaceous marine marl algal rich

The Cretaceous source being regional and the Eocene more discrete occupying the late Cenozoic basins and sub basins where it can be quite thick eg 770m in Cocoa Marina and ~560m in the Montpelier Trough, Jamaica

Differing maturities due the basin and horst geology



Patuca basin, seabed core data





The detail

1) Meth	yl Phenant	hrenes - so	lubleinwa	ater so an ui	nreliable r	atio				
Location	Р	3	2	9	1	2&3		MPI		
PC22-15	49061	2353	3719	2480	2070	11476.08	54794	0.21	immature	
PC35-03	62039	4047	5942	4142	3663	18879.21	71873.3	0.26	immature	
PC77-14	51659	5527	7883	4628	4880	25344.9	63639.08	0.4	early	
PC196-10	108663	7078	9199	5914	5199	30763.53	122665.4	0.25	immature	
PC202-14	43759	4236	6823	3897	3702	20901.51	53333.74	0.39	early	
PC204-10	44028	3596	4445	2913	2091	15197.49	50333.04	0.3	early	
2) Sterane isomerisation - measuring just background immature sterane isomerisation / swamped?										
	C29AAR	C29AAS	S/S+R							
PC22-15	232.9	31.7	0.12	immature						
PC35-03	507.3	51	0.09	immature						
PC77-14	2074.3	286.4	0.12	immature						
PC196-10	20219.1	2554.6	0.11	immature						
PC202-14	2706.9	257	0.09	immature						
PC204-10	5460.6	1206.7	0.18	immature						
3) Triaromatic steroidal hydrocarbon ratio - An indication of type of oil reaching the surface. Both light oil condensate and black oil appear to be present										
PC22-15	0.59	late								
PC35-03	0.63	late								
PC77-14	0.34	early								
PC196-10	nd									
PC202-14	0.52	late								
PC204-10	nd									



101 whole extracts where examined by gas chromatography

5 samples were analysed by gas chromatography-mass spectrometry

GC, GCMS and headspace gas data indicates two hydrocarbon signatures



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A comparison of world-class source rocks adapted from IGI for the Patuca basin



- Two petroleum systems active within the Patuca basin
- Hydrocarbons generated / being generated very late (additional) heating
- Eocene Type II/III marine source with a terrestrial input, mature in the deeper basins, best developed in the sub basins
- Upper Cretaceous Type II restricted marine, algal rich, carbonate-marl source, mature for oil and or condensate, regional
- Older sources such as earlier Cretaceous restricted marine and Jurassic sources are possible - but likely cooked
- Sufficient oil to charge prospects (∑15bbls STIOPP) in the Patuca basin

Geological setting- Middle to late Eocene







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